QUESTION PAPERS FOR END TERM THEORY EXAMINATIONS
November/ December-2023

M.Tech., MTPT, M.Sc., MBA, EMBA, M.Des.,
1st, 3rd & 5th SEMESTER

M.Sc.

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Ist SEMESTER
M.Sc
END SEMESTER EXAMINATION　　　　　　NOV/DEC-2023
MSBT101　BIOCHEMISTRY
Time: 3:00 hours　　　　　　　　　　　Max Marks: 40

> Note: Answer **FIVE** Questions. **Question No. 1 is compulsory.**
> Assume suitable missing data, if any:

Q1 Answer all the following questions　　　　　　**[12]**
[a] What makes water an ideal biologic solvent?　　**[2] [CO#1]**

[b] What is feedback inhibition in enzymes? Explain with Example?
　　　　　　　　　　　　　　　　　　[2] [CO#2]

[c] What are lipids and its types. Give one examples of each
　　　　　　　　　　　　　　　　　　[2] [CO#3]

[d] Why biomembrane described as amphipathic and　semi
　　permeable in nature?　　　　　　　　**[2] [CO#4]**

[e] How is Gibbs free energy related to the first and second
　　thermodynamics?　　　　　　　　　　**[2] [CO#5]**

[f] Which process of metabolism produces more ATP? How much
ATP production in glycolytic pathway and kreb cycle?
　　　　　　　　　　　　　　　　　　[2] [CO#5]

Q2 Answer all the following questions　　　　　　**[7]**

[a] Elaborate on the non covalent interactions in biological systems,
　　providing example to illustrates their importance?　**[3] [CO#1]**

[b] Name and briefly describe any three major types of bio molecules
　　and their importance in living cells?　　　**[4] [CO#1]**

Q3 Answer all the following questions　　　　　　**[7]**

[a] How are enzymes different from chemical catalyst? What are
　　apoenzyme and holoenzyme?　　　　　**[3] [CO#2]**

[b] What is the Michaelis-Menten model of enzyme action?　**[4] [CO#2]**

Q4 Answer all the following questions [7]

[a] What are glycolipids and its types? Explain animal sterol? [3] [CO#3]

[b] Explain polysaccharides with examples? [4] [CO#3]

Q5 Answer all the following questions [7]

[a] Explain Fluid Mosaic model for bio membrane? Difference between peripheral and integral proteins? [3] [CO#4]

[b] Explain the classification, structures and functions of nucleic acids? Describe briefly the phenomenon of central dogma? [4] [CO#4]

Q6 Answer all the following questions [7]

[a] Describe electron transport chain and oxidative phosphorylation? [3] [CO#5]

[b] Describe the process and role of the citric acid cycle in living organisms? [4] [CO#5]

Total no. of Pages:1   Roll no.............

Ist SEMESTER

M.Sc. Biotechnology

END TERM EXAMINATION   Nov/Dec-2023

MSBT103   Cell & Developmental Biology

Time: 03:00 Hours   Max. Marks: 50

Note : All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 Write short notes on any four of these: [10] [CO 1]

(i) Plasmodesmata
(ii) Phase contrast microscopy
(iii) Fluorescence microscopy
(iv) Structure of plasma membrane
(v) Chromatin organization

Q.2 Explain any TWO of the following briefly: [10] [CO 2]

(i) Mitochondrial DNA and male sterility
(ii) Structure and function of eukaryotic nucleus
(iii) Cell cycle and cell cycle check points

Q.3 Write short notes on any TWO: [10] [CO 3]

(i) Structural and functional significance of extracellular matrix in plants
and animals
(ii) Structure and function of microbodies
(iii) Actin binding proteins and their significance

Q.4 Explain any TWO of the following: [10] [CO 4]

(i) Homeotic gene effects in Drosophila
(ii) Cellular polarity
(iii) Differentiation of germ layers
(iv) Maternal and zygotic gene effects

Q.5 Describe in brief any TWO of the following: [10] [CO 5]

(i) "cells of the immune system"
(ii) Sex-determination in Drosophila
(iii) Differentiation of stem cells
(iv) Heterosis and apomixis

FIRST SEMESTER

M.Sc. [BT]

END SEMESTER EXAMINATION   *Nov-Dec-2023*

MSBT105 Molecular Biology

Time: 3.00 Hours

Max. Marks: 40

Note: All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 [A]   Answer <u>any TWO</u> of the following   [2+2 marks] [CO1]
(i)   What is hyperchromic effect? Explain various factors affecting T_m
(ii)   Discuss the correlation between $c_{ot_{1/2}}$ value and genome complexity. How is $c_{ot_{1/2}}$ value related to repetitiveness in DNA sequence?
(iii)   What do you understand by the term 'Nucleosome phasing'? Enumerate various factors affecting nucleosome positioning
[B]   Answer <u>any ONE</u> of the following   [4 marks] [CO1, CO3]
(i)   What is meant by genomic imprinting? What are the two types of imprinting control regions? Describe each in detail. Also explain two mechanisms involved in genome imprinting giving one example for each
(ii)   Discussing the structure of leader peptide of *trp* operon, explain the mechanism of attenuation. Also explain the significance of tryptophan levels in the control of *trp* operon both by TrpR and attenuation

Q.2 [A]   Answer <u>any TWO</u> of the following   [2+2 marks] [CO2]
(i)   In a flowsheet representation, describe various steps involved in prokaryotic DNA mismatch repair mechanism. Also mention the significance of methylation in the process
(ii)   Write a brief note on RecBCD enzyme involved in recombinational repair of double stranded breaks in DNA. Clearly explain its role before and after the recognition of *chi* site
(iii)   Describe the roles of 'DNA photolyase', 'UvrC' and 'LigD' in DNA repair mechanisms in prokaryotes. Clearly mention the repair mechanism in which each is involved

P.T.O.

[B] Discuss the structure of <u>any TWO</u> of the following in detail and correlate them with their functions **[2+2 marks] [CO3, CO4]**
(i) Prokaryotic standard promoter sequences
(ii) C-terminal domain (CTD tail) of RNA polymerase II
(iii) 5'-cap of eukaryotic mRNA

Q.3 [A] Answer <u>any TWO</u> of the following **[2+2 marks] [CO3]**
(i) Assign reasons for abortive initiations during prokaryotic transcription and explain each in brief
(ii) Discuss the significance of various topological structures and channels of bacterial RNA polymerase
(iii) Write short notes on <u>any TWO</u> of the following
   (a) Cro and cI repressors of bacteriophage λ
   (b) Chromatin remodellors and Histone acetyltransferase
   (c) Interactions of σ subunit of bacterial RNA polymerase with core enzyme and promoter sequences
   (d) Hammer-headed ribozyme
[B] Answer the following **[2+2 marks] [CO3]**
(i) Discuss the control of *lac* operon by LacR-Inducer mechanism. Clearly explain the structure of LacR and its binding to operator region(s) and inducer
(ii) How does RNA sequence lead to 'Intrinsic termination of prokaryotic transcription'? Give properties of such terminator sequences and the reason for termination

Q.4 [A] Answer <u>any TWO</u> of the following **[2+2 marks] [CO4]**
(i) Write in brief about <u>any TWO</u> of the following
   (a) Action of class I release factors in prokaryotic translation
   (b) 31 tRNAs are required to read 61 sense codons
   (c) Proteolysis of polyubiquitinated proteins in proteasome
   (d) Significance and details of cyclization and rearrangement steps of intein splicing
   (e) Targeting of secretory proteins to ER lumen
(ii) In the process of prokaryotic translation describe how are formylation and direct localization of initiator tRNA on the P site of ribosome achieved. Explain the significance of formylation

P.T.O.

(iii) Explain the acquisition of hybrid states during translocation step of prokaryotic translation
[B] Specify the functions of <u>any TWO</u> of the following proteins in post-transcriptional processing of RNA. Write in brief about the processes and specific steps in which each is involved
(i) Splicing endonuclease
(ii) C/D box snoRNA
(iii) Uracil rich snRNPs
(iv) Cytidine deaminase

Q.5 [A] Answer the following **[2+2 marks] [CO4, CO5]**
(i) How is p53 stabilized under stressful conditions and triggers cell cycle arrest or apoptosis. Explain various routes to it
(ii) Write two points of differences between <u>any TWO</u> of the following
   (a) Missense mutation and Nonsense mutation
   (b) Autonomous transposon and Non-autonomous transposon
   (c) Conservative transposition and Replicative transposition
   (d) DnaJ and DnaK
[B] Answer <u>any ONE</u> of the following **[4 marks] [CO5]**
(i) What are protooncogenes? Assign reasons for their conversion into oncogenes? Also explain their role in causing chronic myelogenous leukemia
(ii) Retinoblastoma protein plays role in G1 → S phase transition in proliferating cell. Give a flowsheet representation to explain this in detail. Clearly explain the significance of cyclins and CdKs in its regulation

END

Total no. of Pages:2   Roll no..............

ODD SEMESTER

M.Sc. BIOTECHNOLOGY

END TERM EXAMINATION   *Nov/Dec-2023*

COURSE CODE: MSBT107

COURSE TITLE: ANALYTICAL TECHNIQUES

Time: 03:00 Hours   *Max. Marks: 40*

Note: Answer ALL questions. All questions carry equal marks. Assume suitable missing data, if any.

1. Answer all of the following questions:

    [a] Explain briefly the principle and applications of Circular Dichroism Spectroscopy in biochemistry.   [3][CO 1]

    [b] What do you understand by chemical shift, integration, and splitting of peaks in an NMR Spectrum?   [3][CO 1]

    [c] Describe how pulsed field gel electrophoresis is performed to separate large DNA fragments.   [2][CO 2]

2. Answer all of the following questions:

    [a] How can Size Exclusion Chromatography separate proteins from a mixture?   [2][CO 2]

    [b] What is the criterion behind choice of matrix while performing Ion Exchange Chromatography? Give an example each of an anion and a cation exchanger.   [2][CO 2]

    [c] Explain the process of density gradient centrifugation for separation of biological particles in detail.   [4][CO 3]

1

19)

3. Attempt any **TWO** questions out of the following:

[a] How can you determine the relative molecular mass of a particle using Sedimentation Velocity method? [4][CO 3]

[b] A protein is subjected to ultracentrifugation at a rotor speed of 60000 rpm at 20 °C. Calculate its relative molecular mass if: $D = 4 \times 10^{-11}$ m²/s, $\bar{v} = 0.734 \times 10^{-3}$ m³/kg, ρ of water at 20 °C is 998 kg/m³, R = 8.314 J/K/mol, 0 °C = 273 K, s = 7.75×10^{-13} s [4][CO 3]

[c] What is Radiation Dosimetry and why is it important? What is the Absorbed dose and Equivalent dose? [4][CO 4]

4. Answer all of the following questions:

[a] Explain the principle, instrumentation and working of a solid and liquid Scintillation counter for detection of radioactivity. [2][CO 4]

[b] Explain how ionising radiation emanating from within a material can be used for imaging. [2][CO 4]

[c] Why is MALDI-TOF suitable for the analysis of biomolecules such as DNA and proteins? Explain how this technique is utilized for characterising proteins. [4][CO 5]

5. Attempt any **TWO** of the following questions:

[a] Describe in detail how an oligonucleotide chain can be built by solid phase synthesis method. [4][CO 5]

[b] Explain how X rays can be used for determining 3D structure of a protein. Describe a process for obtaining protein crystals for elucidation of its structure. [4][CO 5]

[c] How can enzyme immobilization be achieved by the method of entrapment and cross-linking? Mention 2 industrial applications of immobilized enzymes/cells. [4][CO 5]

2

Critical values of the t distribution

df	Two-tailed test $\alpha=0.10$	$\alpha=0.05$	$\alpha=0.01$	One-tailed test $\alpha=0.10$	$\alpha=0.05$	$\alpha=0.01$
1	6.314	12.706	63.657	3.078	6.314	31.821
2	2.920	4.303	9.925	1.886	2.920	6.965
3	2.353	3.182	5.841	1.638	2.353	4.541
4	2.132	2.776	4.604	1.533	2.132	3.747
5	2.015	2.571	4.032	1.476	2.015	3.365
6	1.943	2.447	3.707	1.440	1.943	3.143
7	1.895	2.365	3.499	1.415	1.895	2.998
8	1.860	2.306	3.355	1.397	1.860	2.806
9	1.833	2.262	3.250	1.383	1.833	2.821
10	1.812	2.228	3.169	1.372	1.812	2.764
11	1.796	2.201	3.106	1.363	1.796	2.718
12	1.782	2.179	3.055	1.356	1.782	2.681
13	1.771	2.160	3.012	1.350	1.771	2.650
14	1.761	2.145	2.977	1.345	1.761	2.624
15	1.753	2.131	2.947	1.341	1.753	2.602
16	1.746	2.120	2.921	1.337	1.746	2.583
17	1.740	2.110	2.898	1.333	1.740	2.567
18	1.734	2.101	2.878	1.330	1.734	2.552
19	1.729	2.093	2.861	1.328	1.729	2.539
20	1.725	2.086	2.845	1.325	1.725	2.528
21	1.721	2.080	2.831	1.323	1.721	2.518
22	1.717	2.074	2.819	1.321	1.717	2.508
23	1.714	2.069	2.807	1.319	1.714	2.500
24	1.711	2.064	2.797	1.318	1.711	2.492
25	1.708	2.060	2.787	1.316	1.708	2.485
26	1.706	2.056	2.779	1.315	1.706	2.479
27	1.703	2.052	2.771	1.314	1.703	2.473
28	1.701	2.048	2.763	1.313	1.701	2.467
29	1.699	2.045	2.756	1.311	1.699	2.462
30	1.697	2.042	2.750	1.310	1.697	2.457
40	1.684	2.021	2.704	1.303	1.684	2.423
60	1.671	2.000	2.660	1.296	1.671	2.390
120	1.658	1.980	2.617	1.289	1.658	2.358
∞	1.645	1.960	2.576	1.282	1.645	2.326

α denotes the level of significance and df the number of degrees of freedom.

MSBT-109 BIOSTATISTICS AND COMPUTER APPLICATIONS

Time: 03:00 Hours   Max. Marks: 50

Note: Answer SIX questions. Question one is compulsory.
Use calculator (if required). Assume suitable missing data, if any.

1. Define any ten of the following terms   [1x10 marks]
   a. Conditional Probability   [CO1]
   b. Sampling error   [CO1]
   c. Exclusive class interval   [CO1]
   d. Threading   [CO5]
   e. Hypothesis testing   [CO1]
   f. Correlation coefficient   [CO1]
   g. Primary Key   [CO2]
   h. Composite Attribute   [CO2]
   i. Primary databases   [CO2]
   j. BLAST   [CO2]
   k. Agglomerative Clustering   [CO3]
   l. Bragg's Law   [CO4]
   m. Docking   [CO5]

2. Answer all the following questions
   a. The following assay results (percentage of label claim) were observed in 50 random samples during a production run.
   102, 100, 96, 99, 101, 102, 100, 105, 97, 100, 92, 103, 101, 100, 99, 102, 96, 100, 101, 98, 107, 95, 98, 100, 100, 99, 97, 104, 101, 103, 98,

101, 100, 105, 99, 101, 102, 100, 87, 98, 101, 103, 93, 99, 101, 97, 100, 102, 99, 104.
Tabulate the data and report results as a stemplot. [3 marks][CO1]

b. Systolic blood pressure of 9 normal individuals was taken. Then a known hypotensive drug was given and blood pressure was again recorded. Did the hypotensive drug lowers the systolic blood pressure?
Data: Blood pressure of nine healthy volunteers before and after injection of hypotensive drug. [5 marks][CO1]

BP Before (X_1)	122	121	120	115	126	130	120	125	128
BP After (X_2)	120	118	115	110	122	130	116	124	125

3. Answer all the following questions
a. List four significant differences between a File-Processing System and a DBMS. [3 marks] [CO2]

b. Define an ER diagram, elucidating its core elements and the array of symbols employed for its depiction. [5 marks] [CO2]

4. Answer all the following questions
a. Explain any three types of clustering method and its significance. [3marks] [CO3]
b. what is the resulting dendrogram after performing single linkage HAC? Show your result by drawing a dendogram. [5 marks] [CO3].

