QUESTION PAPERS FOR END TERM THEORY EXAMINATIONS
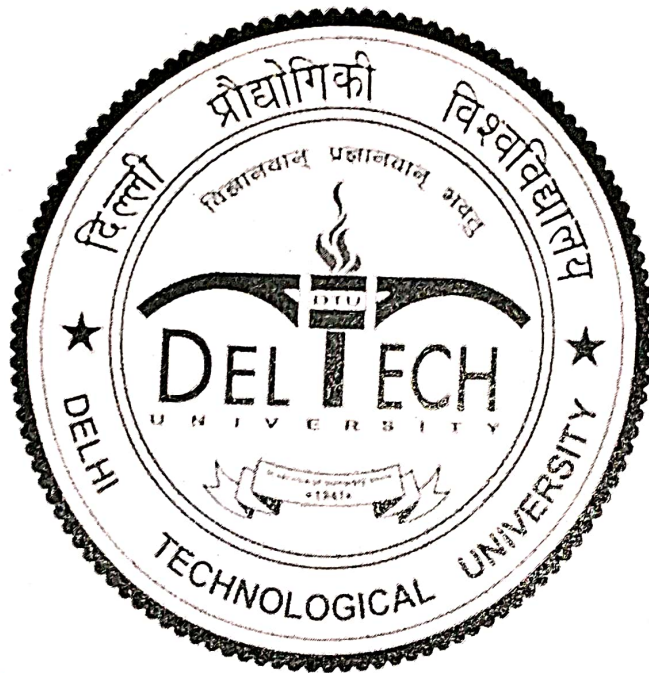## May-2024

M.Tech., MTPT, M.Sc., MBA, EMBA, M.Des., 2nd, 4th & 6th SEMESTER

INDEX

M.Sc.

Total no of pages: 2

Roll No: ....

2nd_ SEMESTER

MSc. [Biotechnology]

END SEMESTER EXAMINATION

May 2024

MSBT 102 : Immunology

Time: 3:00 Hours

Max. Marks : 40

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

1. Write short notes on the following: : [2x4]   [CO#3, 4,5]

   (a) DNA and RNA vaccines

   (b) Allelic exclusion

   (c) Pernicious anaemia

   (d) Immune response to protozoa

2. Attempt any 2 questions of the following: [4x2]   [CO#2,3]

   (a) Difference in anti- viral/ anti tumor immune response by T cytotoxic cells and NK cells. Role of T helper cells in immune response

   (b) Comparative account of classical vs alternate complement fixation pathways

   (c) Mechanism of endogenous antigen presentation on MHC I and cross-presentation of exogenous antigen on MHC I

3. Attempt any 2 questions of the following: [4x2]   [CO#1,2]

   (a) Explain how two B cell clones which have the same set of VDJ rearrangement may have different affinities for the same antigen. Justify the statement that IgM is the only antibody that can exist in both membrane-bound and secreted forms (give suitable schematic diagrams).

   (b) Compare and contrast between T cell and B cell signalling. Explain how T cell activation is regulated by inducible expression of CTLA4.

(c) Enumerate the features of cytokines? How do cytokines determine disease outcome by determining Th1 or Th2 response? What is the difference between the different forms of IL2 receptors, how does it impact the immune response?

4. Attempt any 2 questions of the following: [4x2]   [CO#1, 2,5]

(a) What is the crucial difference in Central and Peripheral tolerance? What is graft vs host rejection and why does it occur?. Explain why at times there is delayed rejection of graft?

(b) What are the different types of tumor antigens? Explain how immune system fights tumorigenesis. What do you understand by Adoptive Transfer?

(c) Describe how the innate immune system plays an important role in immunity to bacterial infections? Explain how co-stimulation is essential for adaptive immune system and is also important in adding to the specificity of the adaptive immune system.

5. Attempt any 2 questions of the following: [4x2]   [CO#3,4, 5]

(a) What is autoimmunity and explain its probable causes. Describe in detail how Graves disease and Hashimoto's thyroiditis differ, despite both being autoimmune diseases involving thyroid.

(b) What is the difference between monoclonal and polyclonal antibodies? What do you understand by hybridoma technology? Explain the principle of HAT selection in monoclonal antibody production.

(c) Explain using suitable diagrams the different types of ELISA. How is a flowcytometer capable of detecting different types of immune cells in a PBMC preparation?

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

SECOND SEMESTER   M.Sc [BT]

END TERM EXAMINATION   MAY-2024

MSBT 104: Microbiology and Industrial Applications

Time: 03:00 Hours   Max. Marks: 40

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

Q.1 (a) How fatty acid profile and DNA composition is used for identifying and classifying bacteria.   [4] [CO1]

(b) Explain Three domain system of classification: Write the differences between Viroid and Prion.   [2+2=4] [CO1, CO2]

Q.2 (a) What do you mean by non-growth associated product formation. The equation for aerobic production of acetic acid from ethanol is:

$$C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$$ [1+3=4] [CO2]
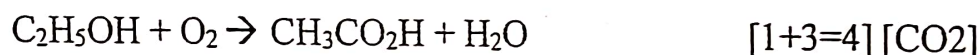
Acetobacter aceti bacteria are added to vigorously aerated medium containing 10 g/l ethanol. After some time, the ethanol concentration is 2 g/l and 7.5 g/l acetic acid is produced. How does the overall yield of acetic acid from ethanol compare with the theoretical yield?

(b) Differentiate any 2 of the following: [2+2=4] [CO2, CO3]
(i) Endotoxin and Exotoxin
(ii) Mutualism and Commensalism
(iii) Oxidative and Substrate level phosphorylation

Q.3 (a) What is an infection. Explain the stages involved in infection and disease with the help of curve.   [1+3=4] [CO3]

(b) Write on *any two* of the following: [2+2=4] [CO3, CO4]

(i) Prebiotic and Probiotic
(ii) Microbial fuel cells
(iii) Pathogenicity islands

Q.4 (a) What is biogeological cycle. Discuss nitrogen cycle with diagram.

[1+3=4] [CO4]

(b) What do you mean by the term Design criteria. Explain the working of Continuous plate heat exchange sterilization along with diagram.
[1+3=4] [CO5]

Q.5 (a) Explain the approaches used for strain improvement of microorganisms.
[4]   [CO5]

Or

What do you mean by Quorum sensing. How do you separate particles based on Ion exchange Chromatography.   (2+2=4) [CO4, CO5]

(b) Describe the steps involved during production and purification of primary metabolite.

[4] [CO5]

IInd SEMESTER

M.Sc. Biotechnology

END TERM EXAMINATION   *May-2024*

MSBT 106 GENETIC ENGINEERING

Time: 3:00 Hours   *Max. Marks: 40*

> **Note:** Answer any 5 questions.
> All questions carry equal marks.
> Assume suitable missing data, if any.

Q.1. How would you differentiate between modifying enzyme verses restriction enzymes? What are different modifications necessary in blunt end cloning? Explain the relevance of vector:insert ratio and ligation conditions in terms of enzyme kinetics.   [08][2]

Q.2. A multi loci region of 500kb in human genome has various regulatory sequences that have lot of importance for gene expression. Describe strategy (ies) to identify these regions in one go with 100-200 picogram of DNA. Explain various limitations to execute the experiment.   [08][3]

Q.3. Explain the mechanism and protocol of agarose gel electrophoresis. Explain the composition of reagents and buffers used in agarose gel electrophoresis. Discuss the difference between horizontal and vertical gel electrophoresis. Explain the colony hybridization technique.   [08][1]

Q.4 An arbitrary internal DNA sequence is present in the qARM of human chromosome number 15 which is; 5' CTCAGTCACTAGCATGGACCGAGCTAGATACAACAATTCACGAT AACTTAGCCGATTGCTAATACTAGCTTACGTTACGACATGAACT AATACGCCGGATCGATCGACTAACATTC-3'. In order to identify and validate the sequence in human genomic DNA what methodology would you opt? Write detail steps with pictorial representation.   [08][4]

Q. 5 (i) Microarray

(ii) Antibody staining and validation through microscopy   [08][5]

Q.6 How would you describe multiplex PCR over semi quantitative and real time PCR? Explain the difference between HOT-start PCR and nested PCR. What are the different factors that cause saturation of an amplicon? During designing of a primer set what criterias should be followed and also explain why the melting temperature is an important criteria in PCR reaction?

[08][4]

Q.7. What are the different tools of recombinant DNA technology? Explain the working protocol and application of recombinant DNA technology with an appropriate diagram. Briefly discuss the role of recombinant DNA technology in human health and disease.   [08][2]

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EVEN SEMESTER
M.Sc. BIOTECHNOLOGY

END TERM EXAMINATION   MAY 2024

COURSE CODE: MSBT108

COURSE TITLE: GENETICS

Time: 03:00 Hours   Max. Marks: 50

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

Q.1 a) Explain the Fluctuation test performed by Luria-Delbruck and its outcomes.

b) Explain briefly the process of genetic recombination in F+ and F- bacteria through conjugation.

[5][CO1]

Q.2 a) Explain the stages of DNA replication of M13 phage inside the host bacterial cell.

b) What is the difference between isoschizomers and isocaudomers? Give one example of both.

[5][CO 2]

Q.3 Discuss the patterns of inheritance, defects in genes, and symptoms associated with any 2 of the following diseases:
   a) Tay Sachs Disease
   b) Phenylketonuria
   c) Lesch Nyhan syndrome

[5][CO 3]

Q.4 a) What do you understand by epistasis? Explain with the help of a relevant example how epistasis can lead to deviation from Mendel's laws.

b) Explain how ABO blood group inheritance represent a case of codominant alleles.

[5][CO 3]

Q.5 a) Explain how an imbalance in the ratio between alpha and beta chains of haemoglobin results in a particular hemoglobinopathy.

b) What causes uniparental disomy? Explain briefly heterodisomy and isodisomy.

[5][CO 3]

Q.6 What are different types of zygotic genes and their roles in Drosophila embryogenesis?

OR

With the help of suitable diagrams explain early stages of embryonic development in Drosophila.

[5][CO 4]

Q.7 What is non disjunction? Explain aneuploidy and write briefly about any two disorders resulting from it.

[5][CO 4]

Q.8 Explain the use of Comparative Genomic Hybridization (CGH) in molecular cytogenetics.

[5][CO 4]

Q.9 How is genome polymorphism different from mutation and what is the possible link between the two? Mention four different kinds of polymorphisms identified in genome.

[5][CO 5]

Q.10 What is genetic drift and how can it arise through founder effect and genetic bottleneck?

[5][CO 5]

OR

State the Hardy-Weinberg Law, its significance, and assumptions made while doing the predictions.

[5][CO 5]

IV SEMESTER
M.Sc Biotechnology
END TERM EXAMINATION   MAY 2024
COURSE CODE – MSBT 204
COURSE TITLE – Genomics and Proteomics

Time: 3:00 Hours   **Max. Marks: 50**

Note : Attempt any 5 questions.
All questions carry equal marks.
Assume suitable missing data, if any.

