

**QUESTION PAPERS FOR END TERM THEORY
EXAMINATIONS**

November/ December-2025



M.Tech., MTPT, M.Sc., MBA, EMBA, M.Des.,

1st, 3rd & 5th SEMESTER

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4303

Roll No.....

Third Semester

Int. BSc-MSc Biotechnology

END SEMESTER EXAMINATION, NOVEMBER 2025

IMSBT101 Introduction to Biotechnology

Time: 3.00-Hours

Max. Marks: 50

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

1. Explain the process of transcription in prokaryotes, highlighting the role of the promoter and the terminator regions?
[5 Marks] [CO4] [BTL2]
 2. A student needs to separate a mixture of pigments from a plant extract. Which chromatographic technique would you recommend and why? How is the Rf value calculated and what is its significance?
[5 Marks] [CO5] [BTL3]
 3. Biotechnology has revolutionized agriculture and Medicine Technology" Justify this statement with one-one distinct examples?
[5 Marks] [CO1] [BTL4]
 4. A fermentation broth contains intracellular antibiotics within tough Bacterial cell walls, describe the downstream process with flow diagram?
[5 Marks] [CO3] [BTL3]
- OR**
- Compare and contrast the principles of Thin-Layer Chromatography (TLC) and Column Chromatography.
[5 Marks] [CO5] [BTL4]
5. Describe the role of restriction enzymes and DNA ligase in the creation of recombinant DNA.
[3 Marks] [CO4] [BTL2]
 6. Prof. Jonasan, a cell biology expert, has recently welcomed a new research scholar to his laboratory. He asked the scholar to design an experiment to study cells using microscopic methods. The scholar was confused about how to achieve better

resolution with the microscope and called you for suggestions.
What key parameters would you suggest that can influence
microscope resolution and why?

2304

- 7 Explain the 'Lock and Key' and 'Induced Fit' models of enzyme action. Which model is more widely accepted and why?
[5 Marks] [CO5] [BTL3]
[2 Marks] [CO4] [BTL1]

OR

Briefly describe the below listed

1. SDS-PAGE Electrophoresis
2. Retention Time

- [2 Marks] [CO5] [BTL1]
- 8 Draw a labelled diagram of a typical batch fermenter and describe the function of any four of its components.
[5 Marks] [CO3] [BTL3]
- 9 Describe the Nuclear Pore Transport? and protein Translocation in Nucleus with suitable diagram
[5 Marks] [CO2] [BTL2]
- 10 Draw a labelled diagram of a typical batch fermenter and describe the function of any four of its components.
[5 Marks] [CO3] [BTL3]
- 11 A materials science researcher is interested in studying the surface topology of a specimen. Which type of electron microscope should he use? Write down the principle of that electron microscope?
[5 Marks] [CO2] [BTL4]

OR

Explain the Function of protein complexes in mitochondria transport with suitable figure?

[5 Marks] [CO3] [BTL4]

Total no. of Pages: 2

3305

Roll no

Ist SEMESTER

Integrated-M. Sc Biotechnology

END TERM EXAMINATION

Nov-2025

COURSE CODE: IMSBT103

COURSE TITLE: Microbiology

Time: 03:00 Hours

Max. Marks: 40

Note: Assume suitable missing data, if any.

Q1- 1-MARK QUESTIONS (Answer Any Five) — $5 \times 1 = 5$ marks

1. What is generation time? [1 mark; CO3; BTL-1]
2. What is ribotyping? [1 mark; CO4; BTL-1]
3. Name the latest edition of Bergey's Manual. [1 mark; CO4; BTL-1]
4. Name one enterotoxin. [1 mark; CO5; BTL-1]
5. Define species in bacterial taxonomy. [1 mark; CO4; BTL-1]
6. What is the pH range preferred by acidophiles?
[1 mark; CO3; BTL-1]

Q2- 2-MARK QUESTIONS (Answer three) — $2 \times 3 = 6$ marks

7. What is phylogenetic classification? [2 marks; CO4; BTL-2]
8. Discuss the different ways pathogens evade host immune responses.
[2 marks; CO5; BTL-4]
9. Explain the role of 16S rRNA in bacterial classification. [2 marks;
CO4; BTL-2]
10. Write two differences between mesophiles and thermophiles.
[2 marks; CO3; BTL-2]

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Q3- 3-MARK QUESTIONS (Answer ALL) — $3 \times 4 = 12$ marks

11. Describe the streak plate, spread plate, and pour plate techniques for obtaining pure cultures. [3 marks; CO1; BTL-2]
12. What are cytoplasmic inclusions? Describe any three with examples. [3 marks; CO2; BTL-2]
13. A bacterial culture starts with 2×10^5 cells. After 3 hours of exponential growth, the population reaches 1.6×10^7 cells. [3 marks; CO3; BTL-2]
Calculate:
 1. Number of generations (n)
 2. Generation time (g) in minutes
14. Describe the steps of microbial infection: adhesion, invasion, and colonization. [3 marks; CO5; BTL-2]

Q4- 4-MARK QUESTIONS (Answer ALL) — $4 \times 3 = 12$ marks

15. Describe the structure and organization of Bergey's Manual of Systematic Bacteriology. [4 marks; CO4; BTL-3]
16. Explain the mechanism of action of enterotoxins with one example. [4 marks; CO5; BTL-3]
17. Explain continuous culture using a chemostat with a neat, labelled diagram. [4 marks; CO3 BTL3]

Q5- 5-MARK QUESTIONS (Answer one) — $5 \times 1 = 5$ marks

18. Describe the bacterial growth curve in detail and explain the physiological events in each phase. [5 marks; CO3, BTL4]
19. Describe exotoxins, endotoxins, and enterotoxins with their structure, mode of action, and role in pathogenesis. [5 marks; CO4 BTL4]

Total no. of Pages: 1

5309

Roll no.....