	A	B	C	D
A	0			
B	2	0		
C	6	3	0	
D	8	7	4	0

5. Answer all the following questions
a. Provide a concise overview of X-ray crystallography, including its fundamental principles and the instrumentation utilized in the process? [3 marks] [CO4]

b. Explain the concept of gene expression and outline the significant steps involved in utilizing microarray technology for gene expression analysis. [5 marks] [CO4]

6. Answer all the following questions
a. What are three computational approaches commonly employed for protein three-dimensional structural modeling and prediction? [3 marks] [CO5]
b. Illustrate the sequential steps involved in homology modelling. [5 marks] [CO5]

7. Answer all the following questions
a. What is the probability of drawing a queen from a stack of cards containing all the hearts from a single deck? [3 marks] [CO1]

b. What are the key stages in hypothesis testing, and what are the various types of errors that can occur during the hypothesis testing process? [5 marks] [CO1]

THIRD SEMESTER

M.Sc. [MSBT]

END SEMESTER EXAMINATION   NOV/DEC-2023

MSBT 201 Bioprocess Engineering & Technology

Time: 3:00 Hours   Max. Marks: 40

Note: ALL questions carry equal marks.
Assume suitable missing data, if any.

Q.1 (a) Explain Monod Kinetics. How the rate at which the C source is metabolized can influence the formation of biomass and production of primary or secondary metabolites.   [2+2=4] [CO1 +CO2]

(b) Define the term Nabla factor. Calculate the sterilization time period for the bacteria whose specific death rate at 121°C was found to be 1.62 min^{-1}, if del factor for heating, cooling and overall are respectively 10, 9, 29.2?   [1+3=4] [CO1]

Q.2 (a) What is Chemostat. Explain the difference between fluidized and packed bed reactor along with diagram.   [1+3=4] [CO2]

OR

Discuss the bioprocess parameters involved in measurement and control of a bioreactor.   [4] [CO2]

[b] Chemostat volume 10 L contains 50 g/L substrate as a feed flowing with flow rate of 50 mL/min. Microbial system follows Monod model with μ_m= 0.8 h^{-1}, Ks = 80 mg/L, Yx/s= 0.3 g cell mass/g substrate. Calculate values of outlet biomass and substrate concentration.   [4] [CO2]

Q.3 (a) Explain the working of rotary vacuum filter press. Write the factors which affects the rate of filtration.   [3+1=4] [CO3]

Or

In a fermentation process producing baker's yeast, the biomass is separated using a continuous centrifuge, operating at 4000 rpm, with a feed rate of 80 l/min. The solid particles may be assumed to have an average diameter of 0.05 mm. The density of the biomass is 1010 kg/m³. The fluid may be assumed to have properties of water. Find the sigma factor for the centrifuge. [4] [CO3]

(b) Elaborate the different methods of cell disruption. [4] [CO3]

Q.4 (a) What is HFCS. Discuss the production and purification of microbial enzyme [1+3=4] [CO4]

(b) Explain how fermentation is a method of preparing and preserving food. [4] [CO4]

Q.5 (a) Explain the difference between internal and external mass transfer resistance in immobilized enzyme system. Explain the process of counter current solvent extraction. [2+2=4] [CO5+CO3]

(b) Derive an equation for Michaelis Menten kinetics. How K_m and V_{max} changes in Uncompetitive Inhibition [3+1=4] [CO5]

THIRD SEMESTER

M.Sc.

END TERM EXAMINATION

Nov-2023

MSBT 203   IMMUNOTECHNOLOGY & MOLECULAR VIROLOGY

Time: 03:00 Hours   *Max. Marks: 50*

Note: All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 Explain all of the following: [2 X 5 = 10]

a). Haptens   [CO 1]

b). ELISPOT assay   [CO 2]

c). Wiscott Aldrich Syndrome   [CO 3]

d). Role of Cro gene in bacteriophage   [CO 4]

e). Microarray   [CO 5]

Q.2 Attempt any Two questions out of the following

a). Define the principle of immunization and explain its significance in public health.
[5] [CO 1]

b). Enumerate the different classes of immunoglobulins and their respective functions.   [5] [CO 1]

c). Explain the fundamental principles of Western blotting and the purpose it serves in molecular biology research.   [5] [CO 2]

Q.3 Attempt any Two questions out of the following

a). Explain the role of the transducer in a biosensor and compare and contrast optical, electrochemical, and piezoelectric transducers in biosensor applications.
[5] [CO2]

b). Discuss the principle of different vaccines development. Highlight the unique advantages and challenges associated with each vaccine platform. [5] [CO 3]

c). Investigate the mechanisms by which autoantibodies contribute to autoimmune pathology. Provide examples of autoimmune diseases where autoantibodies play a prominent role. [5] [CO 3]

Q4. Attempt any Two questions out of the following

a). Define induced pluripotent stem cells (iPSCs) and explain how they are generated from differentiated cells. Provide examples of how iPSCs have been used to cure diseases. [5] [CO 3]

b). Discuss the economic impact of plant viruses on agriculture. Provide examples of plant viruses that have significant effects on crop yields and describe the measures taken to control their spread. [5] [CO 4]

c). A phage stock is diluted in the following manner: 0.1 mL of the phage is diluted into 9.9 mL of dilution buffer (total volume of 10 mL). From the first dilution, 0.1 mL is withdrawn and diluted into a second tube containing 9.9 ml of dilution buffer. From the second dilution, 1 mL is withdrawn and added to 9.0 ml in a third tube. Finally, 0.1 mL is withdrawn from the third tube and placed on lawn of bacterial cells. After incubating the plate overnight, 180 plagues are counted. What is the titer of the phage stock? [5] [CO 4]

Q.5 Attempt any Two questions out of the following

a). Explain the role of the transcriptional switch in determining whether a bacteriophage enters the lytic or lysogenic cycle. What are the key molecular events involved in this decision? [5] [CO4]

b). Explain the principles behind electron microscopy. Compare the wavelength of electrons to the visible light, and how does this impact the resolution of electron microscopes? [5] [CO 5]

b). Describe the mechanisms of post-transcriptional gene silencing, including the roles of microRNAs (miRNAs) and small interfering RNAs (siRNAs). How do these molecules contribute to the downregulation of target genes [5] [CO 5]

Total no. of Pages: 1

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3rd SEMESTER

M.SC.

END TERM EXAMINATION

2023

COURSE CODE MSBT205

COURSE TITLE IPR & Biosafety

Time: 03:00 Hours

Max. Marks: 50

Note: All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 Define the term biosafety. Explain all the biosafety levels and biosafety cabinets along with significance of Cartagena Protocol on biosafety. [10]

Q.2 What are GMO's and LMO's? Explain their applications in food and agricultural sector? [10]

Q.3 What is bio risk assessment and biohazards? Explain the relation of risk groups to biosafety levels and their classification according to infective microorganisms. [10]

Q.4 What is patent infringement? Explain the process of patent grant and consequences for infringement of patent in India. [10]

Q.4 Explain briefly about the following: [10]

(a) Budapest Treaty

(b) History of patents

(c) Patent & economic growth

(d) Cobalt-60 Accident

THIRD SEMESTER
MSBT-217 NANOBIOTECHNOLOGY

END TERM EXAMINATION   NOV/DEC-2023

Time: 3.00 Hours   Max. Marks: 50

> Note: Answer **Five** questions. Question No. 1 is compulsory.
> Assume suitable missing data, if any.

Q 1. Answer all the following questions briefly   [(2×5) CO-1-5]

 a. Write down the two biomaterials used for the preparation of blood vessels, tendons & ligaments, and spinal prostheses each.
 b. Write down three anisotropic etchants and mention the reaction mechanism of anyone.
 c. Describe the working principle of glucose biosensors.
 d. Briefly explain the mechanism of plasma-based nano-synthesis with a suitable example.
 e. What is LD_{50} and LC_{50} explain, Arsenic has an LD50 of 15mg/kg. How many grams of arsenic is toxic to an individual who weighs 100 kg?

Q 2. Answer all the following questions   [(2×5) CO-1]

 a. Define Biomaterials and along with their classification briefly describe, what is the significance of cell-surface interactions in the area of regenerative medicine, and discuss the application of biomaterials in implants and prostheses.
 b. What is tissue engineering and how tissue engineering methods are currently being implemented in regenerative medicines, discuss strategies applied to the development of artificial bladder.

Q 3. Answer all the following questions   [(2×5) CO- 2, 4]

 a. Discuss the biosynthesis of metallic nanomaterials using plant derivatives, In addition, explain the pharmacological properties of metallic nanomaterials

P.T.O

b. Briefly describe the crystal structure of silicon and discuss the physical and chemical properties of silicon and its compounds, In comparison with other compounds why Silicon is an ideal candidate material for microfabrication processes in MEMS, explain.

Q 4. Answer all the following questions [(2×5) CO- 4]

a. Give two important reasons why lithography is one of the most critical technologies in MEMS. What are the ingredients (tools and materials) of a lithography process? Briefly explain the basic principles behind every step in a lithography sequence.

b. Outline the technique used and the fabrication steps involved in fabricating the structure below.

2 µm
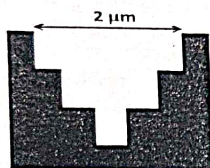
Q 5. Answer all the following questions [(2×5) CO- 3, 4]

a. What is a biosensor, briefly describe the different components and types of biosensors and explain their applications with suitable examples of target analytes.

b. Discuss the role of Etching in MEMS technology, and briefly explain different types of etching and their applications.

Q 6. Answer all the following questions [(2×5) CO- 3, 4]

a. What are pressure sensors, schematically describe their fabrication process and briefly discuss their various medical applications.

P.T.O

b. Briefly describe the various techniques involved in liquid-based synthesis of nanomaterial. How can we get 2D and 3D nanostructures using nano-synthesis methods, explain with a suitable example.

Q 7. Answer all the following questions [(2×5) CO- 4, 5]

a. What is nanotoxicology? How does nanomaterial affect the vital organs of the body, briefly explain the toxicological mechanism of nanomaterials. How to estimate the potential hazard related to nanoparticles.

b. Discuss the properties and applications of PDMS, with a schematic illustration describing the methods for fabricating a microfluidic device using photolithography and soft lithography. Comment on lab-on-a-chip: next-generation companion diagnostics for personalized medicine.

-END-

Total no. of Pages: 01   Roll No. ....
                        3rd Semester
                            M.Sc

END TERM EXAMINATION   NOV/DEC-2023

     MSBT-241   MOLECULAR THERAPEUTICS

Time: 03:00 Hours   Max. Marks: 50

> **Note:** All questions carry equal marks.
> Assume suitable missing data, if any.

Q.1 Describe Gene Therapy? Explain its different types and approaches and what is the difference between gene therapy and cellular therapy?

                                              10 Marks [CO1]

Q.2 Write short note on following?

A. Erythropoietin and its importance   5 Marks [CO2]

B. Transgenics and their uses   5 Marks [CO2]

Q.3 Describe Insulin Analogue and their role in Diabetes? 10 Marks [CO3]

                            Or

Explain role of Cytokine Therapy in cancer?

Q.4 Explain different types of vaccines and their clinical applications?

                                              10 Marks [CO4]

Q.5 Describe Immunostimulants and Immunosuppressor in organ transplant?

                                              10 Marks [CO5]

1st Semester
M.Sc

END TERM EXAMINATION   NOV/DEC-2023
MSCH-101 Chemical Bonding, Stability Constant and
Supramolecular Chemistry
[Time: 3 Hours]   [Max. Marks: 50]

> *Instructions.* Neat diagrams must be drawn wherever necessary.
> Assume missing data if any.

Part A: Chemical Bonding and Stability constants (Attempt any five. Each question carries equal marks)

1. On the basis of Walsh diagram explain different geometries of triatomic (AB_2) molecules.

2. a) Explain the structures of following on the basis of VSEPR theory-
   i) NH_4^+ ii) ClF_5 iii) $(ICl_2)^-$

   b) Write about the atomic inversion process around nitrogen and phosphorous atoms in dissymmetric amine and phosphine molecules.

3. Discuss about the determination of binary formation constants by Job's Method.

4. Draw the titration curve for a redox reaction. Why do we need metallochromic indicators in complexometric titrations? Also write about various instrumental methods present for the detection of end point in complexometric titrations.

5. Discuss in detail about various factors which are responsible for stability of metal complexes.

6. Derive a relation of formation function (n) and degree of overall complexation⊓⊓⊓⊓. How these are interrelated with each-other.

Part B: Supramolecular Chemistry (Attempt any five. Each question carries equal marks)

1. Explain the changes in solvated podand/corand (both having the same number of donor atoms) binds to the same alkali metal ion. **CO4**

2. Discuss different types of interactions in supramolecular molecules. **CO2**

3. Analyse the binding order of K⁺ for the following corands. **CO5**

I   II   III
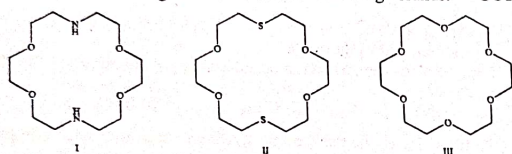
4. Discuss the binding constants of Li⁺, with the following spherands/cryptospherands. **CO5**

I   >   II   >   III
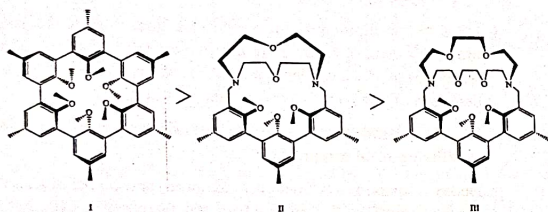
5. Interaction of K⁺ with benzene is about 80 kJ/mol while it is 75 kJ/mol with water. Yet K⁺ is more soluble in water. Provide adequate explanation. **CO4**

6. Consider the following cryptand. What type of interaction would result if it binds F? How would the binding constant change in the series F⁻, Cl⁻, Br⁻, I⁻, and why?

2o4

No of Pages: 02   Roll No.
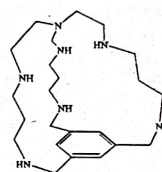
FIRST SEMESTER   **M.Sc. (Chemistry)**

END TERM EXAMINATION   *Nov/Dec-2023*

COURSE CODE: MSCH103

COURSE TITLE: Stereochemistry and Reaction Intermediates & Mechanism

Time: 3 hours   Max. Marks: 50

Note: Assume suitable missing data, if any. Answer Course A and B separately i same answer sheet.

Course A

[1]   Answer any four of the following   [3×4 = 12][CO1&2]

(a)   Explain homotopic, enantiotopic and diastreotopic ligands with suitable examples.

(b)   Draw the conformations of cis-1,2 dimethylcyclohexane and trans 1,2 dimethylcyclohexane and also state their optical activity.

(c)   Write the configurational descriptors (R/S, P/M) of the following compounds.
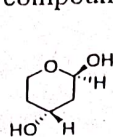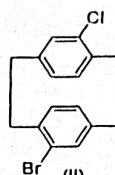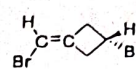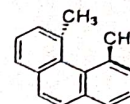
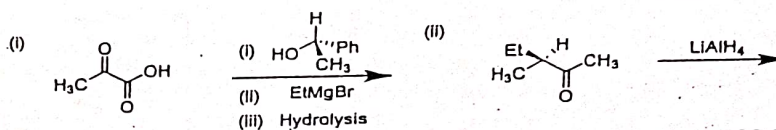(d)   Explain the reason of chirality in biphenyl and allenes system with an appropriate example.