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1. (a) What is RFLP and how is it used in genetic analysis? Describe the process of using RFLP to diagnose a genetic disorder.

   (b) Develop a hypothetical study that uses RFLP to track genetic diversity in an endangered species population.

   [5+5] [CO#MSBT-204.1]

2. (a) Demonstrate how to use the NCBI's Gene database to find information about gene regulation for a specific human gene.

   (b) Consider how improvements in database interfaces and search capabilities could enhance research outputs.

   [5+5] [CO#MSBT-204.2]

3. (a) What is the principle behind isoelectric focusing? Describe a scenario where isoelectric focusing would be used to analyze protein mixtures. What would you expect to achieve?

   (b) Compare and contrast isoelectric focusing with SDS-PAGE in terms of protein separation capabilities.   [5+5] [CO#MSBT-204.3]

4. (a) List the main components of an LC/MS system. Describe how LC/MS can be used to identify and quantify proteins in a sample.

(b) Analyze the strengths and limitations of using LC/MS for proteomic research compared to other mass spectrometry techniques.

[5+5] [CO#MSBT-204.3]

5. (a) Enumerate the primary stages in the drug discovery pipeline, highlighting where gene target identification occurs.

(b) Define 'gene target' and its significance in the development of therapeutic drugs. Describe how a specific gene target is linked to the mechanism of action of a drug.

[5+5] [CO#MSBT-204.4]

6. Compare protein microarrays to peptide microarrays in terms of their synthesis, stability, and application scope. Which applications are better suited to each type and why? Assess the advantages and limitations of using protein microarrays for detecting biomarkers in disease diagnostics.

[10][CO#MSBT-204.5]

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2nd SEMESTER

M.Sc.

END TERM EXAMINATION

May-2024

COURSE CODE MSBT1105

COURSE TITLE ENVIRONMENTAL BIOTECHNOLOGY

Time: 03:00 Hours

Max. Marks: 50

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

Q.1

(a) Differentiate between the three categories of municipal solid waste.

(b) Explain why landfills are harmful to environment.   [10][CO4]

Q.2   Taking example of Ganga River, explain the strategies to control water pollution and state measures for its management.   [10][CO3]

Q.3   Explain the types and processes involved in bioremediation of pollutants in environment.   [10][CO4]

Q.4   Attempt any one from the following:

(a) Explain about the different water quality parameters to measure water pollution in water bodies.

[10][CO3]

OR

(b)   What   is   E-waste?   Explain   the   process   of   e-waste   recycling.
[10][CO4]

Q.5 Define the following (Any five)   [10][CO1, CO2]

(a) Nitrification

(b) Environmental Impact Assessment

(c) Eutrophication

(d) Types of conservation

(e) Xenobiotics

(f) Biofertilizer

(g) Global environmental problems

٩٨   *Roll no..............*

4th SEMESTER

M.Sc.

END TERM EXAMINATION   *May-2024*

COURSE CODE <u>MSBT2065</u>

COURSE TITLE <u>BIOENERGY</u>

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

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

Q1. Explain the development and application of bioenergy technologies in the economic growth and job creation.   **[10][CO5]**

Q2. Explain Biohydrogen production by anaerobic bacteria and photosynthetic algae.   **[10][CO4]**

Q3. (a) What are some recent breakthroughs in bioenergy research, particularly in the development of more efficient biofuel production methods?   **[10][CO1]**

OR

     (b) Explain the general procedure for producing biodiesel from feedstocks such as vegetable oils or animal fats. List advantages and disadvantage of utilising Jatropha seeds in biodiesel production.

                                        [10][CO3]

Q4. Explain the process of bioethanol production from sugar and starch.   **[10][CO2]**

Q5. Write short notes on the following: (Any five)   **[10][CO1, CO2, CO5]**
     (a) Carbon neutrality
     (b) CBG in India
     (c) Future of bioenergy in India
     (d) Generations of biofuels
     (e) Alcohol distillation
     (f) Prospects of solar and wind energy in India

2nd SEMESTER

M.Sc. (Chemistry)

END TERM EXAMINATION

May-2024

COURSE CODE: MSCH-102

COURSE TITLE: Molecular symmetry and Group Theory

Time: 03:00 Hours

Max. Marks: 50

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

Q.1 What is the ground term symbol for octahedral Mn^{2+} ion. Derive.   [CO1]

Q.2 Explain Orgel diagrams with suitable example.   [CO1]

Q.3 Explain some of the most essential aspects of the CFT. How has this theory been used in explaining the colour, magnetic characteristics and distorted shapes of metal complexes?   [CO2]

Q.4 What do you understand by the terms hydrolysis, acid hydrolysis and base hydrolysis of coordination compounds? Explain the mechanism of base hydrolysis of an octahedral complex using suitable example.   [CO3]

Q.5 (a) What is Chelate effect? Why it is considered as an entropy effect? Predict and give reasons which of the following pairs would have higher order of stability.   [CO3]

(i) $[Cu(acac)_2]^{2+}$ $[Cu(en)_2]^{2+}$
(ii) $[Cu(en)_2]^{2+}$ and $[Cu(NH_3)_4]^{2+}$

Q.6 Discuss LFT with suitable example for octahedral complexes.   [CO3]
Q.7 Determine the symmetry elements and point group of the following molecules:

(i) Trans- N_2F_2 (ii) $POCl_3$ (iii) $[PtCl_4]^{2-}$ [CO4]

Q. 8. Differentiate between   [CO5]

(i) Group and subgroup. Give appropriate example.

(ii) Symmetry elements and symmetry operations. Give suitable examples.

Q. 9. What is character table. Construct the character table of C_{3v} point group.   [CO4]

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Q. 10. Give examples of molecules having the following point groups: [CO5]

C_{2v}, D_{5h}, D_{3h}, D_{5d}, C_{3h}

Q. 11. State and explain the Great Orthogonality Theorem. Write its consequences.

[CO]

Q. 12. State answers and provide appropriate explanation for your responses to the following (any 2) -

[CO]

i) Decode the Mulliken symbol- A''_{2u}

ii) $C_{(2)z} \times C_{(2)y}$

iii) Associated symmetry operations of the S_5 axis.

) S)

SECOND SEMESTER

END TERM EXAMINATION

M.Sc. [Chem]

May-2024

Course Code MSCH 104

Course Title: Photochemistry & Pericyclic reactions and Spectroscopy

Time: 3 Hours

Max. Marks : 50

Note: Answer questions of courses A & B separately in single answer sheet. Assume suitable missing data, if any
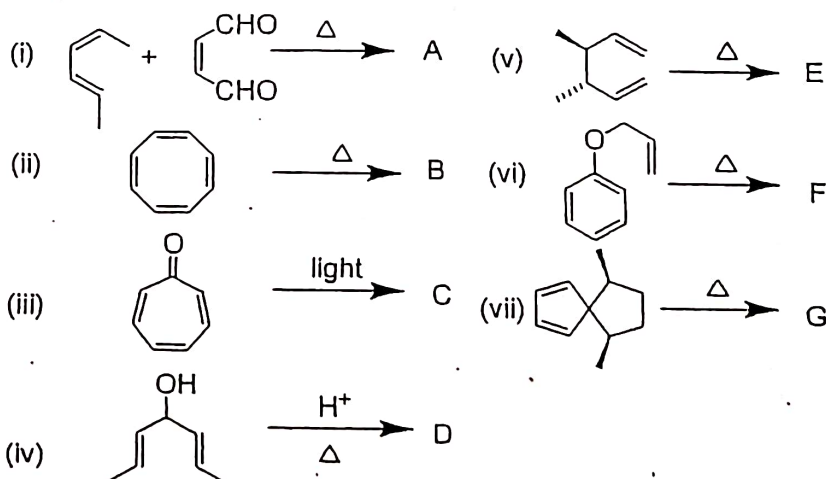
Course A

[1] Explain the mechanism with the help of an example for the following reactions: [4×3; CO1,2]

(i) Paterno Büchi reaction (iii) [1, 5] Sigma-tropic reaction
(ii) Lumiketone rearrangement (iv) Norrish type -I

[2] Explain **any two** of the following: [3+3; CO1,2]

(a) Explain the phenomenon of fluorescence and phosphorescence with the help of Jablonski diagram.

(b) Why group ene transfer reaction occurs at higher temperature and how we can increase the rate of the reaction.

(c) Explain the Frontier molecular orbital (FMO) approach in the presence of heat and light for 1, 3, 5-Hexatriene molecule.
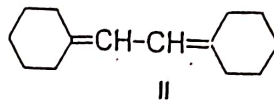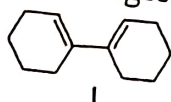
[3] Write product(s) of **all** reactions with the stereochemistry (if required). [1×7; CO1,2]

Course B

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[4] Calculate and explain the λ_{max} values for the dienes given below and explain the changes in wavelength: [3, CO3]

[5] 2-Hydroxy-3-nitroacetophenone shows two carbonyl stretching frequencies. Suggest their values and explain with structure.

[3, CO3]

[6] Write the ^{13}C chemical shift for 2-methylfuran. [3, CO4]

[7] Discuss the ^1H NMR spectrum each of m-dinitrobenzene and 2,4-dichloroaniline.

[4, CO4]

[8] Ethyl phenyl amine displays prominent fragmentation peaks at m/z 77 and 106. How can you account for these values? [4, CO3]

[9] Write short note on any two of the following: [4+4, CO4]
(i) McLafferty rearrangement
(ii) Molecular Vibrations in IR spectroscopy
(iii) ESR

MSCH 106 Physical Chemistry II

Time: 3:00 Hours   *Max. Marks : 50*

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

Q.1 [a] Derive the relation between Pressure and partition function

[CO1] [2.5 Marks]

[b] Find the value of β [CO2] [2.5 Marks]

Q.2 [a] Calculate the entropy of a collection of N independent harmonic oscillators

[CO3] [2.5 Marks]

[b] Show that $Q = q^N$ [CO3] [2.5 Marks]

Q.3 Derive the weight expression for Fermi-Dirac statistics and reduce the statistics to Boltzmann distribution   [CO2,CO4] [5 Marks]

Q.4 Find the expression of Translational contribution of the partition function

[CO2] [5 Marks]

Q.5 Use the electron configurations of NO and N_2 to predict which is likely to have the shorter bond length.   [CO3,CO5] [5 Marks]

Q.6 Discuss the approximations built into the Hückel method.   [CO2] [5 Marks]

Q.7 Discuss the steps involved in the construction of sp hybrid orbitals. (physical Chemistry aspects only).   [CO2,CO5] [5 Marks]

Q.8 Explain Langmuir-Hinshelwood mechanism for a bimolecular process

[CO1] [5 Marks]

Q.9 What is mean by volcano curve? and explain its significance.

[CO2] [CO4] [5 Marks]

Q.10 Illustrate Born-oppenheimer approximation in detail   [CO3] [5 Marks]

SECOND SEMESTER

M.Sc. (Chem)

END TERM EXAMINATION   १५४

May-2024

MSCH112: Basics of IPR and computers

Time: 3.00 Hours

Max. Marks : 50

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

Course A

Q1. Explain in detail with suitable example (**any five**) [5×5, CO1&2]
   [a] Patents
   [b] Copyrights
   [c] Trademarks
   [d] Geographical Indications
   [e] Industrial Designs
   [f] Trade Secrets

Course B (ANY FIVE)

Q2   Write a C program to accept two integers and check whether they are equal or not.   [5 CO 2&3]

Q3   What is a flow chart? Explain different symbols used for the flow chart. Explain with an example.   [5 CO 2&3]

Q4   What are the most prominent features of MS Word and how it is superior then Latex?   [5 CO3]

Q5   What will be the output of the following C code?   [5×1 CO3]

   (a)   ```
#include<stdio.h>
int main()
{
int i;
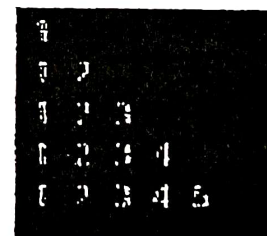for(i=1;i<=5;i++)
```