(e)   Write a short note on circular dichroism (CD).

[2]   Write the products along with their stereochemistry of the reaction.
   [4][CO1&2]

[3]   Write the short note on the following reactions: [3×2 = 6][CO1]
       (a) Prelog's rule (b) Axial haloketone rule

[4]   What is the stereochemistry and the sign of cotton effect when12-ketosteroid (I) undergo bromination?   [3][CO1]

(I)
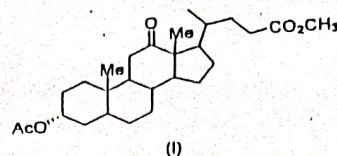
Course B (Q.No. 9 is compulsory, from Q. Nos. 5-8 do any three)

[5] (a) Write Name Reactions involving the following intermediates: (i) Carbocation (ii) Carbanion (iii) Free radical (iv) Carbene (v) Nitrene

(b) Propose a mechanism to explain how both products A and B are formed in the reaction. [2½×2, CO3]
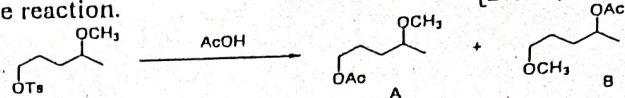
[6] (a) What are ambidient nucleophiles? How does HSAB concept influence the ambidient reactivity?

(b) Discuss the applications of HSAB principle. [2½×2, CO3]

[7] (a) Why is the Hammett equation considered as Linear free energy relationship (LFER)? The Hammett relationship applies only to system where substituents are attached to the reaction centre via aromatic rings and are situated meta- or para. Explain.

(b) What is reaction constant ρ ? Explain its significance. [3+2, CO3&4]

[8] Explain with mechanism any two of the following: [2½×2, CO4]

(a) Curtius rearrangement (b) Steven's rearrangement

(c) Reimer tiemann reaction (d) Sommelet-Hauser rearrangement

[9] For each of the chemical substitution reactions below identify the major products and whether the reaction is likely an S_N1, S_N2, E1 & E2. [5+5, CO3&4]
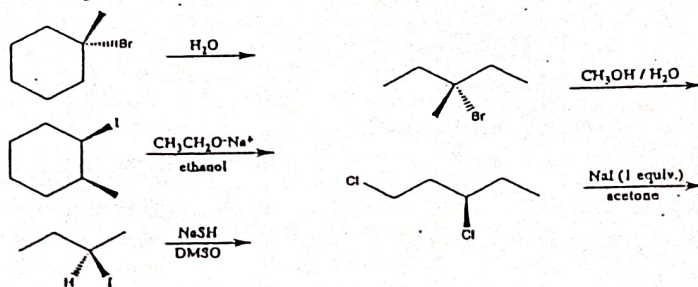
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First Semester
M.Sc.
END TERM EXAMINATION   *Nov-Dec -2023*
MSCH 105 Physical Chemistry-I

Time: 3 Hours   *Max. Marks: 50*

Note:	Attempt all Questions in Part A and Part B Assume suitable missing data, if any

Part-A

Q1 a) Show that $\Psi_1 = \frac{\sqrt{2}}{\sqrt{l}} \cdot Sin\frac{n\pi x}{l}$ and $\Psi_1 = \frac{\sqrt{1}}{\sqrt{l}} \cdot Sin\frac{n\pi x}{l}$ are normalised and orthogonal to each other.

[2.5 Marks] [CO1]

b) Calculate the probability of finding the particle (between 0 to l/2) that is confined to move in 1D box $0 \leq x \leq l$.

$\Psi = \frac{\sqrt{2}}{\sqrt{l}} \cdot Sin\frac{n\pi x}{l}$ [2.5 Marks] [CO1]

Q2 a) Show that eigen value corresponding to Hermitian operators are real.   [2.5 Marks] [CO1]

b) Show that eigen function of Hermitian operators are orthogonal.

[2.5 Marks] [CO1]

Q3 A certain system is described by $\hat{H} = -\frac{d2}{dx} + x^2$ Show that $\Psi = Axe^{-x^2/2}$ is eigen function of $\hat{H}$. Determine the eigen value. If function is normalised determine A. What is the expectation value of x of the system.   [5 Marks] [CO1]

Q4 a) Discuss the five postulates of quantum mechanics.

[2.5 Marks] [CO1]

b) Find the average value of <r> for 1s orbital of hydrogen atom.

[2.5 Marks] [CO1]

$\Psi_s = \frac{1}{\sqrt{\pi}} \cdot \frac{1}{a^{3/2}} e^{-r/a}$

Given: $\int_0^\infty r^n e^{-ar} . dr = \frac{n!}{a^{n+1}}$

Q5 An electron is confined to a box $2\text{Å} \times 3\text{Å} \times 5\text{Å}$.
a) Determine the wavefunction for the four lowest energy states.
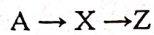[4 Marks] [CO2]

b) What is the ground state energy of this electron?
[1 Mark] [CO2]

Part-B

Q6. Considering a lamina in solution parallel to plane electrode derive the expression for the thickness of the ionic cloud and explain the potential change with distance into the solution. [5 Marks][CO3]

Q7. Explain Bockris, Devanathan and Muller model of electrical double layer in detail.
[5 Marks][CO4]

Q8. Find the concentration of product [Z] in the following consecutive reaction,
[5 Marks][CO5]
$A \rightarrow X \rightarrow Z$

Q9. Draw the relaxation curve for simple first order opposition reaction, derive the rate equation and define relaxation time
[5 Marks][CO5]

Q10. Explain plug flow and derive rate expression for first order reaction.
[5 Marks][CO6]

-------End----

First SEMESTER   **M.Sc. (Chemistry)**

END TERM EXAMINATION   *Dec-2023*

COURSE CODE: MSCH107
COURSE TITLE: Elementary Topics for Chemists

Time: 3 hrs   *Max. Marks: 50*

Note: Assume suitable missing data, if any. Answer Course A and B separately in same answer sheet.

Course A: Mathematics for Chemists

Q1. (a) If $|\vec{a}| = 10$ and $|\vec{b}| = 2$ and $\vec{a}.\vec{b} = 12$, then find the value of $|\vec{a} \times \vec{b}|$. (1, CO1)

(b) If $a = 5i - j - 3k$ and $b = i + 3j - 5k$ then show that the vectors $a + b$ and $a - b$ are perpendicular. (1, CO1)

Q2. If $A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$, then show that $A^2 - 5A = 2I$, where I is the unit matrix of order 2. Hence determine A^4. (2.5, CO1)

Q3. Show that the system of equations (2.5, CO1)

$$3x + y + 2z = 3,$$

$$2x - 3y - z = -3,$$

$$x + 2y + z = 4$$

has a unique solution. Find the solution by matrix method.

Or

If a, b, c are all different and $\begin{vmatrix} a & a^2 & 1 + a^3 \\ b & b^2 & 1 + b^3 \\ c & c^2 & 1 + c^3 \end{vmatrix} = 0$, show that $abc = -1$.

Q4. (a) If $x^3 + y^3 = 3axy$, then find $\frac{dy}{dx}$. (2, CO1)

(b) Integrate: $\int \sin^3 x \cos^2 x \, dx$. (2, CO1)

(c) Find the maximum value of function $x^3 - 12x^2 + 36x + 17$ in the interval [1,10]. (2, CO1)

Q5. (a) Solve $y(1 + xy)dx + x(1 - xy)dy = 0$. (2, CO1)
(b) Solve $(x^3 + y^3)dx = (x^2y + xy^2)dy$. (3, CO1)

Q6. (a) How many different arrangements of letters of the word MATHEMATICS are possible. (1, CO1)

Q7. The percentage of marks obtained by a student in the monthly test are given below:

Test	1	2	3	4	5
Percentage of marks obtained	69	71	73	68	74

Based on the above table, find the probability of students getting more than 70 percent marks in a test. (2, CO2)

Q8. (a) Find (i) the mean (ii) the median (iii) the mode of this set of data

$$5, 6, 2, 4, 7, 8, 3, 5, 6, 6.$$ (2, CO2)

(b) If A and B are two events such that $P(A) = 1/4$, $P(B) = 1/2$ and $P(A \ and \ B) = 1/8$. Find (i) $P(A \ or \ B)$ (ii) $P(not \ A \ and \ not \ B)$. (2, CO2)

Course A: Biology for Chemists

Q1. Define and classify carbohydrates. Give one example of each class and draw their structures. What is the difference between epimers and isomers. [5] [CO3]

Q2. What are biomolecules? Explain different types of biomolecules. [5] [CO3]
[5] [CO4]

Q3. Write a short note on (any two):
1. Cell Organelles
2. Krebs Cycle
3. Double Helix DNA model

Q4. What is a protein? Classify them giving example of each. Explain different types of protein structures [5] [CO4]

Q5. What are nucleic acids? Explain different types of nucleic acids. What are different forces that hold nucleic acid double helices together? [5] [CO3]

Course B: Standard Laboratory Practices and Chemical Safety

Attempt any **FIVE** questions from the following.

Q1. Write SIX principles of green chemistry. Explain any one in detail. [5][CO5]

Q2. List possible sources of fire in lab? Discuss any one in detail. [5][CO6]

Q3. Define and classify Fire. Explain the difference between Fire and explosion. Explain different types of fire extinguishers. Suggest the conditions when you can use them and explain the PASS method. [5][CO6]

Q4. Suggest and explain any three green experiments/ procedures that can be followed in the chemistry laboratory. [5][CO5]

Q5. What do you mean by MSDS of a chemical? Explain. [5][CO5]

Q6. Suggest the possible measures that can be taken in case of accidental contact of chemicals with skin and chemicals in the eyes. Write some of the adverse health impacts due to exposure of chemicals. [5][CO6]

Q7. Draw and explain any five safety symbols that can commonly be found on the label of a chemical container. [5][CO6]

Total no. of Pages:
THIRD SEMESTER
END TERM EXAMINATION

MSCH201 (Organic Chemistry – 3)
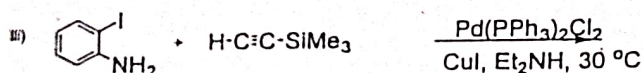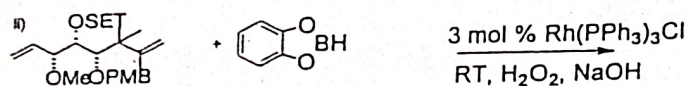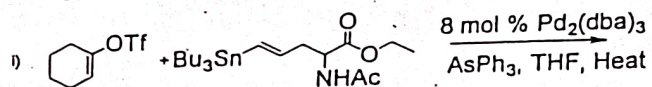
Time: 3 Hours   Max. Marks: 50

Note: Assume suitable missing data, if any. Answer Course A and B separately in same answer sheet.
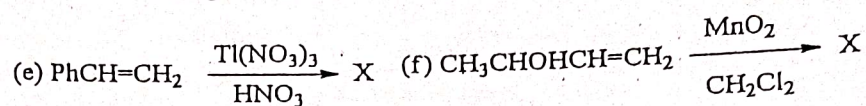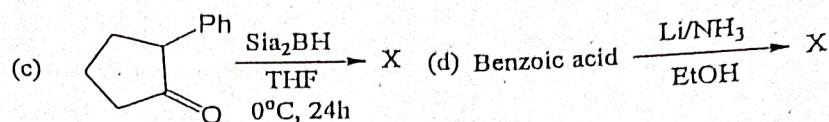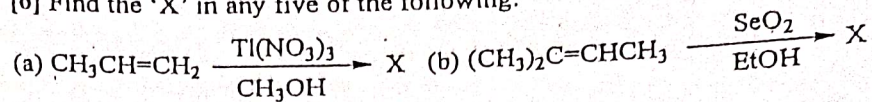
Course A

[1] Answer any four of the following   [3×4 = 12][CO1&2]

(a) Explain the catalytic cycle for the Sonogashira Coupling and its application in organic synthesis.

(b) Explain Julia olefination with suitable example.

€ Explain the Horner-Wadsworth-Emmos reaction with suitable example.

(d) Explain the preparation and uses Umpolung reaction.

€ Explain Corey-Chaykovsky reaction with an example.

[2] Answer the following   [2×2 = 4][CO1&2]

(a) Differentiate between Shapiro and Bamford Stevents Reactions.

(b) Write a short note on Ramberg-Backlund definitions.

[3] Write the short note on the following reactions: [3×2 = 6][CO1&2]

(a) Stork enamine reaction   (b) Wacker reaction

[4] List the products of the following transformations: [3×1 =3, CO1&2]

I) [cyclohexenyl OTf] + Bu$_3$Sn [chain with C(=O)O ethyl ester, NHAc] $\xrightarrow{\text{8 mol \% Pd}_2\text{(dba)}_3}{\text{AsPh}_3\text{, THF, Heat}}$

II) [structure with OSET, OMe, OPMB] + [catecholborane O-BH-O] $\xrightarrow{\text{3 mol \% Rh(PPh}_3\text{)}_3\text{Cl}}{\text{RT, H}_2\text{O}_2\text{, NaOH}}$

III) [aryl I, NH$_2$] + H-C≡C-SiMe$_3$ $\xrightarrow{\text{Pd(PPh}_3\text{)}_2\text{Cl}_2}{\text{CuI, Et}_2\text{NH, 30 °C}}$

Course B

[5] What do you understand by Sharpless Asymmetric Epoxidation?
Explain with example.   [5, CO3]

[6] Find the 'X' in any five of the following: [5, CO3,4]

(a) $CH_3CH=CH_2 \xrightarrow[CH_3OH]{Tl(NO_3)_3} X$ (b) $(CH_3)_2C=CHCH_3 \xrightarrow[EtOH]{SeO_2} X$

(c) $\xrightarrow[THF]{Sia_2BH}{0°C, 24h} X$ (d) Benzoic acid $\xrightarrow[EtOH]{Li/NH_3} X$

(e) $PhCH=CH_2 \xrightarrow[HNO_3]{Tl(NO_3)_3} X$ (f) $CH_3CHOHCH=CH_2 \xrightarrow[CH_2Cl_2]{MnO_2} X$

[7] Find the product for the reaction of toluene with selenium dioxide?
Write the mechanism involved.   [5, CO3]

[8] Discuss with mechanism and example, hydroboration oxidation of alkenes.   [5, CO4]

[9] Discuss reduction with example and mechanism using Wilkinson's Catalyst.   [5, CO4]

Third Semester
M.Sc.

END TERM EXAMINATION   Nov/Dec-2023
MSCH 203 Physical Chemistry-III

Time: 3 Hours   Max. Marks: 50

Note: Attempt all Questions
All Questions carry equal marks.
Assume suitable missing data, if any

Part A

Q1. Deduce the bond-stretching vibration frequency v_{osc} of a diatomic molecule AB by classical method.   [5 Marks] [CO1]

Q2. Explain why the overtone of a particular vibrational band of an anharmonic oscillator will not be found at exactly 2, 3, 4, ... times the frequency of the fundamental.   [5 Marks] [CO3]

Q3. Gilliam et al. (1950) measured the first line in the rotational spectrum of CO as 3.84235 cm^{-1}. Calculate $\dot{B}$, I and r_{CO}.

[5 Marks] [CO1,CO4]

Q4. Deduce Einstein co-efficient for various emission processes.

[5 Marks] [CO2]

Q5. Illustrate schematic representation of Zeeman Effect for $2p^2$ system in detail.   [5 Marks] [CO4]

Part B

Q6. (a) Discuss the construction of a reciprocal lattice from a direct lattice.   [2.5 Marks] [CO2]

(b) Highlight some important properties of reciprocal lattice.

[2.5 Marks] [CO2]

Q7. (a) State and discuss the Franck-Condon principle.