```
{
    int i=10
    printf("%d",i);
    i++;
}
return 0;
}
```

(b)   <<, >> is used for

(c)   How many types of loops are there in C

(d)
```
#include<stdio.h>
int main()
{
int i;
i=(10,20,30);
printf("%d",i);
return 0;
}
```

(e)   Write the range of signed char in C

Q6   (a) Differentiate between prefix and postfix.   [2.5×2 CO3]

(b) differentiate between compiler, assembler and interpreter.

Q7   Explain any five operators used in C programming with the help of an example.   [5 CO3]

Q8   Write a C program to print these patterns   [2.5 × 2 CO3]

IV SEMESTER
MSc Chemistry
END TERM EXAMINATION   May 2024

Course Code: MSCH202a

Course Title: Spectroscopy for Inorganic Chemists

[Time: 3H]   [Max. Marks: 50]

Instructions: *Attempt any 10 questions.*

Ques 1. Using Transition Moment Integral and character table for C_{2v} point group (given below), show that $\pi - \pi^*$ transitions are allowed in formaldehyde molecule.   (5) [CO1]

Character table for C_{2v} point group

	E	C_2 (z)	$\sigma_v(xz)$	$\sigma_v(yz)$	linear, rotations	quadratic
A_1	1	1	1	1	z	x^2, y^2, z^2
A_2	1	1	-1	-1	R_z	xy
B_1	1	-1	1	-1	x, R_y	xz
B_2	1	-1	-1	1	y, R_x	yz

Ques 2. Explain the following terms.   [CO2]
    a) Racah Parameter   (2)
    b) Zeeman Splitting   (1)
    c) Gyromagnetic Ratio   (2)

Ques 3. K_3CrF_6 show three transitions at 34400 cm^{-1}, 22700 cm^{-1} and 14900 cm^{-1}. The Racah parameter for free Cr^{3+} ion is known exactly (B = 918 cm^{-1}). Assign the transitions and calculate the value of Dq. Comment whether there exist any mixing of P and F states.   (5) [CO1]

Ques 4. Explain the significance of Relaxation processes in NMR transitions.   (5) [CO3]

Ques 5. What is Larmor frequency? What is the Larmor frequency of a proton spin with zero chemical shift when it is placed in an external magnetic field of 4.7T (for proton, $\gamma = +2.67 \times 10^8$ rad s^{-1}T^{-1}).   (5) [CO4]

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Ques6. Using NMR selection rule, show that for a system having two coupled nuclear spins, the spectrum consists of two doublets.   (5) [CO3]

Ques7. Prove that the population of energy levels in NMR transition are nearly equally populated.   (5) [CO2]

Ques8. Explain the significance of Isomer shift in Mössbauer spectroscopy.
(5) [CO4]

Ques9. The experimental fundamental vibration frequencies in infrared absorption for N_2O are 2224 cm^{-1}, 1285 cm^{-1} and 588 cm^{-1}. Assuming N_2O is linear, determine if the bonding configuration is NNO or NON.   (5) [CO3]

Ques10. List the main differences between Raman spectroscopy and infrared absorption.   (5) [CO4]

Ques11. Out of CH and CO, which one has greater bond strength? The fundamental vibration frequencies for ^{12}CH and for $^{12}C^{16}O$ are 2860.75 cm^{-1} and 2196.76 cm^{-1} respectively. The bond force constant is given by k $= 4\pi^2\nu^2c^2\mu$ where ν is fundamental vibrational frequency, c is the speed of light and μ is the reduced mass of the molecular system.   (5) [CO5]

Ques12. Discuss the IR active vibrational modes in CS_2 with reasons. (5) [CO5]

**End of question paper

FOURTH SEMESTER
END TERM EXAMINATION

M.Sc. (Chemistry)
May-2024

COURSE CODE: MSCH202 b
COURSE TITLE: Medicinal and Natural product chemistry

Time: 3 hrs

Max. Marks: 50

(Course A)

> **Note :** Attempt any **FIVE** questions.
> All questions carry equal marks.

Q.1   What are the different systems of medicine? Write the salient points of any one in detail.   [5][CO1]

Q.2.   What is the importance of stereochemistry in drug action. Explain it by taking any suitable example. Write down list of things to consider when isomeric drugs are compared.   [5][CO2]

Q.2   What are beta lactam antibiotics? Explain the synthesis of any antibiotic starting from the natural template.   [5][CO3]

Q.3   What are different theories of receptors? Define and classify agonist. Give any two examples of metal based drugs and draw their structures.   [5][CO2]

Q.4   What are neurotransmitters? Write down the characteristics required to be a neurotransmitter. Explain neurotransmitter by taking any suitable example.   [5][CO3]

Q.5   Write short notes on Antihistamines? Give two examples and draw their structures as well.   [5][CO3]

(Course B)

Attempt any **FIVE** questions:

Q. 1)   a) Classify the alkaloids on the basis of their nitrogen heterocyclic ring present.   (1 Marks)

b) Give the products A-E of the following reactions:

1. NaOEt
2. MeI (excess), AgOH, heat → A

(2 Marks)

$MgBr(CH_2)_3OC_2H_5$ → B

1. NH_2OH
2. Zn. AcOH → C

HBr
150-155 °C → D

CH_3I
NaOH → E

(2 Marks)

Q. 2) Briefly discuss the general methods employed for the structure elucidation of alkaloids. (5 Marks)

Q. 3) Briefly discuss the acetate and shikimic acid pathway for the biosynthesis of flavonoids. (5 Marks)

Q. 4) Give the synthesis of any two of the following: ($2.5 \times 2 = 5$)
    a)   Cholesterol
    b)   Nicotine
    c)   Quinine
    d)   Abietic acid

Q. 5) Give the products F-L of the following reactions:

cat. H_2 → F

Ac_2O, Py → G

CrO_3 → H

O_3 → I + J

NaOBr ↓

K + L

Q. 6) Carry out the structure elucidation of Cyanin chloride.

(5 Marks)

(5 Marks)

Total No. of Pages 2

FOURTH SEMESTER

END-SEMESTER

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

M.Sc. (Chem)

May-2024

MSCH 202(C) Advance Electrochemistry

Time: 3:00 Hours   Max. Marks : 50

Note :	Assume suitable missing data, if any.

1. Discuss the theory of membrane potential proposed by Jahn.   [5 Marks]

2. Describe Hodgkin-Huxley experiment in detail.   [5 Marks]

Or

Discuss the derivation and implication of Butler Volmer equation.

3. Answer the following questions: [2.5 x 5 Marks]

   (i)   What are Faradaic processes? Explain using examples.

   (ii)   'Biological cells have honeycomb like complicated structure'.
           Comment.

   (iii)   State the advantages of cell membrane being of semiconducting
           nature in living beings.

   (iv)   What is drift velocity in an ionic solution imposed by an electric
           field? State its expression.

   (v)   Discuss the importance of Hodgkin-Huxley experiment.

4. Explain briefly the concept of Polarisation.   [5 Marks]

Or

Write a short note on the concept of overpotential.

5. Explain the coulometric analysis for Fe^{2+} based on its oxidation to Fe^{3+} at a
   Pt working electrode in 1 M H_2SO_4 with an appropriate ladder diagram .

                                                                  [5 Marks]

6. To determine the purity of a sample of $Na_2S_2O_3$, a sample is titrated coulometrically using I^- as a mediator and I^{3-} as the titrant. A sample weighing 0.1572 g is transferred to a 50-mL volumetric flask and diluted volume with distilled water. A 10.00-mL portion is transferred to an electrochemical cell along with 25 mL of 1 M KI, 75 mL of a pH 7.0 phosphate buffer, and several drops of a starch indicator solution. Electrolysis at a constant current of 36.45 mA requires 221.8 s to reach the starch indicator endpoint. Determine the sample's purity. [5 Marks]

7. Explain quantitative and qualitative aspects of voltammetry for determining concentration and standard potential. [5 Marks]

8. Derive equation of states in two dimensions. [5 Marks]

9. What is surface excess? Explain and show how it related to activity.

[5 Marks]

FOURTH SEMESTER

M.Sc. Chemistry

END TERM EXAMINATION

May-2024

MSCH 206f   Macromolecules

Time: 03:00 Hours

Max. Marks: 50

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

Q.1 (i) What is the importance of coordination polymerization? Explain its mechanism in detail.   [5][CO1]

(ii) Write the IUPAC name of PS and block copolymer of styrene and butadiene?   [2][CO1]

(iii) How is the charge transport possible in polymers?   [3][CO4]

Q.2 (i) How do you measure the viscosity average molecular weight of a polymer? What is the role of viscosity in polymeric solutions?   [5][CO1]

(ii) Viscosity average, number average and weight average molecular weight of a polymer is reported as 24000, 23000 and 25000, respectively. What is the polydispersity index?   [2][CO1]

(iii) How many types of degradable polymers are known to you? Which is the most environment friendly and economically viable? Justify your answer.   [3][CO4]

Q.3 (i) What do you know about the photoconducting polymers? Discuss the technological applications of conducting polymers in detail.   [5][CO4]

(ii) How do you prepare polyaniline? Give its growth mechanism.   [1+4][CO4]

Q.4 (i) What are the parameters which are responsible for polymer dissolution? Discuss the role of these parameters.   [3][CO3]

(ii) Discuss the relationship between glass transition temperature and molecular weight of a polymer.   [2][CO2]

(iii) Discuss the microstructures of a macromolecule based on the geometrical structure.   [5][CO2]

Q.5 (i) What do you mean by smart polymers? Discuss in detail. [4][CO4]

(ii) What is the difference between amorphous and crystalline polymers? Discuss the factors determining the crystal structure. [3][CO2]

(iii) Elaborate the degree of crystallinity in polymeric materials. [3][CO2]

Q.6 (i) What is the Flory-Huggins theory? Elaborate the Flory-Huggins theory of polymer solutions. [5][CO3]

(ii) Elaborate the kinetics of cationic chain polymerization. [5][CO1]

Q.7 Write short notes on any two of the following. [2 x 5][CO1-4]

(i) Ladder polymerization

(ii) Factors affecting the conductivity of conducting polymers

(iii) Practical significance of polymer molecular weight

FOURTH SEMESTER   *163*   M.Sc. [CHEM]

END SEMESTER EXAMINATION   .   *May 2024*

MSCH – 206 h (Forensic Chemical Investigation)

Time: 3 hrs   Max Marks: 50

Note: Attempt any FIVE questions. All questions carry equal marks.

Q1. (a) How is Blood Alcohol Concentration (BAC) defined?   1[CO1]

(b) At the scene of a road traffic accident, a police officer suspects a motorist may be driving under the influence. After the field sobriety test motorist is required to take a breath test. The result confirms BrAC 0.11mg/l. Justify if the motorist commits a moving traffic offense under the Indian Motor Vehicle Act 1988, Section 185.   2 [CO3]

(c) How is Ethyl alcohol isolated from biological materials and analyzed chemically in the exhibits?   4, 3 [CO4]

Q2. (a) Classify dynamite based on its explosive power. What is its principal component?   1[CO3]

(b) What are the oxidative products of RDX.   1[CO3]

(c) With proper reasoning predict the two major fragments observed in the mass spectrum of TNT recorded using negative ion chemical ionization (NICI) with methane reagent gas.   2[CO4]

(d) With suitable explosive analytes, explain the chemistry involved in spot tests with the following reagents.   6[CO4]
      i) Griess reagent
      ii) Nessler's reagent
      iii) Sulphate reagent

Q3. (a) Illustrate Eddy Diffusion in a packed column chromatographic system and show its effect on the width of the band.   2 [CO4]

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(b) What is SDS-PAGE stand for? Write its principle and applications in forensic science. 3[CO4]

(c) How many signals would you expect in the ^{1}HNMR spectrum of amphetamine (in D_2O using TSP as an internal standard)? Predict the intensity and multiplicity of each signal. 2.5 [CO5]

(d) An off-white powder is suspected as an illicit drug. The spot test with Simon's reagent produces a deep blue coloration. The Mass Spectrum (EI) of the underivatized sample showed characteristic peaks of low intensity at m/z 149 (Molecular ion), 91, 77, 65, and base peak at m/z 58. Based on these data

a) predict the drug and draw its chemical structure. 1[CO5]

b) identify any three fragments produced in mass spectrometry. 1.5 [CO5]

Q 4. (a) Differentiate pigments and dyes. Give one example of each and draw their chemical structures. 3, 2[CO3]

(b) Explain the principle and chemistry of a dye employed to catch the bribers red-handed. 5 [CO2]

Q 5. (a) Define arson. Give three major motives of arson 2.5 [CO1]

(b) Explain the extraction of ignitable liquid residues from fire debris according to ASTM E1385 standard. Also, write the advantages and limitations of the method. 5 [CO3]

(c) According to the ASTM E1618 which analytical technique represents the standard test method for the identification of ILRs in samples from a fire scene. Draw a schematic setup of the instrument and label each component. 2.5 [CO5]

Q 6. (a) A hydrated sample (Molecular weight 250 gm per mol), weighing 25 mg, decreases to a weight of 16 mg after heating in TGA due to loss of water molecules. Calculate the number of water molecules lost per molecule of the hydrated sample. 5[CO4]

(b) Write Principles and Applications of 2x 2.5 [CO4, 5]
   i) Head space techniques
   ii) Intoxilyzer

------------END------------

SECOND SEMESTER   M.Sc. Physics

END SEMESTER EXAMINATION   May, 2024

MSPH102: ADVANCED QUANTUM MECHANICS

Time: 3 Hours   **Max. Marks: 50**

> **Note:** *Question No. 1 is compulsory.*
> *Attempt any four (04) questions from remaining five (05).*
> *Assume suitable missing data, if any.*

Q.1 Answer the followings:

(a) The dimension of Dirac's matrices has to be even. Why?   [3] [CO1]

(b) Briefly describe the process of quantization of classical fields. [3] [CO3]

(c) What is Lamb shift?   [2] [CO2]

(d) What is the physical significance of Hermitian operator i.e., $(\hat{\psi})^{\dagger} = \psi$ which appear while quantization of K-G filed?   [2] [CO5]

Q.2 Establish that the spin-orbit interaction comes out automatically from the Dirac equation.   [10] [CO2]

Q.3 Work out for plane wave solution of Dirac's equation for a free particle.   [10] [CO1,2]

Q.4 Starting from the Schrödinger's classical field equation of the matter field, obtain the quantized field equations for system of bosons using the techniques of field quantization.   [10] [CO3]

Q.5 Discuss the concept of Feynman diagrams and draw these diagrams corresponding to following phenomena: [3] [CO4]

(a) Scattering of an electron by a potential. [3] [CO4]

(b) Two-quantum pair annihilation and creation. [4] [CO4]

Q.6 (a) Show that

$$(a^\dagger)^n a^n = N(N-1)...(N-n+1),$$

Where $N = a^\dagger a$ is the number operator for bosonic system. [4] [CO4]

(b) What is occupation number for a quantum state of radiation and prove that photons in a quantum state are unrestricted. [6] [CO5]

***********************END***************************

2

Second Semester
M.Sc. Physics

END SEMESTER EXAMINATION   May-2024
MSPH- 104 STATISTICAL MECHANICS
Time-3.00 hrs   Max. Marks-50

> • All questions are compulsory.

Q1. a) State the postulate of statistical mechanics? Explain how does the postulate of equal prior probabilities laid the basis of the entire theory of sytem in equilibrium?
[5] [CO1]

b) Write a short note on classical and Quantum statistics? Discuss the major difference between them also?
[5] [CO2]

Q2. a) Derive the expression for the Fermi Dirac distribution function. Classify the following paticles according to BE and FD statistics: Proton, neutron, electron, photon, alpha particle, hydrogen atom, hydrogen molecule, positron, lithium ion $_3^6Li^+$?
[5] [CO2]

b) Derive the expression for the Bose Einstein distribution function? [5] [CO2]

Q3. a) Discuss in detail the different types of ensemble by giving an example. Three particles are to be distributed in four energy levels a, b, c, d. Calculate all possible ways of this distribution whwn particles are I Fermions, II Bosons, III Classical particles.
[5] [CO2]

(b) Derive the Gibbs canonical distribution function ($P = \frac{e^{-\beta E}}{\sum e^{-\beta E}}$)? Using the Gibbs canonical distribution function calculate the partition function, mean energy and entropy for classical harmonic oscillator?
[5] [CO2]

Q4. a) Differentiate between the two type of Fermi Dirac and Bose Einstein statistic by discussing at least 5 major difference?
[5] [CO2]

b) Six distinguishable particles are distributed over three non- degenerate level of energies 0, E, 2E.

(1) Calculate the total number of microstates of the system.

(2) Determine the thermodynamic probabilities for all possible distribution of particle in various energy levels and obtain the total energy of the distribution for which the probability is maximum ?

(3) Using the result of the thermodynamic probabilities calculated in part (2) and knowledge of permutation verify the result obtained in part (1) of this question.

[5] [CO1,3]

OR

Q4. a) What is Ising Model? Solve Ising Model in 1D for a magnetic sytem having no interaction ? Derive the expression for the magnetic susceptibility and verify Curie law when weak magnetic field and high temperature is applied to the system?

[5] [CO1,3]

b) Solve Ising Model in 1D for a magnetic sytem having interaction ? Derive the expression for the magnetic susceptibility and discuss the behavior of the system at T=0K?

[5] [CO1,3]

Q5. a) Consider the experiment of tossing a coin. If the coin shows head, toss it again but if it shows tail, then throw a die. Find the conditional probability of the event that 'the die shows a number greater than 4' given that 'there is at least one tail'?

[5] [CO1,4]

b) Suppose that the reliability of a HIV test is specified as follows: Of people having HIV, 90% of the test detect the disease but 10% go undetected. Of people free of HIV, 99% of the test are judged HIV negative but 1% are diagnosed as showing HIV positive . From a large population of which only 0.1% have HIV, one person is selected at random, given the HIV test, and the pathologist reports him/her as HIV positive. What is the probability that the person actually has HIV?

[5] [CO1,4]

OR

Q5. a) Discuss Langevin Theory for the Browanian motion? Calculate mean square displacement and mean square velocity of Brownian particle?

[5] [CO1,4]

b) Define Fluctuation- dissipation theorem. Uing Langevin theory for the Brownian motion derive expression for diffusion coefficient and Einstein relation.

[5] [CO1,4]

Roll No. ....

SECOND SEMESTER

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M. Sc. (Physics)

END SEMESTER EXAMINATION

(May-2024)

MSPH- 106 COMPUTATIONAL METHODS

Time: 3 Hours

Max. Marks: 50

Note: Answer any five questions.

Assume suitable missing data, if any.

1. **(a)** With the help of motion of simple pendulum, explain the various sources of error involved in the said problem. Also derive the expression of maximum possible error in the calculation of wavelength using plane-transmission grating. **[5] [CO # 1, 4]**

   (b) Find the rate of convergence of Bisection method. Also find out the minimum number of steps needed to find the root with desired accuracy for bisection method. **[5] [CO # 3]**

2. **(a)** Apply Newton Raphson Method to find the value of $\sqrt{35}$ using five iterations. **[5] [CO # 3]**

   (b) Show that **[5] [CO # 3]**

   Find the missing term in the following table

x	7	9	11	13	15	17
y	32	78	-	144	257	381

3. **(a)** Derive the formula of single integration when x-limit is divided into subintervals that are multiple of three. **[5] [CO # 2]**

   (b) Find out the expression to calculate the first and second order derivative at point somewhere at the end of the table. Also deduce the formula for special case $p = 0$. **[5] [CO # 4]**

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4. **(a)** Apply Romberg's method to evaluate $I = \int_0^1 \frac{dx}{1+x}$. Take $h = 0.25$ and 0.125. [5] [CO # 4]

(b) Evaluate the double integral: $I = \int_1^2 \int_3^4 \frac{1}{(x+y)^2} \, dx \, dy$ using Trapezoidal method and Simpson's one third rule by taking $h = k = 0.5$, where symbols have their usual meanings. [5] [CO # 4, 5]

5. **(a)** What are the limitations of Picard and Taylor's Series method? Solve $y' = 1 + xy$, given $y(0) = 1$ and find the value of y at $x = 0.2$ using three approximation of Picard Method. [5] [CO # 4]

(b) Solve the given second order differential equation using Taylor's Series Method using expansion upto 4th derivative term and find the value of $y(0.1)$ upto sixth decimal place.

$y'' - xy' - y = 0, y(0) = 1, y'(0) = 0.$ [5] [CO # 1, 4]

6. **(a)** Use Stirling's method to estimate the value of $e^{0.644}$ from the following table: [5] [CO # 4, 5]

x	0.61	0.62	0.63	0.64	0.65	0.66	0.67
$f(x)$	1.840431	1.858928	1.877610	1.896481	1.915541	1.934792	1.954237

(b). What do you mean with interpolation? Create a difference table and mark all the elements used in Everett's interpolation formula and hence find all the unknown coefficient. [5] [CO # 4, 5]

Total No. of Pages: 2
SECOND SEMESTER
END -SEMESTER EXAMINATION   171
MAY -2024   MSPH 108 ELECTRODYNAMICS
Time: 3 Hours

Roll No..........
M.Sc [Physics]

Max. Marks:50

Note: Q.1 is compulsory. Attempt total five questions. Assume
suitable missing data if any. Symbols have their usual meaning.

1. Answer all the following questions.   [2x5=10][CO#1,5]

   a) Formulate $\vec{E} = -\nabla V - \frac{\partial \vec{A}}{\partial t}$ in tensorial form.

   b) If you want to extract very pure monoenergetic beam of charged
      particles. What filed conditions you would require?

   c) Evaluate $F^{\mu\nu} F_{\mu\nu}$.

   d) What happens to a 4 tensor when coordinate system is changed.
      Analyse with at least two arguments.

   e) Do Lienard Wiechart potentials satisfy Coulomb gauge? Give
      reasons.

2.   [5x2=10][CO#1,2]

   a) A long cylindrical wire of radius R and conductivity σ, lying
      along the z axis carries a uniform axial current density j. Calculate
      the Poynting vector on the surface of the wire. ($\hat{\rho}$ and $\hat{\phi}$ denote
      the unit vectors along the radial and azimuthal directions resp.)

   b) Find the ratio of lowest TM cutoff frequency to the lowest TE
      cutoff frequency for a rectangular hollow waveguide.

3.   [5x2=10][CO#2,3]

   a) Prove that current density 4-vector (J^{μ}) and potential 4-vector
      (A^{μ}) are divergenceless quantities.

   b) If the field strength tensor is given by $F^{\mu\nu}$ (and dual tensor $G^{\mu\nu}$).
      Show that maxwell equations (at least two) can be written as
      $\partial_\nu F^{\mu\nu} = \mu_0 J^{\mu}$ and $\partial_\nu G^{\mu\nu} = 0$.

[5x2=10][CO#2,3]

4.

a) Find the inner product (norm) of 4 vector i). A^μ ii). U^μ

b) For a field configuration where uniform electric and magnetic fields are perpendicular to each other and lie in a plane parallel to the earth surface. If a charge particle is moving vertically downwards and enters such a field, what types of drifts would be present and in which directions? Give relevant expressions.

[5x2=10][CO#3,4]

5.

a) With suitable diagram of Tokamak. explain how various drifts lead to energy loss. Develop one better alternate design for a nuclear fusion reactor.

b) In an inertial frame S, the magnetic vector potential in a region of space is given by $\vec{A} = az\hat{\imath}$ (a, constant) and scalar potential V=0. Calculate the electric and magnetic field seen by an inertial observer moving with a velocity $v\hat{\imath}$ with respect to S.

6.   [5x2=10][CO#4,5]

a) Explain the concept of "retarded potentials" with the help of diagram. Write the expressions of retarded potentials for continuous charge distribution and uniformly moving point charge. Explain each term in the expression.

b) Using the expression of electric field $\vec{E}(x, t) = \frac{q}{4\pi\varepsilon_0} \frac{|R|}{(\vec{R}.\vec{u})^3} [(c^2 - v^2)\vec{u} + \vec{R} \times (\vec{u} \times \vec{a})]$, deduce the coulomb's law and show that accelerated charge particle radiates.

SECOND SEMESTER

END SEMESTER EXAMINATION

173

(MAY - 2024)

MSPH-110 - Solid State Physics

Time: 3 Hours

Max. Marks: 50

Note: Answer *Any FIVE* questions,