[2.5 Marks] [CO1]

(b) In the electronic spectrum of the ClO· radical, the continuum starts at 38020 cm⁻¹. The ClO radical dissociates in the excited state as

$$ClO \rightarrow Cl(^2P_{3/2}) + O(^3P_2)$$
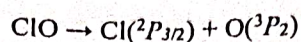
And in the ground electronic state as

$$ClO \rightarrow Cl(^2P_{3/2}) + O(^2D_0)$$
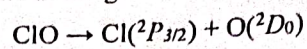
If the energy difference between the $O(^3P_2)$ and $O(^2D_0)$ states is 15868 cm⁻¹, calculate the dissociation energy of the ClO radical in its ground state. Express your answer in Joule. [2.5 Marks] [CO4]

Q8. State and present the mathematical proof of the Bragg's law in vector form. [5 Marks] [CO2]

Q9 (a) How and why the Mossbauer spectra of these two complexes:

$[Fe (H_2O)_5 Cl]^+$ and $[Fe (H_2O)_5 Cl]^{2+}$ is different from each other?

[2.5 Marks] [CO3]

(b) Discuss briefly the phenomenon of Nuclear Zeeman splitting.

[2.5 Marks] [CO1]

Q10 (a) How do we measure distance between origin of lattice and the atom of the unit cell? Discuss briefly with the support of diagrammatic representation. [2.5 marks] [CO2]

(b) Find the distance from origin of lattice to the unit cell (2 3 0).

[2.5 marks] [CO2]

———End———

Ques 6. Water is an essential reaction component in the production of acetic acid by the Monsanto process. The Eastman tennessee process for the production of acetic anhydride has some similarity to the Monsanto process but does not use water as a reactant. How have they tackled this difficulty and how is the project formed? 5,   CO4

Ques 7. Show the steps involved in preparation of ferrocenyl acetylene starting from the ferrocene by (a) palladium catalyzed cross coupling reaction and (b) via acetyl ferrocene. Which one of these two method is better and why? 5,   CO2

Ques 8. Discuss the following with suitable examples (a)Reductive elimination, (b) Migratory insertion, and (c) Agostic interaction. 5,   CO1

Total No. of Pages: 4   Roll No....................
THIRD SEMESTER
M.Sc. Chemistry
END TERM EXAMINATION   NOV/DEC-2023
MSCH205 Organometallic Chemistry and its Application
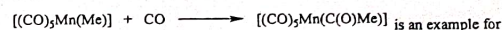[Time: 3 Hours]   [Max. Marks: 50]

Instructions: Question 1 is Compulsory. Attempt any 6 from
            question 2 to 8, carrY equal marks.
            Assume missing data if any.

Ques1. 1 X 20   [CO1, CO2, CO3, CO4, CO5]
1. The reaction

$$[(CO)_5Mn(Me)] + CO \longrightarrow [(CO)_5Mn(C(O)Me)]$$ is an example for

(a) Oxidative edition, (b) Electrophilic substitution, (c) Nucleophilic substitution, and (d) Migratory insertion.

2. In the trans-$PtCl_2L(CO)$ complex, the CO stretching frequency for L= NH_3. Pyridine, NMe_3 decreases in the order:
(a) Pyridine > NH_3 > NMe_3 (b) NH_3 > Pyridine > NMe_3, (c) NMe_3 > NH_3 > Pyridine, and (d) Pyridine > NMe_3 > NH_3

3. The infra-red stretching frequency υ_{CO} of P-S follows the order:
(P) $Mn(CO)_6^+$, (Q) CO, (R) $H_3B \leftarrow CO$,and (S) $[V(CO)_6]^-$

    (a) P > R > S > Q, (b) S > P > R > Q, (c) Q > S > P > R, and (d) R > Q > P > S

4. Intense band at 15000 cm^{-1} in the UV- visible spectrum of $[Bu_4N]_2Re_2Cl_8$ is due to the transition:

(a) π to π^*, (b) δ to δ^*, (c) δ to π^*, and (d) π to δ^*

5. Total number of M-M bonds in the given complexes $Fe_3(CO)_{12}$, $Co_4(CO)_{12}$ and $\eta^5CpMo(CO)_2]_2$ are respectively.

(a) 3,4,5, (b) 3,4,2, (c) 4,3,2, and (d) 3,6,3

6. Which one of the following statements is true for $[MLn(CR)_2]$ complex, in which, M = transition metal, L = ligand, CR_2 = Fisher carbene?

(a) L is non-acceptor type, (b) R Group is non π -donor type, (c) Carbon center is electrophilic in its reactivity, and (d) Metal atom is in its high formal oxidation state.

7. A compound A having the composition $FeC_9H_8O_3$ shows one signal at 2.5 m and another one around 5.0 ppm in its ^1H NMR spectrum. The IR spectrum of this compound shows, two bands around 1900, 1680 cm^{-1}. The compound follows the 18electron rule. Of the following statement for A, the correct one is/are:

(A) It has η^5 -Cp group, (B) It has terminal CO ligand, (C) It has CH_3 ligand, (D) It has Fe- H bond.

 (a) (A) and (B) only, (b) (C) only, (c) (A) and (C) only, and (d) (B) and (D) only

8. The bonding of cyclopentadieyl in Ti(Cp)₄ is such that:

(a) All Cp rings are pentahapto, (b) One Cp ring is pentahapto and other three rings are monohapto, (c) Two Cp rings are monohapto and other two rings are pentahapto, (d) All Cp rings are monohapto
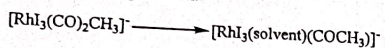
9. In a homogeneous catalytic reaction, 1.0 M of a substance and 1.0 microM of a catalyst yields 1.0 mM of a product in 10 seconds. The turnover frequency of the reactant (s⁻¹) is:

(a) 10^{-2}, (b) 10^2, (c) 10^{-3}, and (d) 10^3

10. Metals used in automobile catalytic convertors are:

(a) Pt and Pd, (b) Pt and Rh, (c) Pd and Rh, (d) Rh and Ni

11. The following reaction:

$[RhI_3(CO)_2CH_3]^-$ ⟶ $[RhI_3(solvent)(COCH_3)]^-$

(a) Oxidative addition, (b) Reductive elimination, (c) Migratory insertion, (d) Addition

12. High dose of dietary supplement $ZnSO_4$ for the cure of Zn deficiency:

(a) Reduces myoglobin, (b) Increase iron level in blood, (c) Increases copper level in brain and (d) Reduces copper, iron and calcium level in body

13. Patients suffering from Wilson's disease have:

(a) Low level of Cu-Zn superoxide dismutase, (b) High level of Cu-Zn superoxide dismutase, (c) Low level of copper storage protein, ceruloplasmin, and (d) High level of copper storage protein, ceruloplasmin

14. The organometallic compound $W(C_5H_5)_2(CO)_2$ follows the 18electron rule. The hapticities

Of two cyclopentadienyl groups are:

(a) 5 and 5, (b) 3 and 5, (c) 3 and 3, and (d) 1 and 5

15. Among the following, the unstable carbonyl species is:

(a) $Mn(CO)_5Cl$, (b) $[Mn(CO)_5]^-$, (c) $[Mn(CO)_5]^+$, and (d) $Mn(CO)_5$

16. In metal carbonyl complexes, as more electron density moves from the metal d- orbitals to the CO π^* orbitals the CO stretching frequency:

(a) Increases, (b) Decreases, (c) Remains same, and (d) Disappears

17. Amongst the following, the metal that does not form homoleptic polynuclear metal carbonyl is:

(a) Mn, (b) Fe, (c) Cr, and (d) Co

18. The total number of M-M bonds in $Ru_3(CO)_{12}$, and $Co_4(CO)_{12}$ respectively is:

(a) 3 and 6, (b) 4 and 5, (c) 0 and 4, and (d) 3 and 4

19. Though cyclobutadine (C_4H_4) is highly unstable and readily polymerizes in its free state, is transition metal complexes could be isolated because:

(a) It engages in long range interaction with transition metals, (b) It gains stability due to formation of $C_4H_4^{-2}$ on binding to transition metals, (c) Its polymerization ability reduces in presence of transition metal, and (d) It becomes stable in presence of transition metals due to formation of $C_4H_4^{+2}$

20. Which one of the following statements about the ferrocene is False?

(a) It obeys the 18electron rule, (b) It is diamagnetic, (c) It is an orange solid, and (d) It resists electrophilic substitution

Ques 2. The following compound looks very different from acetylene. But both are isolobal with each other. Justify the statement. 5,
   CO3
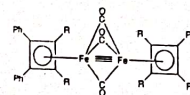
Ques 3. From the following isolobal analogies. Pick true or false in each series. 5,   CO4

(a) CH_2 ⟶ SiH_2 ⟶ $Fe(CO)_4$ ⟶ $Ru(CO)_4$

(b) CH_3 ⟶ BH_3^- ⟶ $[Fe(CO)_3]^+$ ⟶ $Mn(CO)_5$

(c) CH_3^+ ⟶ BH_3 ⟶ $[Cr(CO)_3]^-$ ⟶ $Mn(CO)Cl$

(d) CH^+ ⟶ $Fe(CO)_3$ ⟶ $CpCo$ ⟶ $Ni(PR_3)$

(e) $Ni(CO)_3$ ⟶ CH_2 ⟶ CH_3^+ ⟶ $CH-$

Ques 4. The hydroformylation of ethylene oxide to 3-hydroxypropane aldehyde is catalyzed by $HRh(CO)_2(PPH_3)_2$ the reaction works best with the solvent is basic propose the mechanism of this transformation. 5,
          CO5
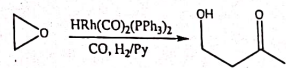
Ques 5. When the Wacker reaction was carried out on ethylene in D_2O instead of H_2O, it was observed that no deuterium was incorporated into the acetaldehyde formed. 5,   CO3

(a) Modify the given mechanism using D_2O instead of H_2O at step 2 and indicate why deuterium is not incorporated in the product.
(b) As Vinyl alcohol can also tautomerise to the acetaldehyde under normal conditions, does the above statement support a situation where the π coordinated vinyl alcohol falls off from the metal centre and rearranges by itself to the aldehyde? Explain.

Total no. of Pages: 02   Roll no.....................
THIRD SEMESTER   M.Sc. (CHEM.)
END TERM EXAMINATION   Nov/Dec-2023
MSCH207b (Inorganic Reaction Mechanisms and Bioinorganic Chemistry)
Time: 3 Hours   Max. Marks: 50

Note: Assume suitable missing data, if any. Answer Course A and B separately in same answer sheet.

Section A (Do any five questions)

1. What is *trans effect*? Explain with suitable example. Distinguish between *trans-effect* and *trans-influence*.   [5, CO2]

2. How does the magnitude of CFSE affect the rate of substitution reaction of an Octahedral complex? Explain with reference to complexes of Cr^{2+}, Mn^{2+} and Fe^{2+}?   [5, CO1]

3. The Outer Sphere Electron Transfer Reactions involving Ru^{2+}/Ru^{3+} are faster than those involving Co^{2+}/Co^{3+}. Explain   [5, CO2]

4. In the following reaction,
   $$trans\text{-}[Pt(en)_2Cl_2]^{2+} + Cl^* \longrightarrow trans\text{-}[Pt(en)_2ClCl^*]^{2+} + Cl^-$$
   the exchange of radioactive Cl^* is catalyzed by the addition of $[Pt(en)_2]^{2+}$. Explain with mechanism. (where *en* = ethylenediamine) [5, CO1&2]

5. Suggest a method for the synthesis of either of the enantiomers of $\pm[Co(en)_2]^{3+}$ in nearly 100% theoretical yield. (where *en* = ethylenediamine)   [5, CO2]

6. Distinguish between substitution in square planar complexes and octahedral complexes.   [5, CO1&2].

Section B (Do any five questions)

7. What are Tensed (T) and Relaxed (R) forms of Haemoglobin and what are their significance?   [5, CO3]

8. Explain the different types of Ferridoxins and mention the one which is responsible for photosynthesis.   [5, CO3]

9. Describe in detail the structure, composition, and function of Nitrogenase.　　[5, CO3&4]

10. Explain any two　　[5, CO3&4]
   A) Porphyrin ring system
   B) Siderosis
   C) Wilson's disease

11. Describe the mechanism of *cis*-platin in the chemotherapy. Discuss why the trans-isomer is not recommended for the same.　　[5, CO3]

12. What is GTF? Explain its significance with respect to importance of Chromium metal in the body.　　[5, CO3]

No of Pages: 02

THIRD SEMESTER

END TERM EXAMINATION

Roll No.

M.Sc. [Chemistry]

Nov/Dec-2023

218

COURSE CODE: MSCH207c

COURSE TITLE: Organic Synthesis and Heterocyclic Chemistry

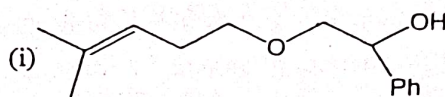Time: 3 Hours   Max. Marks: 50

Note: Assume suitable missing data, if any. Answer Course A and B separately in same answer sheet.

Section A

Q1. Answer **any five** from the following:

Write the Retrosynthetic analysis and Synthetic pathways with proper reagents and each step clarity for the target molecules.

[5×5 = 25, CO1&2]

(i) [structure: 3-methylbut-2-enyl ether with CH(OH)Ph group]

(ii) N-(4-hydroxyphenyl)-acetamide

(iii) $PhCH_2NHCH(Ph)CH_3$

(iv) [cyclobutane with COOH substituent]

(v) Cyclopentane

(vi) [bicyclic pyrrolizidine structure]

Section B

[1] Answer **any four** of the following   [3×4 = 12][CO3&4]

(a) Explain the Knorr pyrrole synthesis.

(b) Explain the electrophilic substitution in pyrazole.

(c) Discuss the aromaticity order of pyrrole, thiophen, furan, and benzene.

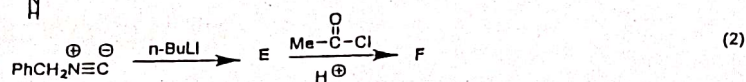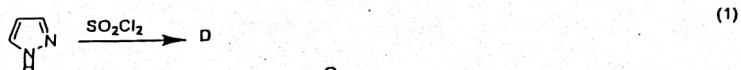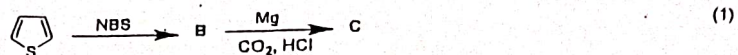(d) Show the mechanism of synthesis of thiazole from α-halo-carbonyl compounds.

(e)   Write the Napieralski synthesis of isoquinoline with an example.

[2]   Write the short note on the following reactions: [3×2 = 6][CO3]

(a) Skraup synthesis   (b) Hantzsch synthesis

[3]   List the products of the following transformations:

[7×1=7][CO3 & 4]

(1)

(1)

(1)

(2)

(1)

(1)

Total No. of Pages: 02
Roll No. ... ...

'220

THIRD SEMESTER   MSc [Chem]
END SEMESTER EXAMINATION   Nov/Dec-2023
MSCH-207d Solid state chemistry
Time: 3 Hours   Max. Marks: 50

Note: Assume suitable missing data if any. Do any 5 questions

Q1(a) Explain the chemical approach to band theory.   [CO3, 4]

(b) Explain the band structure of carbon (diamond) and beryllium.   [CO3, 3]

(c) What are cooper pairs. How cooper pair elucidate mechanism by which electrons can travel through solid with zero resistance.   [CO1, 3]

Q2(a) Explain how magnetic susceptibility varies with temperature in Ferromagnetic and antiferromagnetic materials (with diagram).   [CO4, 3]

(b) Why the observed magnetic moment value for ions in solid materials is similar or larger than the spin only value.   [CO4, 2]

(c) Define superexchange in antiferromagetic material. Elaborate the phenomenon of superexchange by considering the example of NiO. [CO4, 3]

(d) Draw a typical B-H loop for ferromagnetic material and explain.[CO4, 2]

Q3(a) Calculate the structure factor for CsCl.   [CO2, 3]

(b) Explain the phase transition in crystal structure of rock salt and CsCl by the dilation mechanism.   [CO2, 2]

(c) What are systematic absences. Explain with example.   [CO2, 3]

(d) How crystallite size can be determined from X-ray spectrum.   [CO2, 2]

Q4(a) What is the thermodynamic classification of phase transition? Explain.   [CO1, 2]

(b) Explain the phase transition in $LiFeO_2$ at ~700 °C. [CO1, 3]

(c) Draw temperature dependence of the transition rates for typical first order transition between low temperature polymorph and high temperature polymorph. Explain the occurrence of maximum at T_M. [CO1, 3]

(d) Explain transition involving second coordination in Buerger's classification. [CO1, 2]

Q5 (a) What are the sources of error in XRD? [CO2, 2]

(b) Define and Explain Kirkendall effect in the reaction between MgO and Fe_2O_3. [CO2, 3]

(c) Describe coprecipitation method and why it is effective in solid state reactions. [CO2, 3]

(d) On which factor band structure depends? [CO2, 2].