Assume suitable missing data, if any.

1.(a). Draw Wigner Seitz cell in a 2-D crystal system. How is it different from Brillouin zone? (CO1) [2]

(b). Explain the persistent current in superconductor and write the relation between current and critical magnetic field. (CO5) [2]

(c). Draw and briefly explain Born – Haber cycle. (CO2) [2]

(d). Show that Meissner effect in superconductivity is inconsistent with Maxwell relation. (CO5) [2]

(e). Explain Burger Vector for a line dislocation with proper diagram. (CO2) [2]

2(a). Discuss about ferromagnetism, ferrimagnetism and anti-ferromagnetism in magnetic materials. Derive an expression for magnetic susceptibility for ferromagnetic materials using Weiss theory. (CO4) [6]

(b). A paramagnetic system of electronic spin magnetic dipole moment is placed in an external field of 10^5 ampere/meter. Calculate the average magnetic moment per dipole at 300 K. Also calculate the fractional number of spin which are parallel to the field. (CO4) [4]

3(a). What is effective mass? Show that the effective mass of an electron is given by; $m^* = \hbar^2/(d^2E/dk^2)$. (CO3) [4]

(b). Explain the important conclusions of Kronig-Penney model. Draw E-k diagram for one dimensional lattice. (CO3) [3]

(c). Consider two dimensional square lattice of side 3.0 Å. At what electron momentum values do the sides of first Brillouin zone appear? What is the energy of free electron with this momentum? (CO3) [3]

4(a) Discuss Rotating crystal method of crystal structure analysis by X-ray
(CO1) [4]

(b). How many atoms per mm^2 surface area are there in (100), (110) and (111) planes for lead (Pb) which has fcc structure. The radius of atom is 0.174 nm.
(CO1) [3]

(c). A diatomic helium (He) gas has two electrons in its ground state. Its density is 0.17 kg/m^3 and average radius of the atom is 1 Å. Calculate the Susceptibility.
(CO4) [3]

5(a). What is meant by Shottky defects in solids. Drive an expression for equilibrium concentration of vacancies at a given temperature for ionic crystal using Shottky method.
(CO2) [4]

(b). What is Madelung constant? Calculate the Madelung constant for ionic solid.
(CO2) [3]

(c). Calculate the binding energy of NaI of which the nearest neighbour distance is 0.324 nm. Express the energy in eV and also in kJ/kmol. Madelung constant for NaI=1.748 and n= 9.5
(CO2) [3]

6(a). Give salient features of BCS theory in superconductivity. Describe the formation of cooper pairs.
(CO5) [4]

(b). A superconducting material has critical temperature of 3.7 K in zero magnetic field of 0.0306 tesla at 0 K. find the critical field at 2 K.
(CO5) [3]

(c). Estimate the intrinsic coherence length of aluminum if the size of energy gap is 3.4 x 10^{-4} eV and Fermi velocity is 2.02 x 10^6 m/s.
(CO5) [3]

7. Explain briefly any FOUR;
(a). Structure factor of body centered cubic structure (BCC) (CO1) [2.5]
(b). Bloch theorem and periodic potential   (CO3) [2.5]
(c). Specific heat in normal and superconducting materials   (CO5) [2.5]
(d). Reciprocal lattice of FCC structure   (CO1) [2.5]
(e). Ferrites and their applications.   (CO4) [2.5]
(f). Properties of Ionic and Covalent bonds.   (CO2) [2.5]

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Fourth SEMESTER

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M.Sc (Physics)

END SEMESTER EXAMINATION   *(May.-2024)*

MSPH-202 Advanced Semiconductor Devices

Time: 3 Hours   *Max. Marks: 50*

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

1. (a) What are the limitations of 2- cavity, multi-cavity and Reflex klystron in terms of frequency, power and efficiency.   [5][CO-1,4,5]

   (b) What is the two cavity Klystron? Prove that the relation for the optimum spacing between the two cavityies "L" i.e $L_{Optimumm} = v_0 \frac{\pi V_0}{\omega \beta_i V_1}$
   [5][CO-1,4,5]

2. (a) A two cavity Klystron amplifier has the following parameters: beam voltage Vo=1000V, resistance Ro=40kΩ, beam current Io = 25mA, operating frequency. f=3GHz, gap in either cavity d= 1mm, spacing between the two cavities L=4cm, effective shunt impedance R_{sh}=30kΩ. Determine (i) the electron velocity just leaving the cathode (ii) the gap transit angle θg (iii) the beam coupling coefficient $β_i$.   [5][CO-1,3,4]

   (b) What is Gunn diode? Explain, voltage-controlled and current controlled mode and phenomenon of negative-resistance mode.
   [5][CO-1,4,5]

3. (a) Explain the principle and working of quantum well (QW) lasers. What are the advantages of QW over heterstructure lasers?   [5][CO-2,4,5]

   (b) Explain the difference between avalanche and PIN photodiode with suitable diagrams
   [5][CO-2,4,5]

4. (a) A thin film deposition chamber, with a circular aperture of diameter 10 cm in its wall, contains oxygen molecules at a pressure of 1×10^{-5} torr at 300 K. Calculate (i) mean free path of oxygen molecules; (ii) gas impingement flux; (iii) contamination time for complete monolayer coverage of a surface containing 10^{15} atoms/cm^2; and (iv) conductance of the circular aperture.
[5][CO-4,5]

(b) What are the sequential steps involved in the CVD processes of thin film deposition? Explain with the help of a neat diagram. Describe following reaction used in CVD with the help of at least one suitable example in each: (i) pyrolysis; (ii) oxidation; and (iii) compound formation. [5][CO-1,4,5]

5. (a) Define Knudsen number. Write the criteria for distinguishing between molecular, intermediate and viscous flow regimes on the basis of magnitude of Knudsen number. [5][CO-1,4,5]

(b) What are the modes of thin film growth? Describe them with help of suitable diagrams. Obtain Young's condition of surface energy for each mode. [5][CO-1,4,5]

6. (a) Briefly explain working principle of photo multiplier tube (PMT) with suitable diagram. [5][CO-1,2,4,5]

(b) What are electro-optic and magneto-optic effects? 5][CO-1,2,4,5]

7. Write short notes on **any two**. [10][CO-1,3,4,5]

(a) Application and working principle of charge couple device (CCD)

(b) Principle and application of optical memories

(c) SAW and integrated devices

END SEMISTER EXAMINATION

MSPH-204 Space and Atmospheric Science

(ELECTIVE COURSE)

Time: 3:00 Hours	Max. Marks: 50

Note: Answer *All the Five* questions
Assume suitable missing data, if any.

Q.1. What is an automatic weather station (AWS)? Describe how it measures various meteorological parameters? What are the advantages of AWS. (10M) (CO-1)

Q.2. What is the necessity of air borne systems for measuring upper air observations? Describe the construction, working conditions and applications of GPS sonde. (10 M) (CO-2)

Q.3. What are trace gases? Explain various natural mechanisms and anthropogenic causes responsible for trace gases production. Explain the adverse effects of trace gases on human beings, animals and agriculture. (10 M) (CO-3)

Q.4. Explain in detailed the mechanism of production of tropospheric Ozone. Write its effect on various things in troposphere. Explain the role of Ozone in stratosphere. Explain depletion of Ozone in stratosphere and discuss its consequences. (10 M) (CO-2)

Q.5. What are aerosols and describe their sources and production mechanisms. Describe their effect on climate and human health. (10 M) (CO-1)

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Total Number of Page 1
IV SEMESTER
END SEMESTER EXAMINATION

17 8

Roll. No........
M.Sc. (Physics)
May 2024

MSPH206: Laser and Spectroscopy

Time: 3:00 Hours   Max. Marks: 50

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

Q1. Derive an expression (rate equations) for two- and three-level lasers and show the necessary condition for population inversion. Also, demonstrate why a two-level laser is not feasible.
[5+5=10][CO#1,3]

Q2. Describe homogenous and inhomogeneous line broadening to the spectral line of laser output with derivations.
Describe quantum yield and lifetime of a fluorophore in terms of radiative and nonradiative transitions.   [6+4=10][CO#1,2]

Q3. Differentiate linear and nonlinear spectroscopy with suitable diagrams. What is a harmonic generation? How to obtain the second harmonic generation (SHG)? Also, discuss the theory of SHG and THG.   [4+6=10][CO#2,5]

Q4. Describe steady-state spectroscopy and types of equipment used for this with a schematic diagram and their applications in scientific fields.   [3+5+2=10][CO#1,4]

Q5. Write short notes on any Two of the following:
[5×2=10][CO#1,3,4]
   (a) Raman effects with energy level diagram and measurement system.
   (b) Time-domain spectroscopy
   (c) Excimer lasers
   (d) Semiconductor lasers

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Total No. of Pages 2

Roll No. ... ...

Fourth SEMESTER

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M.Sc (Physics)

END SEMESTER EXAMINATION

(May.-2024)

MSPH-216 Advanced Function Materials

Time: 3 Hours   Max. Marks: 50

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

1. (a) What do you understand by nanomaterials and classified them in terms of their electronic and bonding structures.   [5][CO#1,4]

(b) Explain, Clausius-Clapeyron equation and prove the relation between the vapor pressure and temperature.   [5][CO#2,4]

2. A metal film is to be deposited by evaporation using the source-substrate geometry as shown in the figure below:

Show that the ratio of thickness of the film at point P (d) to the thickness at O (d_0) would be

$$\frac{d}{d_0} = \frac{1}{\left(1 + \frac{l^2}{h^2}\right)^2}$$

.What conclusion do you drawn from this equation about the film uniformity of the deposited film?   [10][CO#2,3]

2. (a) State the working principle of Scanning electron microscopy and application of EDAX to differentiate elements present in the sample.

(b) State the principle of X-ray photoelectron spectroscopy and differentiate it with Auger electron spectroscopy. [10][CO#1,3,5]

3. **(a)** With suitable diagram explain the working principle of electrostatic force microscopy/ Kelvin probe microscopy in atomic force microscope. [5][CO#1,3]

(b) What do you mean by critical speed? Define, key properties of grinding media used in Ball Milling Technique. [5][CO#2,4]

4. With suitable example, explain the synthesis of nanomaterial by using either by solid state synthesis or sol-gel process for the synthesis nanoparticles. [10][CO#2,3,5]

6. **(a)** Explain the mechanism of charge transfer between analyte and nanotube. [5][CO#3,4,5]

(b) Explain, response (I_{SD}-V_G response curve) of CNTFET device with a single semiconducting SWCNT as the conduction channel to NH_3 and NO_2 gas. [5][CO#3,4,5]

7. Write shorts notes on: [10][CO#1,3,5]

(a) Working principle of transmission electron microscope

(b) Estimation of band using UV-Vis-NIR spectroscopy

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

SECOND SEMESTER   **M. Sc**

END *SEMESTER EXAMINATION*   *(May 2024)*

MSMA-102, Complex Analysis

Time: 3 Hr.   *Max. Marks: 50*

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

1. (a) Find the analytic function $f(z) = u(r, \theta) + iv(r, \theta)$ such that $v(r, \theta) = r^2 \cos 2\theta - r \cos \theta + 2$.

   (b) State and prove Cauchy's integral formula.

2. (a) Define conformal mapping. If f is analytic and $f'(z) \neq 0$ for any z then show that f is conformal.

   (b) State and prove Morera's theorem.

3. (a) If a function f is analytic everywhere in the finite plane except for a finite number of singular points interior to a positively oriented simple closed contour C, then show that

$$\int_C f(z)dz = 2\pi i Res_{z=0}\left[\frac{1}{z^2}f\left(\frac{1}{z}\right)\right].$$

(b) State and prove Laurant's theorem

4. (a) Find the image of the infinite strip (i) $1/4 < y < 1/2$ (ii) $0 < y < 1/2$ under the mapping function $w = 1/z$.

(b) Find the residue of

$$\frac{z^3}{(z-1)^4(z-2)(z-3)}$$

at $|z| = 1$.

5. (a) State and prove open mapping theorem.

(b) Evaluate the following integral

$$\int_0^{2\pi} \frac{d\theta}{2 + \cos\theta}.$$

6. (a) State and prove Casorati-Weierstrass theorem.

(b) State and prove Rouche's theorem.

....

MSMA – 104   PARTIAL DIFFERENTIAL EQUATIONS

Max. Marks: 50

Time : 3 Hrs.

Note: Attempt **Any five** questions. Assume missing data if any.

Q.1 (a) Solve $x(z - 2y^2)p = (z - qy)(z - y^2 - 2x^3)$. [5M] [CO1]

(b) Solve $(D^2 - DD' - 20D'^2) = e^{5x+y} + \sin(4x - y)$. [5M] [CO2]

Q. 2 (a) Find the solution of Cauchy first order partial differential equations $u_x + 2u_y = 0,\ \ u(0,y) = 4e^{-2y}$. Find also $u(1,1)$. [5M] [CO1]

(b) Classify $u_{xx} - x^2y\, u_{yy} = 0$ and transform into the canonical form. [5M] [CO2]

Q.3 (a) The ends A and B of a rod $l\,cm$ long have their temperature at 30^0C and 80^0C respectively, until steady-state condition prevails. The temperature at B is suddenly reduced to 60^0C and at the same time that at A is increased to 40^0C. Find the temperature distribution in the bar at time t. [5M][CO3]

(b) Find the all-possible solutions of $\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$ by using method of separation of variables. [5M][CO5]

Q.4 Solve the Neumann problem:

PDE: $\nabla^2 u = 0,\ \ 0 \le x \le 1, 0 \le y \le 1$

BC: $u_x(0,y) = 0,\ \ \ u_x(1,y) = 0,\ \ 0 \le y \le 1$

$u_y(x,0) = 4\cos\pi x,\ \ u_y(x,1) = 0,\ 0 \le x \le 1.$ [10M][CO4]

P.T.O.

Q.5 (a) Using d'Alembert's method, solve the following.

$$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}, \ y(x, 0) = 0 \ \text{and} \ \frac{\partial y}{\partial t}(x, 0) = h(x) \quad |x| < \infty, t > 0.$$

[5M][CO5]

(b) Find all possible solutions of Laplace equations

$$u_{rr} + \frac{1}{r}u_r + \frac{1}{r^2}u_{\theta\theta} = 0.$$

[5M][CO4]

Q. 6 Solve by Duhamel principle:

PDE: $u_t - c^2 u_{xx} = t^2 sin3x, \ 0 \le x \le \pi, 0 < t < \infty,$

BC: $u(0, t) = 0, \ u(\pi, t) = 0, \ 0 < t < \infty,$

IC: $u(x, 0) = 0.$

[10M][CO3]

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Total No. of Pages: 2

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

2nd SEMESTER

M.Sc. (Math)

END SEMESTER EXAMINATION

(MAY-2024)

MSMA 108: Linear Algebra

Time: 3:00 Hours

Max. Marks: 50

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

Q1. a) Exhibit a basis of $C^2_{\mathbb{R}}/\mathbb{R}^2_{\mathbb{R}}$, hence verify that

$$\dim(C^2_{\mathbb{R}}/\mathbb{R}^2_{\mathbb{R}}) = \dim C^2_{\mathbb{R}} - \dim \mathbb{R}^2_{\mathbb{R}} \qquad [CO4]$$

b) Determine explicitly a L.T. from R^2 to R^2 such that T(1,1)=(1,3) and T(-1,1)=(3,1). [CO1]

OR

Consider the vector space $\mathbb{R}^3(\mathbb{R})$. Find the dual basis of the standard basis of $\mathbb{R}^3$ and by using transition matrix find the dual basis of the basis $\beta = \{(1,1,1),(1,1,0),(1,0,0)\}$. [CO1]

Q2. a) Determine all possible Jordan canonical forms for a linear operator $T:V \rightarrow V$ which has characteristic polynomial $\Delta(t) = (t-2)^3(t-5)^2$. In each case, write the minimal polynomial $m(t)$. [CO1]

OR

Show that a matrix A and its transpose A^T have same characteristic polynomial. [CO1]

b) If T is invertible, the show that $(T^{-1})^* = (T^*)^{-1}$. [CO5]

Q3. a) Is the matrix $A = \begin{pmatrix} 3 & 1 & -1 \\ 2 & 2 & -1 \\ 2 & 2 & 0 \end{pmatrix}$ similar to a diagonal matrix over the field R ? Is matrix A similar to a diagonal matrix over the field C ? [CO5]

PTO

b) Find all invariant subspaces of a linear operator T on R^2, which has a matrix in the standard basis as $A = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.   [CO2]

Q4. a) Let V be an inner product space and $x, y \in V$. Prove that
$$\| x+y \|^2 + \| x-y \|^2 = 2(\| x \|^2 + \| y \|^2).$$ [CO2]

b) Let V be the vector space of the real functions satisfying the equation $\frac{d^2y}{dx^2} + 9y = 0$. Find an orthonormal basis of V, if the inner product on V is defined by $< f, g > = \int_0^\pi f g \, dx$.   [CO2]

Q5. a) Find the symmetric matrix of a quadratic form which corresponds to the following quadratic polynomial
$$q(x, y, z) = 4x^2 - 2yz + xz.$$
Check whether this matrix is positive definite or not?   [CO4]

b) Let f be a bilinear form on R^2 defined by
$$f((x_1, y_1), (x_2, y_2)) = x_1 y_1 + x_2 y_2.$$
Find the matrix A of f in the basis $B = \{(2,1), (1,-1)\}$.   [CO3]

- END -

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END TERM EXAMINATION   *MAY-2024*

Course Code : MSMA106   **Course Tilte :** **Topology**

Time: 3 Hours   **Max. Marks: 50**

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

Q1(a) Let Y be a subspace of a topological space (X, T). Then Y is compact iff every covering of Y by sets open in X contains a finite subcollection covering Y . (CO1,2)

(b) Prove that every closed subspace of a locally compact space is locally compact. Show by an example that locally compact space need not be compact. (CO4)

Q2(a) Define one-point compactification. Let (X, T) be a topological space and let $X^* = X \cup \{\infty\}$, where ∞ is an object not belonging to X. Let $\mathrm{T}^* = \{G^* \subseteq X^*: G^* \in \mathrm{T}\ or$

$$X^* - G^* \text{ is } \mathrm{T}\text{ closed \& compact subset of } X\}$$

Then show that T^* is a topology on X^*. (CO2,4)

(b) Prove that the homoeomorphic image of a T_1 space is T_1.

(CO4)

Q3(a) Show that every compact Hausdorff space is regular.

(CO1,4)

(b) Is the following statement true? If yes then prove it, otherwise state and prove the correct statement.
"Complete regularity is a hereditary property". (CO2,4)

Q4(a) Show that a subset of a topology space is open iff it is a neighbourhood of each of its points.

Let $X = \{1,2,3,4,5\}$ and

$1 = \{\emptyset, \{1\}, \{1,2\}, \{1,2,5\}, \{1,3,4\}, \{1,2,3,4\}, X\}$. Find the
neighbourhoods of the points 1,3,5. (CO1)

(b) Let $X = \{a, b, c, d, e\}$ and

$$1 = \{\emptyset, \{a\}, \{a, b\}, \{a, c, d\}, \{a, b, c, d\}, \{a, b, e\}, X\}$$

Find local base at each points of X. (CO1)

Q5(a) Let X and Y be two topological spaces and y_0 a fixed element
of Y Let $A = X \times \{y_0\}$. Then prove that the restriction of π_x to
A is a homeomorphism of the subspace A of $X \times Y$ onto X.
(CO5)

(b) Prove that the product space $X \times Y$ is connected iff X and Y
are connected. (CO5)

6(a) Define Tychonoff topology. Let $\{(X_\lambda, 1_\lambda): \lambda \in \Lambda\}$ be an arbitrary
collection of topological spaces and let $X = \times \{X_\lambda : \lambda \in \Lambda\}$. Show that
the collection C of all sets of the form $\times \{G_\lambda : \lambda \in \Lambda\}$ where $G_\lambda \in 1_\lambda$,
is a base for some topology for X. (CO1,5)

(b) Let $(X_1, 1_1)$ and $(X_2, 1_2)$ be two topological spaces. Show that
$f: X \to Y$ is continuous iff $\forall x \in X$, the inverse image under f of every
1_2- nbd of $f(x)$ is a 1_1-nbd of x. (CO3)

2ND SEM
M.Sc.
END TERM EXAMINATION   MAY-2024

MSMA 110   **NUMERICAL ANALYSIS**
TIME : 3:00 Hrs   MAX MARKS = 40

NOTE: Attempt any five questions. All questions carry equal marks.
Assume any missing data.

1. Construct the interpolating polynomial that fits the data

x	0	0.1	0.2	0.3	0.4	0.5
f(x)	-1.5	-1.27	-0.98	-0.63	-0.22	0.25

   using Gregory-Newton forward difference interpolation and estimate f(0.15).

2. The following data for the function $f(x) = x^4$ is given.

x	0.4	0.6	0.8
f(x)	0.0256	0.1296	0.4096

   Find $f'(0.8)$ and $f''(0.8)$ using quadratic interpolation. Obtain the bound on the truncation error.

3. Use Milne,s method to estimate for the following differential equation

   $$u' = t + u^2, \quad u(0) = 0,$$

   the value of u(0.8). Assume h = 0.2.

4. Use classical Runge-Kutta method of fourth order to find the value of y at x = 0.8 for

   $$dy/dx = (x+y)^{1/2}, \quad y(0.4) = 0.41.$$

   Assume step length h = 0.2.

5 Solve the initial value problem

$$y' = t^2 - y^2 \quad , \quad y(0) = 1 \text{ for t in } [0, 0.6].$$

Use the third order Adams – Bashforth method with h =0.1. Obtain the starting values using the third order Taylor

series method.

6 Use second order finite difference method to solve the differential equation

$$y'' = xy + 1 \quad , \text{ for x in } [0, 1],$$

$$y(0) + y'(0) = 1 \quad , \quad y(1) = 1,$$

with step length h = 0.25.

Total No. of Pages: 02

Roll No.:.................

II SEMESTER

M.Sc.

END TERM EXAMINATION

May-2024

MSMA-114 : Fundamentals of Computer

Time: 3 Hours

Max. Marks: 40

> **Note:** Answer any five questions. (Assume suitable missing data, if any.)

1) (i) Explain the different types of desktop/laptop operating systems.

(CO1) (4)

(ii) Describe the different types of operators in C programming with suitable examples.

(CO2) (4)

2) Write a sample Latex document that include section, subsection, image, Table and equation along with labelling each in the document at appropriate places.

(CO5) (8)

Note: Specific Table and equations whose syntax is required to be included is given as:

Whole Sale Items		
Item	Qty	Cost
	10	50
Pencil 2B	20	70
	50	100

$$\mu_{ij} = \left\{ \sum_{p=1}^{k} \left(\frac{exp(\|x_i^T w_j + b_j\|^2)}{exp(\|x_i^T w_p + b_p\|^2)} \right)^{\frac{1}{\alpha}} \right\}^{-1}$$

3) (i) You are conducting a statistical analysis using SPSS and need to calculate the mean, median, and mode of a dataset, as well as generate a graph to visualize the data. Describe the steps you would take to perform these tasks in SPSS.

(CO3, CO4) (4)

(ii) Write a program in C to calculate the factorial of a given number using recursion.

(CO2, CO4) (4)

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4) (i) Consider the following function

$$f(x) = \begin{cases} -x, & x < 0 \\ x, & x \geq 0 \end{cases}$$

Plot the above function f(x) using **Mathematica**. Label the two segments of the function with appropriate axes labels and legend.

(CO3, CO4) (4)

(ii) Write the commands to perform the following operations in **MATLAB**
   a) Create a 3x3 matrix A with random values
   b) Find the eigenvalues and eigenvectors of the matrix A
   c) Extract the entire 2nd row and 3rd column of the matrix A
   d) Find the maximum element of the matrix

(CO3, CO4) (4)

5) (i) Write a program in MATLAB to implement the bisection method for finding the root of an equation. (CO3, CO4) (4)

(ii) Differentiate the use of command **piece wise** and **which** in Mathematica with example. (CO3, CO4) (4)

6) (i) Describe the key features of Microsoft PowerPoint and Microsoft Excel. (CO5) (4)

(ii) Create a Beamer presentation including the following slides.
   a) Title slide
   b) Outline of the topics
   c) Enumeration slide
   d) References slide

(CO5) (4)

**************All The Best*************

Total No. of Pages: 2

SECOND SEMESTER

END TERM EXAMINATION

173   Roll No...............

M.Sc. (BIOINFORMATICS)

May-*2024*

MSMA-114 FUNDAMENTALS OF COMPUTERS

Time: 3:00 Hours   *Max. Marks: 40*

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

SECTION A

Q1 Attempt any *FIVE*:   [2X5]   [CO1,2,3,4]

a) What is the drawback of FCFS algorithm?

b) What is an Operating System and what are the goals of an Operating System?

c) What is MATLAB used for?

d) What is the full form of SPSS and what is it used for?

e) What are Loops in C?

f) What is the error in?

    int a;
    3=a

SECTION B

Q2 a) Describe the multiple partition allocation memory management scheme.
                                              [4][CO1]

b) Explain the following commands **(in Linux):**   [3] [CO1]
    i) whoami   ii) traceroute   iii) mv   iv) echo   v) pwd
(In windows):
    i) Ipconfig   ii) TRACERT   iii) Netstat   iv) DIR   v) Shutdown

c) What does header and footer in MS Word describe? In which view are headers and footers visible? Is it possible to insert footer without header?   [3][CO4]

Q3 a) Explain all the four basic data types in C programming language? [4] [CO2]

b) Write a c code to find the largest number among the three numbers. [3][CO2]

c) Give the output of the code: 194 [3][CO2]