Q6. (a) Explain the temperature dependence of carrier concentration for a semiconducting material. [CO3, 2]

(b) What is the fundamental difference between the diamagnetism in superconductor and in normal materials. [CO4, 2]

(c) Why in semiconducting devices. semiconductors are desirable to use in their exhaustion range and how it can be extended over a wide range of temperature. [CO1, 2]

(d) Describe the phenomenon by which a superconductor floats over a magnet. [CO1, 2]

(e) What are the reasons for peak broadening in X-ray spectrum? [CO2, 2]

Total no. of pages: 01   Roll No...............

1st Semester

M.Sc Maths

END TERM EXAMINATION   **NOV/DEC- 2023**

MSHU-113 COMMUNICATIVE ENGLISH

Time: 3.00 Hour   Max. Marks: 50

Note: Answer all questions accordingly.

1. Write short notes on the following: (10) (CO2)

   a. Interview skills
   b. Formal language vs Informal language
   c. Clarity of Speech

2. Discuss how your presentation skills help you in a professional set up.   (10) (CO1)

3. Write a Resume for the post of an Assistant Professor in XYZ University. (Assume details)   (10) (CO4)

4. Give your views on one of the following topics of Group Discussion: (10) (CO3)

a) Private jobs vs government jobs

b) Reservation for women in jobs

5. Transcribe the following: art, crack, top, luck, and page   (10) (CO4)

Total No. of Pages: 01   Roll No:..............................

FIRST SEMESTER   **M.Sc.**

END *SEMESTER EXAMINATION*   *(Nov. 2023)*

MSMA-101, Abstract Algebra

Time: 3 Hr.   Max. Marks: 50

Note: *Attempt Any Five questions.*
All questions carry equal marks.

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1. (a) If G is a group in which $(ab)^{ni} = a^{ni}b^{ni}$ for three consecutive integers m and any a, b in G, then show that G is abelian.

   (b) If G be a finite cyclic group of order n then show that G has a unique subgroup of order d for every divisor d of n.

2. (a) Define a simple group with an example. Show that if H is a subgroup of index 2 in the group G then H is normal in G.

   (b) Define signature of a permutation with an example. State and prove Cayley's theorem.

3. (a) State and prove Cauchy's therem.

   (b) Define stabilizer with an example. Let G be a finite group acting on a finite set S. Show that $|S| = \sum |G : stab(s)|$, where the summation runs over the set of representatives of distinct G-orbits of S.

4. (a) Show that every field is an Integral domain. Is converse true? Justify.

   (b) If R is a commutative ring with 1, then show that every maximal ideal in R is a prime ideal. Is converse true? Justify.

5. (a) Define principal ideal domain with an example. Show that the ring $R = \{n/m \,|\, m, n \in \mathbb{Z}, n \text{ odd}\}$ is a principal ideal domain.
(b) Define Principal Ideal domain with an example. Let R be a PID then show that every $a \in R$ which is not a unit can be expressed as product of irreducible elements.

6. (a) Define embedding. State and prove the embedding theorem.
(b) Define unique factorization domain with an example. If R is a ED or PID then show that R is UFD.

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First Semester
End Term Examination

M. Sc
December, 2023

MSMA-103, Real Analysis

Time: 3 Hours   Max. Marks: 50

> *Note: Attempt any five and all questions carry equal marks.*

(1) (a) Let (X, ρ) be a metric space then show that
   (i) $\rho(x, y) \geq |\rho(x, z) - \rho(z, y)|$
   (ii) $|\rho(x, y) - \rho(x', y')| \leq \rho(x, x') + \rho(y, y')$,
   where x, x', y and $y' \in X$.   (CO2)

 (b) Let (X, ρ) be a metric space and let a be a point in X. Let f and g be real-valued functions whose domains are subsets of X and ranges are sets of real numbers $\mathbb{R}$ with the usual metric. If $\lim_{x \to a} f(x) = L$ and $\lim_{x \to a} g(x) = M$, where $L, M \in \mathbb{R}$, then show that
   (i) $\lim_{x \to a} [f(x) + g(x)] = L + M$
   (ii) $\lim_{x \to a} [f(x) - g(x)] = L - M$
   (iii) $\lim_{x \to a} [f(x)g(x)] = LM$
   (iv) $\lim_{x \to a} \frac{f(x)}{g(x)} = \frac{L}{M}$, $M \neq 0$ (CO1 & CO2)

(2) (a) Let (X, ρ) be a metric space. Every decreasing sequence F_n of non-empty closed sets with $diam(F_n) \to 0$ as $n \to \infty$ has exactly one point in its intersection. Then show that (X, ρ) is complete.   (CO2)

 (b) Define the complete metric space. If $\{A_n\}$ is a sequence of nowhere-dense sets in a complete metric space (X, ρ), then there exists a point in X. Show that which is not a point in any of the $A_n's$, i.e., $X \neq \bigcup_{n=1}^{\infty} A_n$.   (CO2)

(3) (a) Let (X, ρ_X) and (Y, ρ_Y) be two metric spaces and $f : X \to Y$ be uniformly continuous. If $\{x_n\}$ is a Cauchy sequence in X, then show that $\{f(x_n)\}$ is a Cauchy sequence in Y.   (CO3)

(b) State and prove the Banach contraction mapping theorem. (3+7) (CO2)

(4) (a) Prove that a compact subset of a metric space is bounded. (CO2)

(b) State and prove the Heine-Borel theorem. (3+7) (CO1)

(5) (a) If $(Y_\alpha; \alpha \in \Lambda)$ is a family of connected subsets of a metric space (X, ρ_X) and if $\bigcap\limits_{\alpha \in \Lambda} Y_\alpha \neq \phi$, then show that

$$Y = \bigcup\limits_{\alpha \in \Lambda} Y_\alpha$$

is also connected. (CO2)

(b) Show that a non-empty subset Y of a metric space (X, ρ_X) is disconnected iff there exists closed sets G_1 and G_2 in X with the following properties:

(i) $G_1 \cap Y \neq \phi$;

(ii) $G_2 \cap Y \neq \phi$;

(iii) $(G_1 \cap G_2) \cap Y = \phi$;

(iv) $Y \subseteq G_1 \cup G_2$. (CO2)

(6) Let $f : [0, 1] \to \mathbb{R}$ and n is non-negative integer. The Bernstein polynomial of f of degree n is defined as:

$$B_n(f, x) = \sum\limits_{k=0}^{n} p_{n,k}(x) \cdot f\left(\frac{k}{n}\right), \quad x \in [0, 1],$$

where $p_{n,k}(x) = \binom{n}{k} x^k (1 - x)^{n-k}$.

i) Find the values of $B_n(1, x), B_n(t, x), B_n(t^2, x)$, where $t = k/n$.

ii) Find the recurrence relation which is as follows:

$$B_n(e_{m+1}, x) = \frac{x(1-x)}{n} B_n'(e_m, x) + x B_n(e_m, x),$$

where $e_m = t^m$ and $m \in \mathbb{N} \cup \{0\}$. (CO4)

(7) If a function $f \in \mathcal{R}[a, b]$, then taking $|f| \in \mathcal{R}[a, b]$, show that

$$\left| \int_a^b f \right| \leq \int_a^b |f|.$$ (CO4)

Total No. of Pages: 01

FIRST SEMESTER

M.Sc[Maths]

END SEMESTER EXAMINATION

Dec. 2023

MSMA105, Ordinary Differential Equations

Time: 3.0 Hours

Max. Marks: 50

Note: *Attempt **ALL** questions. Assume suitable missing data, if any.*

1. Solve the initial value problems (IVP):

$$\frac{dX}{dt} = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 1 & -2 \\ 3 & 2 & 1 \end{bmatrix} X, \text{ with } X(0) = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}.$$

[10 marks] [CO-3,4]

2. Solve the IVP: $y'' - 3y' + 2y = 4x^2$, $y(0) = 1, y'(0) = 1$.   [5 marks]
   [CO-2,4]

3. Solve the initial value problems (IVP):

$$\frac{dX}{dt} = \begin{bmatrix} 3 & -2 \\ 2 & -2 \end{bmatrix} X + \begin{bmatrix} t \\ 3e^t \end{bmatrix}, \text{ with } X(0) = \begin{bmatrix} 2 \\ 1 \end{bmatrix}.$$

[10 marks] [CO-2,5]

4. (a) Discuss analytic functions with an example.   [4 marks]
   (b) Solve $2x^2 y'' + xy' + x^2 y = 0$ [6 marks]
   [CO-3]

5. (a) Define Strum-Liouville problems with all its properties. [5marks]
   (b) Solve $y'' + \lambda y = 0$, $y'(0) = 0, y(\pi) = 0$.   [5 marks]
   [CO-1,4]

6. Analyze qualitatively the first order non-linear ODE:

$$y' = y^3 - 3y + 2$$

[5 marks][CO-1,4]

I SEMESTER   **M.Sc.**

END TERM EXAMINATION   *NOV-2023*

COURSE CODE: MSMA107

COURSE TITLE: Discrete Mathematics

Time: 3 Hours   *Max. Marks: 50*

Note: Attempt any Five questions.
All questions carry equal marks.
Assume suitable missing data, if any.

Q1(a)Prove that the direct product of two lattices is again a lattice.

(5) (CO1)

(b)Let $f: L \to M$ be a lattice homomorphism. Then

(i) if S is a sublattice of L, $f(S) = \{f(a) : a \epsilon S\}$ is a sublattice of M.

(ii) if T is a sublattice of M, $f^{-1}(T) = \{ a \epsilon L : f(a) \epsilon T\}$ is a sublattice of L.

(5) (CO1)

Q2(a) Covert the following Boolean expression into Disjunctive normal form

$$(xy' + xz)' + x'$$

(5) (CO1)

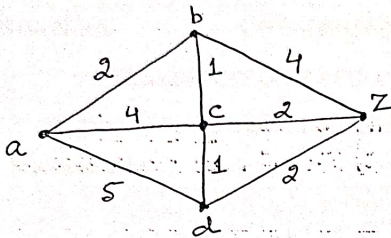(b) Write $x.y$ in conjunctive normal form in three variables.

(5) (CO1)

Q3(a) By applying Havel-Hakimi theorem show that the sequence 3,2,2,1,1,1 is graphical.
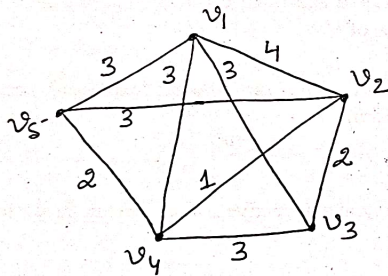
(5) (CO3)

(b) Apply Dijkshtra's algorithm, find the shortest path from a to z for the graph below:

(5) (CO3,4)

Q4(a) Prove by mathematical induction that if G is a tree with n vertices then it has (n-1) edges. (5) (CO4)

(b) Explain Prim's algorithm for finding minimal spanning tree of a weighted graph and hence find the minimal spanning tree for the graph below:

(5) (CO4)

Q5(a) Construct a deterministic automaton equivalent to $M = (\{q_0, q_1, q_2, q_3\}, \{0,1\}, \delta, q_0, \{q_3\})$ where δ is given by the table

State/Σ	0	1
$\rightarrow q_0$	q_0, q_1	q_0
q_1	q_2	q_1
q_2	q_3	q_3
(q_3)	--	q_2

Explain each step in the construction. (5) (CO3)

(b) Prove that in an automaton, for any transition function δ and for any two input strings x & y,
$$\delta(q, xy) = \delta(\delta(q, x), y)$$
(5) (CO3)

Q6(a) Solve the following recurrence relation using generating function
$$a_n - 9a_{n-1} + 20a_{n-2} = 0, \quad a_0 = -3, a_1 = -10$$
(5) (CO1)

(b) Define Predicate. Translate each of the statement into symbols using quantifiers, variables and predicate symbols.

Let P(x): x can speak Tamil and Q(x): x knows the language C++

(i) There is a student who can speak Tamil and knows the language C++.
(ii) There is a student who can speak Tamil but does not know C++.
(iii) Every student either can speak Tamil or knows C++.
(iv) No student can speak Tamil or knows C++.

(5) (CO2)

END TERM EXAMINATION

Nov -2023

COURSE CODE: MSMA 109

COURSE TITLE: MATHEMATICAL STATISTICS

Time: 03:00 Hours

Max. Marks: 40

Note:Assume suitable missing data, if any.

Q.1 (i) If there is a war every 15 years on the average, find the probability that there will be no war in 25 years. [3][CO1]

(ii) A point P is taken at random on a line segment AB of length $2a$. Find the probability that the area of the rectangle $AP.PB$ will exceed $\frac{a^2}{2}$. [5][CO1]

Q.2 (i) A continuous distribution is given by:

$$f(x) = \frac{1}{x\sqrt{2\pi}} e^{\frac{-(\log x)^2}{2}}, \quad x > 0$$
$$= 0 \qquad\qquad , x < 0$$

Calculate the mean and standard deviation. [4][CO2]

(ii) State Tchebycheff's inequality. Use it to show that in 2000 throws with a coin the probability that the number of heads lies between 900 and 1100 is at least $\frac{19}{20}$. [4][CO2]

Q.3 (i) Find the mean and standard deviation of Binomial distribution. [4][CO3]

(ii) In a bolt factory, machines A, B and C manufacture respectively 25%, 35% and 40% of the total of their output. 5%, 4% and 2% are defective bolts. A bolt is drawn at random from the product and is found to be defective. What are the probability that it was manufactured by machine C. [4][CO3]

OR

An urn contains 4 white and 6 black balls. Two balls are successively drawn from the urn without replacement of the first ball. If the first ball is seen to be white, what is the probability that the 2nd ball is also white? [4][CO3]

Q.4 (i) If the probability is 0.6 that an examinee will pass the NET exam on any given try, what is the probability that an examinee will finally pass the examination on the 5th try. [4][CO4]

(ii) A shipment of 80 burglar alarms contains four that are defective. If three from the shipment are randomly selected and shipped to a customer, find the probability that the customer will get exactly one bad unit. [4][CO4]

Q.5 (i) The mean of a sample of size 100 from a normal population is found to be 13.70. If it is known that the standard deviation of the population is 2.1, find the 95% confidence interval for the population mean. [Given $u_e = 1.960$] [4][CO5]

(ii) Estimate the parameter α of a continuous population having the density function $(1+\alpha)x^\alpha, (0 < x < 1)$ by the method of maximum likelihood. [4][CO5]

OR

A random variable X can take all non-negative integral values, and $P(X = i) = p(1-p)^i$ $(i = 0,1,2,\dots)$ where $p\,(0 < p < 1)$ is a parameter. Find the maximum likelihood estimate of p on the basis of a sample of size n from the population of X. [4][CO5]

Note: Attempt ANY FIVE questions. All questions carry equal marks. Assume suitable missing data, if any.

(1) State TRUE or FALSE. Justify your answer.
   (a) For a unitary linear operator $U : \mathcal{H} \to \mathcal{H}$ on a complex Hilbert space $\mathcal{H} \neq 0$, the spectrum $\sigma(U)$ is not a closed subset of the unit circle. [2] [CO5]
   (b) The space $C[a, b]$ is a Hilbert space. [2] [CO1]
   (c) A reflexive normed space is a Banach space. [2] [CO2]
   (d) For a compact linear operator $T : V \to V$ on a normed space V, the null space of $T - \lambda I$, for every $\lambda \neq 0$, is finite dimensional. [2] [CO3]
   (e) For any two nonzero elements v, w of an inner product space V,

$$|\langle v, w \rangle| = \|v\| \, \|w\|$$

   if $v = \lambda w$, where λ is some scalar. [2] [CO1]

(2) (a) State and prove Riesz's theorem for functionals on Hilbert spaces. [5] [CO2]
   (b) Let $\mathcal{H}$ be a Hilbert space.
   (i) Let $u \in \mathcal{H}$ with $\|u\| = 1$, and $P : \mathcal{H} \to \mathcal{H}$ be given by $P(w) = \langle w, u \rangle u$. Is P an orthogonal projection onto a subspace of $\mathcal{H}$?
   (ii) Let $u, v \in \mathcal{H}$ be linearly independent, and $P : \mathcal{H} \to \mathcal{H}$ given by

$$P(w) = \langle w, u \rangle u + \langle w, v \rangle v$$

   for all $w \in \mathcal{H}$. Prove that P is an orthogonal projection if and only if $\|u\| = \|v\| = 1$ and $u \perp v$. [5] [CO1]

(3) (a) Let ϕ be a sublinear functional on a real vector space V. Further, let ψ be a linear functional which is defined on a subspace W of V satisfying $\psi(v) \leq \phi(v)$ for every $v \in W$. Show that ψ has a linear extension $\widetilde{\psi}$ from W to V satisfying $\widetilde{\psi}(v) \leq \phi(x)$ for every $v \in V$. [5] [CO2]
   (b) Let V and W be Banach spaces. Show that a bounded linear operator T from V onto W is an open mapping. Further, show that T^{-1}, if it exists, is continuous and bounded. [5] [CO4]

(4) (a) State and prove the uniform boundedness theorem. [5] [CO4]
   (b) Show that a sequence (ϕ_n) of bounded linear functionals on a Banach space V is weak* convergent, the limit being a bounded linear functional on V, if and only if (i) the sequence $(\|\phi_n\|)$ is bounded, (ii) the sequence $(\phi_n(v))$ is Cauchy for every v in a total subset W of V. [5] [CO3]

2

(5) (a) For any bounded self-adjoint linear operator T on a complex Hilbert space $\mathcal{H}$, denote $m = \inf_{\|v\|=1} \langle Tv, v \rangle$ and $M = \sup_{\|v\|=1} \langle Tv, v \rangle$. Show that

$$\|T\| = \max(|m|, |M|) = \sup_{\|v\|=1} |\langle Tv, v \rangle|.$$

[5][CO3]

(b) Let the operator $T : \ell^2 \to \ell^2$ be defined by

$$T(x_1, x_2, \ldots, x_n, \ldots) = (0, x_1, x_2, \ldots, x_n, \ldots).$$

Show that T is linear and bounded. Find the adjoint operator T^*. [5] [CO4]

(6) (a) Let V be a normed space and $T : V \to V$ a compact linear operator. Prove that

(i) the set E of eigenvalues of T is countable.

(ii) $\lambda = 0$ is the only possible point of accumulation of E. [5] [CO5]

(b) Let T be a bounded linear operator on a complex Banach space. Show that the spectral radius $r_\sigma(T)$ of T is

$$r_\sigma(T) = \lim_{n \to \infty} \sqrt[n]{\|T^n\|}.$$

[5] [CO5]

-END-

End Term Examination
II Semester (M.Sc.), Nov-Dec 2023
Operations Research (MSMA-203)

Max Marks: 50   Time: 3 Hours

Note: Attempt any 5 questions. Assume suitable missing data, if any.

Q 1. (a) Define MM1 models - Single Channel and explain the same using suitable examples.

(CO-4)

(b) Write the dual of the following Linear Programming problem and interpret the optimal results.

Maximize $Z = 5x + 20y$

s.t.

$$5x + 2y \leq 20$$
$$x + 2y \leq 8$$
$$x + 6y \leq 12 \text{ and}$$
$$\text{Both x and } y \geq 0$$

(CO-1)

Q 2. Four factories, A, B, C and D produce sugar and the capacity of each factory is given below: Factory A produces 10 tons of sugar and B produces 8 tons of sugar, C produces 5 tons of sugar and that of D is 6 tons of sugar. The sugar has demand in three markets X, Y and Z. The demand of market X is 7 tons, that of market Y is 12 tons and the demand of market Z is 4 tons. The following matrix gives the transportation cost of 1 ton of sugar from each factory to the destinations.

Factories.	Cost in Rs. per ton (100)			Availability in tons.
	X	Y	Z	
A	4	3	2	10
B	5	6	1	8
C	6	4	3	5
D	3	5	4	6
Requirement in tons.	7	12	4	

(CO-1,2,3)

(a) Find Initial Basic Feasible solution by VAM.

(b) Find the Optimal Solution.

Q 3. On a given day District head quarter has the information that one ambulance van is stationed at each of the five locations A, B, C, D and E. The district quarter is to be issued for the ambulance van to reach 6 locations namely, P, Q, R, S, T and U, one each. The distances in Km. between present locations of ambulance vans and destinations are given in the matrix below.

From	P	Q	R	S	T	U
A	18	21	31	17	26	29
B	16	20	18	16	21	31
C	30	25	27	26	18	19
D	25	33	45	16	32	20
E	36	30	18	15	31	30

(CO-1,2,3)

(a) Obtain the optimal assignment of vans for minimum total distance.

(b) State which destination should not expect ambulance van to arrive.

Q 4. Solve the following Integer Programming Problem for all integer solution by using Gomory's fractional cut method. Also illustrate the proposed cut geometrically.

$$\text{Maximize: } Z = X_1 - X_2$$
$$\text{Subject to:} \quad X_1 + 2X_2 \leq 4$$
$$6X_1 + 2X_2 \leq 9$$
$$X_1; X_2 \geq 0 \quad \text{and both integer}$$

(CO-1)

Q 5. (a) Define rules for drawing network diagrams and explain with suitable examples.

(b) Draw the Network Diagram for given data and find out Critical path for the same.

Activity (i,j)	Normal time $d_{i,j}$
(1,2)	20
(1,3)	23
(1,4)	8
(2,5)	19
(3,4)	16
(3,7)	24
(4,6)	18
(5,7)	4
(6,7)	10

(CO-2,5)

Q 6. (a) Solve the following game problem using Principle of Dominance.

Stratergies for Player 1/ Stratergies for player 2	S_1^2	S_2^2	S_3^2
S_1^1	10	5	-2
S_2^1	13	12	15
S_3^1	16	14	10

(b) Solve the following game problem by Graphical Method.

Stratergies for Player 1/ Stratergies for player 2	B_1	B_2	B_3
A_1	2	3	11
A_2	7	5	2

(CO-1,2,5)

Total No. of Pages: 2

3rd SEMESTER

Roll No.....................

END SEMESTER EXAMINATION

M.Sc. (Math)

MSMA 211: Number Theory

(Nov-Dec 2023)

Time: 3:00 Hours

Max. Marks: 50

Note: All questions are compulsory. Assume suitable missing data, if any.

Q1. a) Prove that $3n^2 - 1$ is never a perfect square. [5] [CO1]

b) Show that $16! + 86$ is divisible by 323.

OR

A certain integer between 1 and 1200 leaves the remainders 1, 2, 6 when divided by 9, 11, 13 respectively. What is the integer? [5] [CO2]

Q2. a) Show that for $n > 2$, $\phi(n)$ is an even number. [5] [CO3]

b) For any integer $n \geq 3$, show that $\sum_{k=1}^{n} \mu(k!) = 1$. [5] [CO3]

Q3. a) For a square free integer n, show that $\tau(n^2) = n$ if and only if $n = 3$.
[*Explanation: An integer is square free if it is divisible by no square number other than 1.*] [5] [CO3]

b) Using a table of indices for a primitive root of 17, solve the congruence: $9x^8 \equiv 8 \pmod{17}$.
[*Hint: 3 is a primitive root.*] [5] [CO4]

Q4. a) Prove that $\phi(2^n - 1)$, is a multiple of n for any $n > 1$.
[*Hint:*   *find order of 2 $\bmod 2^n - 1$*] [5] [CO4]

b) For an odd prime p, show that

$$1^n + 2^n + 3^n + \dots + (p-1)^n \equiv \begin{cases} 0 \pmod{p} & \text{if } (p-1) \text{ does not divide } n \\ -1 \pmod{p} & \text{if } (p-1) \text{ divides } n \end{cases}$$

[5] [CO4

Q5. a) State and prove Euler's Criterion for quadratic residues.

OR

For an odd prime p, prove that there are $\dfrac{p-1}{2} - \phi(p-1)$ quadratic

non residues of p that are not primitive roots of p.   [5] [CO5]

b) Evaluate the Legendre symbol: $\left(1234 \middle/ 4567\right)$.   [5] [CO5]

– END –

Total No. of Pages: 01   Roll no...........................

3ʳᵈ SEMESTER
M.Sc.
END TERM EXAMINATION   *November-2023*
COURSE CODE: MSMA 213

COURSE TITLE: Mathematical Modeling and Simulation

Time: 3 Hours   *Max. Marks : 40*

> **Note :** All question are compulsory.
> All questions carry equal marks.
> Assume suitable missing data, if any.

Q. 1 Develop a compartment model with three differential equations describing a predator − prey interaction, where there are two species of prey and one species of predators. What assumptions have been made in this model formulation. Discuss its stability also.

[CO 1, 2, 3]

Q. 2 Find all the fixed points and classify their stability $\dot{x} = e^{-x} \sin x$..

[CO 2, 3, 4]

Q. 3 Use phase portrait for stability of the system

$$\dot{x} = x + y^2, \dot{y} = -y$$ [CO 2, 3, 4]

Q. 4 A battle is modelled by

$$\dot{x} = -4y, \dot{y} = -x, x(0) = 150, y(0) = 90.$$

a. Write the solution in parametric form.
b. Who wins and when? State the loss at each side.   [CO 3, 5]

1

Q. 5 Use Routh Hurwitz-criterion the discuss the stability of   [CO 2, 4, 5]
$$\dot{x} = x + y, \dot{y} = 4x - 2y.$$

Q. 6 Use $V(x,y) = x^2 + y^2$ as a candidate Lyapunov function to prove the stability of the following model:
$$\dot{x} = -x + y + xy$$
$$\dot{y} = x - y - x^2 - y^3 \qquad \text{[CO 2, 4, 5]}$$

Q. 7 Sketch all the qualitatively different vector fields that occur as r varied for $\dot{x} = 1 + rx + x^2$. Show that a saddle node bifurcation occurs at a critical value of r, to be determined. Finally sketch the bifurcation diagram of fixed point x^* versus r.   [CO 2, 4, 5]

Q. 8 Consider the system $\dot{x} = \mu x - y + xy^2, \dot{y} = x + \mu y + y^3$. Show that a Hopf bifurcation occurs at the origin as μ varies. Is the bifurcation subcritical, supercritical or degenerate.   [CO 2, 4, 5]

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2

Total no. of pages: 02

III SEMESTER   240   Roll No.............
M.Sc. (Mathematics)
END TERM EXAMINATION   NOV/DEC-2023
MSMA219   Database Management System
Time: 3:00 Hours   Max. Marks: 40

Note : Answer any one in Question 3,
Assume suitable missing data, if any.

Q.1   Explain various constraints that may apply to generalization and/ or specialization in an ER diagram.   [5][CO2]

Q.2   Consider the relational schema: [2+3][CO1, CO2]
Emp (*Eid*, Ename, dno, salary, gender)

a) Write a relational algebra expression to retrieve Eid(s) who gets more salary than employees of department number 5.

b) Write an SQL query to retrieve department numbers for which department male employee(s) average salary is greater than the average salary of female employee(s).

Q.3   Consider the relation R (P, Q, S, T, X, Y, Z, W) with the following functional dependencies: [5][CO3]

{PQ → X; P →YX; Q →Y; Y→ZW}

The relation R is decomposed into two decomposition schemes, check whether the given decompositions D1 and D2 are lossy or lossless decompositions.

D1: R = [(P, Q, S, T), (P, T, X), (Q, Y), (Y, Z, W)]
D2: R = [(P, Q, S), (T, X), (Q, Y), (Y, Z, W)]

OR

Consider the relation R (A, B, C, D, E, F, G, H), with all the attributes having atomic values. F = {CH→G; A→BC; B→CFH, E→A; F→EG} is a set of functional dependencies.   [2+3][CO3]

a) Find all the candidate keys of R.
b) State and explain the highest normal form of R.

Q.4   Given a relational Schema R (W, X, Y, Z) and set of Function Dependency FD = { W → X; Y → X; Z → WXY; WY → Z }. Find its canonical cover.

[5][CO3]

Q.5

a) State whether the following transactions follow 2PL and/ or Strict 2PL and why?

T1	T2
Lock-S(A); Read (A);	
	Lock-S(A); Read (A);
Lock-X(B); Read (B); Write (B); Commit; Unlock (A); Unlock (B);	
	Lock-X (B); Read (B); Write (B); Commit; Unlock (A); Unlock (B);

b) For each of the following schedules, determine whether they are conflict serializable:

S1: R1(A), R1(B), W1(A), R2(B), W2(D), R3(C), R3(B), R3(D), W2(B), W1(C), W3(D)

S2: R1(A), R1(B), W1(A), R2(B), W2(A), R3(C), R3(B), R3(D), W2(B), W1(C), W3(D)

Q.6 Consider the following schedules and determine which of the following properties hold: *recoverable, cascadeless, or strict*   [4][CO4]

a) S1: T1:R(X), T2:W(X), T1:W(X), T2:Abort, T1:Commit

b) S2: T1:R(X), T2:R(X), T1:W(X), T1:Commit, T2:W(X), T2:Commit

Q.7 Write a short note on organization of record in Files.   [5][CO5]

Q.8 Differentiate between sparse and dense indices with the help of an example.   [5][CO5]

Total No. of Pages: 2

Roll No.........

FIRST SEMESTER

M.Sc. Physics

END SEMESTER EXAMINATION

Nov. 2023

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MSPH-101: MATHEMATICAL PHYSICS

Time: 3 Hours

Max. Marks: 50

> **Note:** Attempt *Any Five* questions.
> Assume suitable missing data, if any.

1. (a) Verify the divergence theorem for $\vec{A} = 4x\hat{\imath} - 2y^2\hat{\jmath} + z^2\hat{k}$ taken over the region bounded by $x^2 + y^2 = 4, z = 0$ and $z = 3$. (8) [CO2]

   (b) Identify and name the singularities of the function (2) [CO1]

   $$f(z) = \frac{1}{z \sin z}$$

2. (a) Verify that the following is an inner product in R^2, where $u = (x_1, x_2)$ and $v = (y_1, y_2)$ (5) [CO5]

   $$\langle u, v \rangle = x_1 y_1 - x_1 y_2 - x_2 y_1 + 3x_2 y_2$$

   (b) For the linear mapping $F: R^4 \to R^3$, find the basis and dimension of the kernel and image of F defined by: (5) [CO5]

   $$F(x, y, z, t) = (x + 2y + 3z + 2t, 2x + 4y + 7z + 5t, x + 2y + 6z + 5t)$$

3. (a) Show that the set I of all integers with the operation defined by (5) [CO4]

   $$a * b = a + b + 1$$

   forms an abelian group for the given composition.