```c
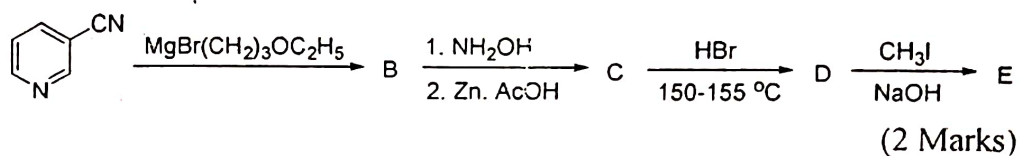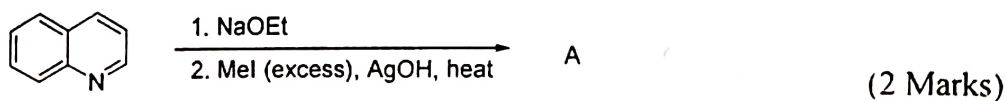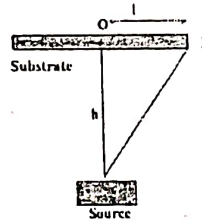#include<stdio.h>
int main(void)
{
    int a = 1;
    int b = 0;
    b = ++a + ++a;
    printf("%d %d",a,b);
    getchar();
    return 0;
}
```

Q4 a) what is the syntax of LaTeX? And why do we use LaTeX in research?

[3][CO4]

b) What is the use of tool bar in Microsoft Word? What are formatting tools?

[3][CO3]

c) A Spreadsheet contains names and marks of a class. (Write the formulae).

[4][CO2]

Sno.	A NAME	B SUB1	C SUB2	D SUB3	E TOTAL MARKS
1	RAJ	45	67	45	
2	SIMRAN	67	89	56	
3	SWATI	55	66	67	
4	GUNJAN	58	55	78	
5	RAHUL	78	43	77	
6	KAJAL	89	36	76	
7	PREM	99	68	56	
8	KITTU	78	65	55	
9	JIYA	87	32	44	
10	ERA	55	33	43	
11	NANCY	54	45	34	

i) Calculate the total marks and percentage of each student.
ii) Calculate the total marks and average of each SUB.

1 9 5

FOURTH SEMESTER

M.Sc. Mathematics

END TERM EXAMINATION
May 2024

Course Code: MSMA-202

Course Title: Measure and Integration

Time: 3:00 Hours

Max. Marks: 50

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

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(1) (a) Prove that the collection of measurable sets is a σ-algebra. [5][CO1]

(b) For every non-negative measurable function f defined on E, show that there exists a non-negative non-decreasing sequence $\{f_n\}$ of simple functions such that [5][CO2]

$$\lim_{n\to\infty} f_n(x) = f(x), \ \forall \, x \in E.$$

(2) (a) Prove that the Lebesgue outer measure of an interval equals its length. [5][CO1]

(b) Let f be a function defined on a measurable set E. Show that f is measurable if and only if the set $\{x \in E : f(x) > r\}$ is measurable for each rational number r. [5][CO3]

(3) (a) State and prove Lusin theorem. [5][CO3]

(b) Let $\{f_n\}$ be a sequence of measurable functions defined on a set E of finite measure. Assume that there exists a real number M such that $|f_n(x)| \le M$, for all x and all n. If $\lim_{n\to\infty} f_n(x) = f(x)$ for each $x \in E$, prove that

$$\int_E f = \lim_{n\to\infty} \int_E f_n.$$

[5][CO3]

(4) (a) Let $\{f_n\}$ be a sequence of nonnegative measurable functions and $f_n \to f$ almost everywhere on E. Prove that

$$\int_E f \le \varliminf_{n\to\infty} \int_E f_n$$

[5][CO4]

(b) State and prove Lebesgue dominated convergence theorem. [5][CO4]

(5) (a) If $1 \le p \le \infty$, prove that $\|f + g\|_p \le \|f\|_p + \|g\|_p$ for every pair $f, g \in L^p$. [5][CO5]

(b) State and prove Riesz-Fischer theorem. [5][CO5]

(6) (a) Let f be a nonnegative function which is integrable over a set E. Then given $\epsilon > 0$ there exists $\delta > 0$ such that for every set $X \subset E$ with $m(X) < \delta$, we have

$$\int_X f < \epsilon.$$

[5][CO4]

(b) Let E be a measurable set with $m(E) < \infty$. Show that $L^\infty(E) \subset L^p(E)$ for each p, where $1 \le p < \infty$. Furthermore, prove that $\|f\|_\infty = \lim_{p\to\infty} \|f\|_p$ if $f \in L^\infty(E)$. [5][CO5]

-END-

Max Marks: 50   **Time: 3 Hours**
Note: Attempt any 2 parts from each question. All questions carry equal marks.

Q 1. (a) Find the dimensions of a box of largest volume that can be inscribed in a sphere of radius r. Also show that the volume is maximum if the side of each box is equal to $\frac{r}{\sqrt{3}}$. If the radius of the sphere is unity, what will be the volume of the box? What should be the minimum radius of the sphere, for which the maximum volume of the box will be 8 cubic units?

(b) What do you mean by convex optimization problem. Is the following convex optimization problem ? Justify your answer.

$$\text{Min } f(x) = \text{Max } \left(x^2, (x-2)^2, 4\right)$$
$$\text{subject to : }$$
$$0 \le x \le 5$$

(c) Prove the following:
Let $S \subseteq R^n$ be an open convex set and $F : S \to R$ be a pseudoconvex function on S. Then f is a quasiconvex function on S.

CO- 1,2,5

Q 2. For the QPP in the form $\text{Max } c^T x + x^T Q x$ subject to $Ax \le B, x \ge 0$; We have the following KKT conditions.

$$\begin{pmatrix} 2 & -2 & 2 & -1 & 0 & 0 \\ -2 & 4 & 1 & 0 & -1 & 0 \\ 2 & 1 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ \lambda_1 \\ \mu_1 \\ \mu_2 \\ s_1 \end{pmatrix} = \begin{pmatrix} 3 \\ 0 \\ 0 \end{pmatrix}$$

$$x_1, x_2, \lambda_1, \mu_1, \mu_2, s_1 \ge 0; \lambda_1 s_1 = \mu_1 x_1 = \mu_2 x_2 = 0$$

(a) Write the QPP being solved.

(b) It is claimed that the above optimization problem can be solved by Wolfe's method. Justify this claim.

(c) Give one complete iteration of Wolfe Method to solve the QPP.

Q 3. (a) Let $\bar{x}$ be a local minimum point of the convex optimization problem $\min_{x \in S} f(x)$. Then prove that $\bar{x}$ is also the global min point.

(b) Explain briefly Charne's and Cooper method to Solve fractional programmin problem and solve the following problem.

$$\text{Max } Z = \frac{-2x + y + 2}{x + 3y + 4}$$

subject to:

$$- x + y \le 4$$
$$2x + y \le 14$$
$$x \le 6$$
$$x, y \ge 0.$$

(c) Obtain the Lagrange dual of the following problem:

$$\text{Min } f(x) = - x^2$$
$$\text{subject to}$$
$$0 \le x \le 1$$

Comment about duality gap.

Q 4. (a) Use Barrier Method to solve

$$\text{Min } Z = 2x_1^2 + 3x_2^2 + x_1 + x_2$$
subject to:
$$3x_1 - 15 \ge 0$$
$$- x_2 \le 0$$

(b) Consider the following problem.

$$\text{Min } Z = (x_1 - 4)^2 + (x_2 - 6)^2$$
subject to :
$$x_2 \ge x_1^2$$
$$x_2 \le 4$$

Write a necessary condition for optimality and verify that it is satisfied by the point $(2, 4)$. Is this the optimal point? Why?

(c) Use Penalty function Method to solve

$$\text{Min } Z = \frac{1}{3}x_1^3 + x_1^2 + x_1 + x_2 + \frac{1}{3}$$

subject to :

$$1 - x_1 \leq 0$$
$$x_2 \geq 0$$

CO-2, 3, 5,6

Q 5. (a) Use the steepest descent method to minimize $f(x_1, x_2) = 3x_1^2 - 4x_1x_2 + 2x_2^2 + 4x_1 + 6$ over $(x_1, x_2) \in \mathbf{R}^2$.

(b) Use Newton's method to minimize $f(x_1, x_2) = 8x_1^2 - 4x_1x_2 + 5x_2^2$, $(x_1, x_2) \in \mathbf{R}^2$

(c) Prove the following theorem.
Let $S \subseteq R^n$ be an open convex set and $F : S \rightarrow R$ be differentiable. Let f be a convex function on S. Then for all $x, u \in S$, we have

$$f(x) - f(u) \geq (x - u)^T \nabla f(u)$$

Converse is also true.

CO- 1, 4, 6

Fourth Semester
M.Sc. Applied Mathematics

End Term Examination   May, 2024

MSMA-212   Approximation Theory

Time: 3:00 Hours   Max. Marks: 50

Note: Attempt any five. Assume suitable missing data, if any.

1. For a sequence of linear positive operators $\mathcal{L}_n(f; x)$ if

$$\mathcal{L}_n(1; x) = 1 + \alpha_n(x),$$
$$\mathcal{L}_n(\cos t; x) = \cos x + \beta_n(x),$$
$$\mathcal{L}_n(\sin t; x) = \sin x + \gamma_n(x),$$

   where $\alpha_n(x)$, $\beta_n(x)$, $\gamma_n(x)$ converge uniformly to zero in the interval $a \leqslant x \leqslant b$, then for any bounded and 2π-continuous function $f(x)$ prove that the sequence $\mathcal{L}_n(f; x)$ converges uniformly to $f(x)$.

   (10)[CO1]

2. (a) Define the Szasz-Mirakyan operators. Find their moment generating function and hence find the first, second and third moment for the Szasz-Mirakyan operators.   (7)[CO2]

   (b) Find the moment generating function of Baskakov operators.

   (3)[CO2]

3. Derive the Kantorovich variant of the Szasz operators and find its first, second and third moment.   (10)[CO3]

4. (a)   (i) When is the function f said to belong to the lipschitz class?

      (ii) When is the function f said to be of bounded variation on the interval $[a, b]$?   (4)[CO3]

   (b) Write the CauchySchwarzs, Holders and Minkowskis inequality for integration.   (6)[CO3]

5. (a) Define the Durrmeyer variant of the Bernstein operators and derive the first, second and third moments.   (7)[CO4]

   (b) Define modulus of continuity. Prove that for any uniformly continuous function f, $\omega(f; \lambda\delta) \leqslant (\lambda + 1)\omega(f; \delta)$.   (3)[CO4]

2

6. (a) State and prove the second Jackson theorem. (5)[CO4]

(b) If a periodic function $f(x)$ is differentiable k times $(k \geqslant 2)$ then prove that

$$E_n(f) \leq \frac{6^k E_{n,0}(f')}{n}.$$

(5)[CO4]

=======X=======

Max Marks: 40   **Time: 3 Hours**

Note: Attempt any four questions.

Q 1. (a) Explain machine learning with explanation of supervised and unsupervised learning.

(4)

(b) Give algorithm for k-means clustering.Comment on," We can do k-means clustering, partition the instances, and then calculate S_i separately in each group. Why is this not a good idea?"

(6)

CO- 1,2

Q 2. A retail company wants to build a decision tree to predict whether customers will buy an extended warranty. They have a dataset with the following features:

(10)

- **Age:** The age of the customer.
- **Product Price:** The price of the product purchased.
- **Purchase Location:** A categorical variable indicating whether the purchase was made online or in-store.
- **Purchased Warranty:** A binary variable indicating whether the customer purchased the warranty (1 for yes, 0 for no).

Given this dataset, the company found the following:

- The first split that maximizes information gain is based on "Product Price> 500."
- After this split, the company found that among customers with "Product Price > 500," those who purchased online were more likely to buy the warranty.

(a) Draw the first two levels of the decision tree based on this information, showing the conditions for each split and the resulting groups.

(b) Calculate the entropy before the first split if, out of 1000 customers, 200 purchased the warranty.

(c) Calculate the information gain for the first split on "Product Price > 500." Given the following data:

- Out of 1000 customers, 200 purchased the warranty.
- After splitting by "Product Price > 500":
  - In the "Product Price > 500" group, 150 out of 300 customers purchased the warranty.
  - In the "Product Price ≤ 500" group, 50 out of 700 customers purchased the warranty.

CO- 1,3,5

Q 3. (a) Explain Principal Component Analysis in detail with algorithm.

(4)

(b) A company wants to analyze its business data to find patterns in their "Profit" and "Sales" performance. The data provided has 8 sets of inputs and 2 outputs, representing the following:
- **Inputs:** Various business-related factors such as "Marketing Spend," "Customer Feedback," "Market Trends," etc.
- **Outputs:** The outputs include "Profit" and "Sales."

The matrix for "Profit" and "Sales" for 8 input sets is as follows:

$$x = \begin{pmatrix} 10 & 100 \\ 12 & 110 \\ 11 & 105 \\ 9 & 94 \\ 9 & 95 \\ 10 & 99 \\ 11 & 104 \\ 12 & 108 \end{pmatrix},$$

where the first column represents "Profit" and the second column represents "Sales."

i Calculate the mean of each output.

ii Compute the covariance matrix for the standardized data.

iii Calculate the eigenvectors and eigenvalues of the covariance matrix. Indicate which eigenvector corresponds to the principal component with the highest variance.

iv Using the eigenvector(s) from Part 4, transform the original data to a new space where the principal component(s) form the axes.

v Discuss the insights you can gain from PCA. How does reducing the dimensionality using PCA help in understanding the data?

(6)

CO- 1,2,3,5

Q 4. (a) Explain Reinforcement Learning with Algorithm. Define Policy in RL model, State action value function and bellman equation.

(5)

(b) Explain Over-fitting and Under-fitting in detail. With suitable examples.

(5)

CO- 1,2,4,5

Q 5. Consider a scenario where a robot is allowed to move in six states: state 1, state 2, state 3, state 4, state 5, and state 6, in left and right directions only. State 1 on the left has a reward of 100 units, and state 6 on the right has a reward of 40 units. Given that the robot initially finds itself in state 4, calculate the return, state-action value function, and Bellman equation for the following cases: (Take discount factor=0.5)

(a) The robot moves towards the right.

(b) The robot moves towards the left.

(c) The robot starts from state 4 and decides to move to the right once, then to the left.

(d) The robot starts from state 4 and decides to move to the left once, then to the right.

(10)

CO- 3,4,5