   (b) Let I be the set of all integers and let R be the relation defined in I, such that xRy holds if $(x - y)$ is divisible by 5, $x \in I, y \in I$, i.e. $R = \{(x, y) : x \in I, y \in I, (x - y)$ is divisible by 5$\}$. Show that R is an equivalence relation in I and determine all the possible equivalence classes in the set I with respect to relation R. (5) [CO4]

4. A string is stretched and fastened to two points l apart. Motion is started by displacing the string into the form $y = k(lx - x^2)$ from which it is released at time $t = 0$. Apply the method of separation of variables to find the displacement of any point on the string at a distance x from one end at time t. (10) [CO3]

5. (a) Prove that $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$ (5) [CO3]

1

(b) Establish the recurrence formula: $P'_n(x) - xP'_{n-1}(x) = nP_{n-1}(x)$ (5) [CO3]

6. (a) Find the residues of the function $f(z) = e^z csc^2 z$ at all its poles in the finite plane. (4) [CO1]

(b) Let a be an element of a group G. Prove that the set $H = \{a^n; n \in I\}$ of all integral powers of a is a subgroup of G. (3) [CO4]

(c) Prove that $(ab)^{-1} = b^{-1}a^{-1}$ for all $a, b \in G$ i.e. the inverse of the product of two elements of a group G is the product of the inverses taken in the reverse order. (3) [CO4]

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Total No. of Pages: 2
FIRST SEMESTER
END TERM EXAMINATION

Roll No.......................
M.Sc. Physics
Nov.- 2023

MSPH-103: CLASSICAL MECHANICS

Time: 3 Hours

Max. Marks: 50

Note: Q1. is compulsory. Attempt Any four from the remaining questions. The marks assigned to questions are mentioned against them. Assume suitable missing data, if any.

1. (i) Consider a proton of energy 10MeV hitting a gold nucleus. The proton gets scattered by an angle of 45°. Calculate the differential cross section in barns/sterdian. Given, [$e^2 = 1.44$ MeV.fm, Z=79 for gold] (2) [CO3]

   (ii) Given a Lagrangian, $L = \frac{1}{3}T^2 + 2TV - V^2$ where, $T = \frac{1}{2}m\dot{x}^2$, $V = V(x)$ Find the corresponding Hamiltonian. (2) [CO1]

   (iii) The motion of a system during at interval of time may be regarded as an infinitesimal contact transformation generated by Hamiltonian. Explain. (2) [CO1]

   (iv) What is a four vector? Show that scalar product of two four vectors is invariant under Lorentz transformations. (2) [CO4]

   (v) Investigate the stability of circular orbit of radius r_o, when a particle of mass m, moves under the influence of central force

   $$f(r) = \frac{-k}{r^2} + \frac{\alpha}{r^3}$$ (2) [CO5]

2. (i) Derive Hamilton's canonical equations of motion Prove that the Hamiltonian of a conservative system is equal to the total energy of the system. (5) [CO4]

   (ii) The lagrangian for a system of one degree of freedom can be written as,
   $$L = \frac{m}{2}(\dot{q}^2 \sin^2 \omega t + \dot{q} q \omega \sin 2\omega t + q^2 \omega^2).$$
   What is the corresponding Hamiltonian? Is it conserved? Also, Introduce a new coordinate defined by, $Q = q \sin \omega t$, Find the Lagrangian in terms of new coordinate and the corresponding Hamiltonian. Is H conserved? (5) [CO5]

3. (i) Determine the canonical transformation defined by the generating function
   $$F_1(q, Q, t) = \frac{1}{2}m\omega(t)q^2 \cot Q$$
   Find also the new Hamiltonian, K. The old Hamiltonian is $H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 q^2$ (5) [CO3]

   (ii) Define the Poisson bracket of two dynamical variables. Given a Hamiltonian defined by,
   $H = \frac{p_x^2}{2m} + \frac{p_y^2}{2m} + V(\sqrt{x^2 + y^2})$ and a function, $u = xp_y - yp_x$, show that u is a constant of motion of the system. (5) [CO5]

4. (i) Obtain Rutherford's formula for differential scattering cross-section of charged particles by a coloumb field. Discuss the significance of results. (5) [CO3]

(ii) Derive the equation of orbit of a particle moving under the influence of a central force consistent with the inverse square law and discuss briefly the special cases depending upon the energy and hence of eccentricity. (5) [CO1]

5. (i) Apply the Hamilton Jacobi method to solve the one dimensional harmonic oscillator problem. (5) [CO3]

(ii) What are action-angle variables? Explain how they can be used to obtain the frequencies of periodic motion. Hence determine the frequency of linear harmonic oscillator. (5) [CO4]

6. (i) What is Minkowski space? Show that the Lorentz transformations can be regarded as transformations due to a rotation of axes in the four – dimensional Minkowski space. Hence deduce the Lorentz transformation. (5) [CO3]

(ii) What is the energy of a photon whose momentum is the same as that of a proton whose kinetic energy is 10MeV? Rest mass of the proton is 1000 MeV/c². (5) [CO2]

Total No. of Pages: 3

FIRST SEMESTER

END SEMESTER EXAMINATION

Roll No.................

M.Sc. Physics

Nov.-Dec. 2023

MSPH105: QUANTUM MECHANICS

Time: 3 Hours   Max. Marks: 50

> Note: Attempt any five questions.
> All questions carry equal marks.
> Assume suitable missing data, if any.

Q.1 (a) Consider a one-dimensional wave function   [5] [CO1]

$$\psi(x) = A\left(\frac{x}{x_0}\right)^n e^{-x/x_0},$$

where A, n and x_0 are constants. Using Schrödinger equation, find the potential $V(x)$ and energy E for which this wave function is an eigen function. Assume that as $x \to \infty$, $V(x) \to 0$.

(b) The wave function in $1s$ state of hydrogen atom is given as   [5] [CO1]

$$\psi_{1s} = \frac{1}{\sqrt{\pi}}\left(\frac{1}{a_0}\right)^{3/2} e^{-r/a_0},$$

where $a_0 = \dfrac{(4\pi\varepsilon_0)h^2}{4\pi^2 me^2}$ is the Bohr radius. Find the expectation value of

potential energy of electron in the $1s$ state. Use, $\dfrac{1}{4\pi\varepsilon_0} = 9\times10^9$.

Q.2 (a) Calculate the commutator $\left[\hat{X}, \hat{P}\right]$ in the momentum as well as the position representation and hence show that the commutators are representation independent.   [7] [CO2]

1

(b) Finite rotations about different axes do not commute; verify? [3] [CO2]

Q.3 (a) Why it is not possible to measure simultaneously all the three components of the orbital angular momentum operator? [3] [CO3]

(b) Consider a system which is in the initial state [7] [CO3]

$$\psi(\theta,\varphi) = \frac{1}{\sqrt{5}}Y_{1,-1}(\theta,\varphi) + \sqrt{\frac{3}{5}}Y_{10}(\theta,\varphi) + \frac{1}{\sqrt{5}}Y_{11}(\theta,\varphi)$$

(i) Find $\langle\psi|\hat{L}_z|\psi\rangle$.

(ii) If $\hat{L}_z$ were measured what values one will obtain and with what probabilities?

Q.4 Consider a three-dimensional infinite cubical well: [10] [CO5]

$$V(x,y,z) = \begin{cases} 0, & \text{if } 0 < x < a,\ 0 < y < a,\ 0 < z < a; \\ \infty & \text{otherwise} \end{cases}$$

The stationary states are

$$\psi^0_{n_x,n_y,n_z}(x,y,z) = \left(\frac{2}{a}\right)^{3/2}\text{Sin}\left(\frac{n_x\pi}{a}x\right)\text{Sin}\left(\frac{n_y\pi}{a}y\right)\text{Sin}\left(\frac{n_z\pi}{a}z\right),$$

where n_x, n_y and n_z are positive integers.

Now let's introduce the perturbation

$$H' = \begin{cases} V_0, & \text{if } 0 < x < a/2 \text{ and } 0 < y < a/2; \\ 0, & \text{otherwise.} \end{cases}$$

Invoke the *Degenerate Perturbation Theory* to calculate the first-order correction to the ground state and the first excited state energy.

Q.5 Find the Clebsch-Gordan (CG) coefficients associated with the addition of two angular momenta $j_1 = 1$ and $j_2 = \frac{1}{2}$. [10] [CO4]

Q.6 (a) Elaborate the principle underlying *Variational* method. [4] [CO4]

(b) Use *Variational* method to evaluate ground state energy for the one-dimensional harmonic oscillator:

$$H = -\frac{\hbar^2}{2m}\frac{d^2}{dx^2} + \frac{1}{2}m\omega^2x^2.$$
[6] [CO5]

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Total No. of Pages: 2

Roll No. ....

FIRST SEMESTER

M.Sc. (Physics)

END TERM EXAMINATION

(Nov.-Dec. 2023)

Course Code- MSPH 107

Course Title- Applied Optics

Time: 3:00 Hours

Max. Marks: 50

Note: Question 1 is mandatory. (2.5 x 4 = 10 marks)
Answer any five from question 2-8, (8 marks each)
Assume suitable missing data, if any. Where symbols have their usual meaning

1. (i) In free space $E(x,t) = 10\cos(\omega t - \beta x) 1_y$ V/m. Find the (a) the components of magnetic field intensity (H) of the wave and (b) average power crossing area of radius 1m in the plane x.

   (ii) What is the highest order of spectrum may be seen with monochromatic light ($\lambda = 6000\text{Å}$) by a diffraction grating with 5000 lines/cm.

   (iii) In Fraunhofer diffraction due to narrow slit, a screen is placed 2m away from the lens. If the slit width is 0.2mm and the first minima lie 5mm on either side of the central maxima, find the wavelength of the light used.

   (iv) Calculate the thickness of half wave plate with $\mu_o = 1.5247$, $\mu_e = 1.6672$ for $\lambda = 5893\text{Å}$.

   [CO#1-5]

2. What do you understand by Resolving power? Describe the resolving power of a plane diffraction grating and a prim. Differentiate between resolving power and dispersive power of a prism.

   [CO#2]

3. Describe the Fresnel type of diffraction due to a straight edge with Fresnel half-period zone. Also, show the intensity distribution in the diffraction pattern.

   [CO#2]

4. Draw a neat-labelled diagram of Fabry-Perot interferometer and describe it principle and application in details.

   [CO#5]

5. Define Holograms. Explain types of holograms namely reflection holograms and transmission holograms. Who discovered the off-axis holograms? How the shortcomings of in-line "Gabor" holograms been overcome by an off-axis holograms.

   [CO#3]

6. Describe half-period zones? Show that the resultant due to a plane wavefront at point in front of it on the screen is half that due to the first half-period zone. [CO#2]

7. Write short notes (any two)
   (a) evanescent waves and Goos-Hänchen shift
   (b) Coherence length and Coherence Time [CO# 3-5]
   (c) Optical beats

..................................END.................................

Roll No.................

1st Semester
M.Sc Physics

End Semester Examination

Time: 3:00 Hours   MSPH109: Electronics   Nov/Dec-2023

Max Marks-50

Note: Question 1 is compulsory. Attempt any four questions out of the remaining five.

Q1. Answer the following questions:

(10 = 2x5)

(a) Calculate the reverse saturation current of a diode if the current at 0.2V forward bias is 0.1mA at a temperature of 25°C and the ideality factor is 1.5.

[CO1]

(b) The datasheet of a JFET gives the following information: I_{DSS} = 3 mA, V_{GS} (off) = – 6V and gm (max) = 5000 μS. Determine the transconductance for V_{GS} = – 4V and find drain current I_D at this point.

[CO2]

(c) The output of a particular OP-AMP increases 8V in 12μs. The slew rate is ....

[CO3]

i) 90V/μs   ii) 0.67V/μs   iii) 1.5V/μs   iv) none of these

(d) If ADM= 3500 and ACM=0.35, the CMRR is given by... [CO3]

i) 1225   ii) 10,000   iii) 80 dB   iv) answers (ii) and (iii)

(e) Draw the state diagram of a Decade counter.
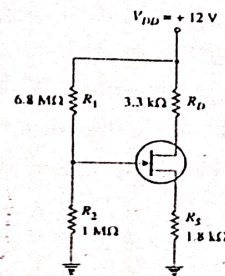
[CO4]

Q2 (a) What is difference between JFET and BJT and also determine the drain characteristics   of JFET. Also draw the symbol for P-type and N-type JFET. Sketch the transfer curve define by I_{DSS} = 12 mA and V_p = - 6V.
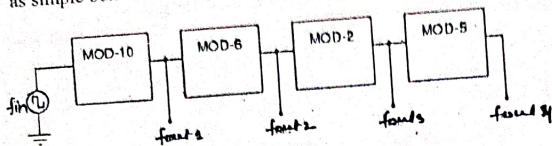
[6][CO2]

(b). Determine I_D and V_{GS} for the JFET with voltage-divider bias circuit given below, given that V_D = 7V   [4][CO2]

V_{DD} = + 12 V

6.8 MΩ R_1 3.3 kΩ R_D

R_2 1 MΩ R_S 1.8 kΩ

Q3 (a) When counters are used as frequency dividers, they are often drawn as simple boxes with one input and one output each, like the circuit

given below. Calculate the four output frequencies (f_{out1} through f_{out4}) given an input frequency of 1.5 kHz.   [4] [CO5]

Q3 (b) Determine the output pulses for this counter circuit, known as a Johnson Counter, assuming that all Q outputs begin in the low state.
                                                                                                    [6] [CO5]
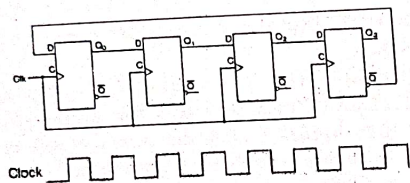

Q4(a) What are the different type of shift registers? Explain the working of Parallel in Serial Out (PISO) shift register with suitable circuit diagram.   [6] [CO4]

Q4(b) Design a MOD-6 counter using MOD-8 counter.   [4] [CO5]

Q5(a) Explain the working of OP-AMP as differentiator and derive the expression for the output voltage (V_0) for a given input voltage (V_i). Draw the output voltage for sinusoidal and square wave as input signal. Also explain the limitation of simple differentiator circuit and re-design the differentiator circuit for circumventing the limitations.   [6] [CO3]
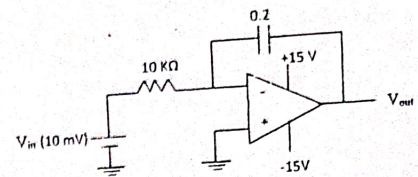
Q6(a) Design a non-inverting summing amplifier with three inputs and derive the V_{out} as (V1+V2+V3).   [6][CO3]

Q6(b) Define slew rate (SR) of an OP-Amp. Find the frequency of the square wave input pulse (Vi), where the output (Vo) will be a triangular wave with peak voltage of 4 V. The SR of an OP-Amp is 2V/µS.   [4][CO3]

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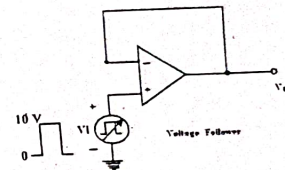
Total Number of Page 2
3rd SEMESTER
END SEMESTER EXAMINATION

Roll. No...........
M.Sc. Physics
Nov-Dec 2023

MSH201: Atomic and Molecular Physics

Time: 3:00 Hours   Max. Marks: 50

> Note: Answer All questions.
>   Assume suitable missing data, if any

Part A (Atomic Physics)

Q1. (a) Show that the ionisation potential of He^+ is four times that value for Hydrogen atom? An electron is in n=3 level of hydrogen. Compute the energy in Joules and in eV required to ionise the atom?   [2.5] [CO#1]
(b) Explain the meaning of degeneracy and define parity of a state? Show that for allows transitions the parity changes?   [2.5][CO#1]

(c) Explain the four quantum numbers. If the wavelength of the first line of the Balmer series of hydrogen is 6562.8 Å. Calculate the ionisation potential of the atom. (h=6.6 x 10 $^{-27}$ erg sec, c= 3 x 10 ^{10} cm/sec)
[5] [CO#1,2]

Q2. (a) What are the shortcomings of Bohr-Sommerfeld theory? How are they overcome in vector atom model?   [2.5] [CO#1]
(b) How many Revolutions does an electron in the n=2 state of a hydrogen atom make before dropping to the n=1 state? The average life time of an excited state is 10^{-8} second.   [2.5] [CO#1]
(c) Explain the quantum mechanical treatment of one-electron atom? Write the Schroedinger's Equation (S.E.) in spherical polar coordinates and using separation of variables, break the S.E. of hydrogen atom in three differential equations?   [5] [CO#1]

Q3. Write short notes on any **Two** from the following:
[2.5×2=5][CO#1,2]

(a) Space quantisation
(b) Orbital Magnetic Dipole Moment
(c) Larmor precession
(d) Electron Spin

Part B (Molecular Physics)

Q4. Describe Kasha's Rule and intensity of vibrational-electronic spectra, i.e., the so-called Franck-Condon principle with suitable diagrams.
[4][CO:4]

(a) Describe absorption and photoluminescence with Jablonski diagram, and fluorescence lifetime and quantum yield with mathematical expressions.
[5][CO:4]

(b) Sketch a diagram for spectrophotometer and spectrofluorometer and discuss their applications and important optical and electronic components.
[4] [CO:3]

Q5. (a) Drive energy expression of a diatomic vibrating rotator considering the concept of Born-Oppenheimer approximation and obtain the transitions between the rotational-vibrational energy levels, i.e., the vibration-rotation spectrum.
[4][CO#5]

(b) The frequency of OH stretching vibration in CH_3OH is 3,300 cm^{-1}. Estimate the frequency of OD stretching vibration in CH_3OD.
[4][CO#4]

[4][CO#3-5]

Q6. Discuss any **One** from the following
(a) Silent features of rigid and non-rigid rotators
(b) Predissocaiation
(c) Fortrat diagram

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END -SEMESTER EXAMINATION

NOVEMBER -2023 MSPH 203 NUCLEAR AND PARTICLE PHYSICS

Time: 3 Hours

Max. Marks:50

> Note: Q1 is compulsory. Attempt any four from the remaining questions. Symbols have their usual meanings.

1. Answer all the following questions.　　　　　[2x5=10][CO#1-5]
   a) Why low energy scattering is described as S -wave scattering.
   b) A nucleus decays by the emission of a gamma ray from an excited state of spin parity 2^+ to the ground state with spin parity 0^+. What is the type of corresponding radiation.
   c) The Q value of the α − decay of Th^{232} to the ground state of Ra^{228} is 4082 KeV. Calculate the maximum possible kinetic energy of the α-particle.
   d) Why can we say that the π^0 meson is its own antiparticle? Do all particles have anti particles? What about the photon?
   e) Explain in brief LIGO and INO.

2.
   a) Elucidate assumptions in nuclear shell model. Why nuclear shell model is called a model and not a theory. Analyse role of spin orbit coupling in this model.　　　　　[5][CO#3]
   b) Predict using shell model, the nuclear spins and parities of $^{11}_{6}C$, $^{44}_{20}Ca$, Ni^{61}_{28}, Ge^{73}_{32}, Sr^{89}_{38}. Briefly justify each prediction.　　　　　[5][CO#3,4]

3.
   a) The energy, E (in MeV) and their corresponding spin parity (j^p) of the low lying excited states of a even -even light nucleus are $0(0^+)$, $E(j^p)$, $1.17(4^+)$, $1.25(2^+)$, $1.35(0^+)$. Are these rotational excitations or vibrational excitations? Find the value of $E(j^p)$ for first excited state.　　　　　[5][CO#2,4]
   b) Distinguish between Mott scattering and Rutherford scattering. Provide at least three differences. Also write their differential. cross section expressions.　　　　　[5][CO#1]

4.

a) Draw a meson octet and baryon decuplet. Determine the quark structure of Δ^+, ρ^- and η'. Define Exotic particles. [5][CO#1,5]

b) [i]. The π^+ meson decays by the process $\pi^+ \to \mu^+ + \upsilon$. To what Lepton family does the neutrino υ belong? Is this neutrino a particle or anti particle? [2.5][CO#1]

[ii]Is the proposed decay process $\Xi^- \to \pi^- + n + K^- + p$ possible? Give at least two reasons in terms of conservation laws. [2.5][CO#2]

5.

a) A Co^{60} nucleus beta decays from its ground state with $j^p = 5^+$ to a state of Ni^{60} with $j^p = 4^+$. From the angular momentum selection rules, Find the allowed values of the orbital angular momentum L and total spin S of the electron-antineutrino pair. [5][CO#1,4]

b) There are four distinctly different K mesons. Determine their isospin quantum numbers. Why do we not assign to them the isospin quantum number T=3/2 so that they would constitute a isospin quartet? Also list two reasons for calling it a strange particle. [5][CO#1,2]

6.

a) Analyse the following processes. Find the dominant interactions in each one of them with reasons. [5][CO#1,4,5]

i. $K^- + p \to \Sigma^- + \pi^+$

ii. $\Delta^0 \to p + \pi^-$

iii. $\mu^- + \mu^+ \to k^- + k^+$

iv. $\Omega^- \to \Xi^0 + \pi^-$

v. $\Lambda^0 \to n + \gamma$

b) Explain principle and working of Scintillation detector. List three uses of Scintillation detector. [5][CO#4,5]

THIRD SEMESTER   **M.Sc.(Physics)**

END SEMESTER EXAMINATION   (*Nov.-2023*)

MSPH207 – FIBER AND INTEGRATED OPTICS

Time: 3 Hours   Max. Marks: 50

Section A

Answer all questions

1. (a)   Enumerate the limitations of ray theory of light guidance.

   (b)   Distinguish between radiation modes and guided modes of an optical waveguide.

   (c)   Write the transcendental equations for the symmetric and asymmetric TM modes of a symmetric planar step index waveguide at cut off.

   (d)   Sketch a diagram for normalised frequency vs normalised propagation constant for fundamental and first higher order propagating mode in case of step index optical fiber.

   (e)   Consider a 5mW laser beam passing through a 40 km fiber link of loss 0.5 dB/km. Calculate the output power in dBm & in mW.

   (f)   Determine the wavelength at which the quantum efficiency and the responsivity of a PIN photodetector are equal.

   (g)   The band gap energy E_g of $Ga_{1-x}Al_xAs$ depends on x through the following approximate equation.
$$E_g(x<0.37) = (1.424 + 1.247x) \, eV$$
   Calculate the band gap energy and the corresponding cut off wavelength for x = 0.2 and 0.3.

   (h)   Consider an LED operating at 0.9 μm with a spectral width of 45 nm. At this wavelength $\left|\dfrac{d^2n}{d\lambda_0^2}\right| = \approx 0.04 \, \mu m^{-2}$. Calculate the pulse broadening per kilometer due to material dispersion.

                                              [2*8 =16] [CO:1,2,3,4,5]

2. Plot normalized radial intensity distribution of LP_{01}, LP_{22} and LP_{31} modes for a step index fiber.

[3] [CO:2]

3. Explain the Vapor Phase Axial deposition method for the fabrication of optical fibers.

[3] [CO:3]

4. Explain the line width narrowing techniques which are adopted in semiconductor laser diodes.

[3] [CO:4]

Section B
Answer any five questions

5. Starting from the Maxwell's Equations for dielectric medium, establish an eigen value equation for step index optical fiber. Point out the method to solve the above mentioned Eigen value equation.

[5] [CO:2,5]

6. Calculate the power associated with the symmetric TE mode in a planar step index waveguide.

[5] [CO:1,4]

7. (a) Obtain the expression for waveguide dispersion in optical fibers.

(b) Estimate the waveguide dispersion in single mode step index fiber at a wavelength of 1.34 μm when the fiber core radius and refractive index are 4.4 μm and 1.48 respectively.

[3,2] [CO:3,5]

8. (a) A double heterojunction InGaAsP LED emiting at peak wavelength of 1310 nm has radiative and non radiative recombination times of 25ns and 90ns respectively. The drive current is 35 mA.
   (i) Find the internal quantum efficiency and the internal power.
   (ii) If the refractive index of the light source material is $n = 3.5$. Find the power emitted from the device.

(b) With the help of suitable diagram, explain the frequency response for an LED, exhibiting electrical bandwidth and optical bandwidth. Mention the relationship between optical bandwidth and output power.

[3,2] [CO:4,5]

9. (a) Establish the relation between responsivity and quantum efficiency of a PIN photodiode.

(b) Consider an InGaAs PIN photodiode with a quantum efficiency of 0.6. Calculate the responsivity at 1300 and 1550 nm. Why is the responsivity larger at 1550nm?

[3,2] [CO:4,5]

10. (a) Describe the design and working mechanism of semiconductor laser diode. Discuss both quantitatively and qualitatively, how the condition of population inversion and light amplification is achieved in semiconductor laser diodes.

(b) Consider a semiconductor laser operating at 900 nm. If the spectral width over which gain is available is 15 nm, what is the maximum cavity length for single longitudinal mode operation? Assume the refractive $n = 3.6$.

[3,2] [CO:4,5]

Third Semester
M.Sc. (Physics)

END TERM EXAMINATION
COURSE CODE: MSPH 215
Time: 3.00 Hours

COURSE TITLE: Plasma Physics

November/December 2023

Max. Marks : 50

Note : Attempt any Five Questions
All Questions carry equal Marks
Assume Suitable missing data, if any

Q.1. Explain the construction and working of Microwave plasma CVD system. How can you measure the plasma parameters (electron density n_e and electron temperature T_e) using Langmuir probe techniques?
[10][CO#1]

Q.2. (a) What is the plasma sheath? In what aspects plasma sheath is different from bulk plasma?
[5][CO#1]

(b) What is Carbon Nanotube (CNT)? Differentiate between Carbon Nanotube and 2D graphene.
[5][CO#5]

Q.3. Show that the dispersion relation for electrostatic waves in a magnetized plasma is given by

$$\varepsilon \equiv 1 - \frac{\omega_p^2}{\omega^2}\frac{k_z^2}{k^2} - \frac{\omega_p^2}{\omega^2-\omega_c^2}\frac{k_x^2}{k^2} - \frac{\omega_{pi}^2}{\omega^2}\frac{k_z^2}{k^2} - \frac{\omega_{pi}^2}{\omega^2-\omega_i^2}\frac{k_x^2}{k^2} = 0$$
[10] [CO#2]

Q. 4. What is kelvin Helmholtz Instabilities (KHI)? For a fully ionized plasma in the presence of magnetic field, show that the instability occurs if
[10] [CO#3]

$$A > \frac{\gamma}{\beta}\left[1 + \frac{1}{2}\frac{\Lambda^2}{(\gamma/\beta)^2}\right].$$

Q.5. What is the distribution function f? Solve the Vlasov equation for an isotropic plasma ($B_s = 0$) and

obtain $\varepsilon = 1 + \chi_e + \chi_i$, where
[10] [CO#4]

$$\chi_e = \frac{2\omega_{pe}^2}{k^2 v_{th}^2}\left[1 + \frac{\omega}{kv_{th}}Z(\omega/kv_{th})\right] \quad \text{and} \quad \chi_e = \frac{2\omega_{pi}^2}{k^2 v_{thi}^2}\left[1 + \frac{\omega}{kv_{thi}}Z(\omega/kv_{thi})\right]$$

Q.6. What is Cerenkov free electron laser (CFEL)? Explain the physical mechanism using suitable schematic diagram.
[10] [CO#5]

Q.7. What is Free Electron Laser (FEL)? Explain the physical mechanism using schematic diagram. Show that the growth rate of the FEL instability is given by

$$\Gamma = \left(\frac{v_{0\perp}^2}{c^2}\frac{\omega_{pb}^2 k_w c}{\gamma_0^3}\right)^{1/3}\frac{\sqrt{3}}{2}.$$
[10] [CO#5]

Total No. of Pages: 2

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THIRD SEMESTER
END SEMESTER EXAMINATION

Roll No. ... .

M.SC. [PHYSICS]
(December, 2023)

MSPH-217   CHARACTERIZATION TECHNIQUES

Time: 3:00 Hours

Max. Marks: 50

> Note: Answer Any FIVE questions.
> Assume suitable missing data, if any.

1. Answer all the questions.   [2 x 5]
   [a]. Distinguish between bright-field and dark-field imaging in optical microscopy.
                                                                   (CO4)
   [b]. Discuss about average and root mean square (RMS) roughness in AFM. Write roughness calculation relation for both   (CO4)
   [c]. Draw atomic energy level transition diagram for Molybdenum (Mo) and explain the α and β transitions of K, L and M shells.   (CO1)
   [d]. What is dead time? Explain proportional counter of X-ray detection with proper diagram.
                                                                   (CO1)
   [e]. What is the range of skeleton region in FTIR? How it is helpful for the characterization in FTIR?
                                                                   (CO3)

2[a]. Explain 'Unit Cell' scattering. Prove that Unit Cell scattering (Structure factor) is given by;

$$F_{hkl} = \sum_{1}^{N} f_n e^{2\pi i (h u_n + k v_n + l w_n)}$$

                                                                   (CO1) [5]

   [b]. Differentiate between rotating crystal and powder diffraction method of X-rays for characterization of the materials. Discuss the factor affecting the intensity of X-rays in brief. Write down the $K\alpha 1$ and $K\alpha 2$ wavelengths of Cu target. Why Ni filter is used with Cu target?
                                                                   (CO3)[5]

3[a]. Discuss working and principle of Fourier transform infra-red spectroscopy (FTIR). Consider a FTIR pattern of any compound and show finger print and characteristic regions in it and explain.
                                                                   (CO3) [5]

   [b]. Describe the working and principle of polarization type optical microscope with all its components. How it is different from dark

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filed microscope? Write any two applications of polarization type optical microscope. (CO4) [5]

4[a]. What do you mean by electron microscope? Describe electron beam generation process using thermionic emission process in scanning electron microscope(SEM). Why LaB$_6$ filament material is better prospect to use in thermionic emission? (CO2) [5]

[b]. Explain brightness in SEM. How many electrons per second can directed at the given area of specimen, for a beam of electrons generated by thermionic emission at high temperature of 2700 K and applied potential 40 kV? if the work function of filament material is 4.5 eV. (CO2) [5]

5[a]. Using force – distance curve, explain the cantilever and tip interaction with the specimen to measure adhesion force using AFM. (CO4) [5]

[b]. Define piezo sensitivity in AFM, what will be the distance travelled by a cantilever during adhesion force measurement? if the sensitivity of piezo crystal is 8.0 nm/V for measured adhesion force with a deflection of 5 V signal. (CO2) [5]

6[a]. Explain the principle, working and application of thermal gravimetric technique (DSC). What are the factors affecting the DSC? (CO5) [5]

[b]. What are the information deduced from thermogravimetric analysis (TGA)? A mixture of $CaCO_3$ and CaO is analyzed using TGA technique. TGA curve of the sample indicates that there is a mass change from 145.3 mg to 115.4 mg between 500–900 °C. Calculate the percentage of $CaCO_3$ in the sample. (CO5) [5]

7. Discuss briefly any *FOUR*. [2.5X4]
[a]. Magnetic force microscopy (MFM) (CO4)
[b]. Transmission Electron Microscopy (TEM) (CO2)
[c]. Tapping Mode Atomic Force Microscopy (TM-AFM) (CO4)
[d]. Differential thermal analysis (DTA) (CO5)
[e]. Atomic absorption spectroscopy (AAS) (CO3)
[f]. Scanning Tunnelling Microscopy (STM) (CO4)

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