ODD (1st) SEMESTER

Integrated BSc-MSc Biotechnology

END TERM EXAMINATION **Nov-2025**

COURSE CODE -IMSBT105

COURSE TITLE: BIOCHEMISTRY

Time: 03:00 Hours

Max. Marks: 40

Note: All questions are compulsory. Choice has been given in last question only. Assume suitable missing data, if any.

Q.1 Write short note on [4X4 = 16 marks][CO1,2][BTL2]

- Oxidative Phosphorylation.**
- Regulation of fatty acid biosynthesis**
- Oxidative phase of Hexose monophosphate shunt and its significance.**
- Levels of organization of Protein**

Q.2 Discuss in detail about Electron Transport Chain with well labelled diagram. Enumerate various inhibitors of ETC chain and uncouplers of oxidative phosphorylation.

[5+3 = 8 marks][CO1,2][BTL3]

Q.3 Explain why

[4X2 = 8 marks][CO3,4][BTL4]

- Significance of 2,3 BPG at high altitude.**
- Importance of anaplerotic reactions.**
- Excess of glucose is converted to fats, but the opposite is not true, Justify.**
- Gluconeogenesis and glycolysis do not take place at the same time?**

Q.4 Describe in detail about the β -Oxidation of 16C palmitic fatty acids, its regulation, and bioenergetics.

[4+3+1 = 8 marks][CO 3,4][BTL3]

OR

Describe in details about Glycogenesis and glycogenolysis. Discuss its hormonal regulation. [4+4 = 8 marks][CO 3,4][BTL3]

Total No. of Pages: 2

FIRST SEMESTER

END TERM EXAMINATION

6308

Roll No.

IMSBT 107

NOV/DEC-2025

IMSBT 107 CURRENT TOPICS IN BIOTECHNOLOGY

Max. Marks: 50

Time: 3 Hours

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

Q1. (a) Define cellular reprogramming. Write any two applications of stem cells in medicine with examples. (6marks)

(b) How can you treat a patient with sickle cell anemia using genome editing tools. (4 Marks)

(CO# 1, 2)

Q2. (a) Elaborate CRISPR-Cas9 mechanism with suitable diagram. Mention two advantages of CRISPR-Cas9 system. (6 marks)

(b) Define RNA interference with suitable diagram. (4 Marks)

(CO# 2, 5)

Q3. Write short note on:

(a) Metagenomics

(b) Biomaterials

(c) Tissue Engineering

(d) TALENS

(e) Lipidomics (2*5=10 Marks)

(CO# 1,2, 3)

Q4. (a) Define Pharmacogenomics. How is pharmacogenomics useful as compared to conventional medicines? (4 Marks)

(b) What are the limitations of conventional drug delivery system. How does advanced drug delivery system help in overcoming these limitations. (6 Marks)

(CO# 5, 4)

Total No. of Pages: 2

FIRST SEMESTER

END TERM EXAMINATION

6308

Roll No.

IMSBT 107

NOV/DEC-2025

IMSBT 107 CURRENT TOPICS IN BIOTECHNOLOGY

Time: 3 Hours

Max. Marks: 50

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

- Q1. (a) Define cellular reprogramming. Write any two applications of stem cells in medicine with examples. (6marks)
(b) How can you treat a patient with sickle cell anemia using genome editing tools. (4 Marks)

(CO# 1, 2)

- Q2. (a) Elaborate CRISPR-Cas9 mechanism with suitable diagram. Mention two advantages of CRISPR-Cas9 system. (6 marks)

- (b) Define RNA interference with suitable diagram. (4 Marks)

(CO# 2, 5)

- Q3. Write short note on:

- (a) Metagenomics
- (b) Biomaterials
- (c) Tissue Engineering
- (d) TALENS
- (e) Lipidomics (2*5=10 Marks)

(CO# 1,2, 3)

- Q4. (a) Define Pharmacogenomics. How is pharmacogenomics useful as compared to conventional medicines? (4 Marks)
(b) What are the limitations of conventional drug delivery system. How does advanced drug delivery system help in overcoming these limitations. (6 Marks)

(CO# 5, 4)

30 9

Q5. (a) Explain mRNA vaccines with their mechanism of action. Give suitable example. (6 Marks)

(b) How stem cells can be used for organ transplantation give example. Mention ethical issues related to stem cell research. (4 Marks)

(CO# 5, 1)

Q6. (a) What are miRNA? Give some therapeutic roles of miRNA. (6 Marks)

(b) Describe metabolomics and its role in biotechnology. (4 Marks)

(CO# 5,3)

END

8 No

Total No. of pages-2

Roll No.....

THIRD SEMESTER

INTMSc (BIOTECHNOLOGY)

END SEMESTER EXAMINATION

NOVEMBER 2025

IMSBT201: BASIC TECHNIQUES IN BIOLOGICAL
SCIENCES

Time: 3.00 Hours

Max. Marks: 40

Note: Answer 5 of the following questions. Q1 is compulsory.
Assume suitable missing data, if any.

Q1. Attempt the following question [4×2=8] [CO-1-4] [BTL 1,2]

- What is Resolution (R_s) in chromatography?
- What is the Numerical aperture of an optical microscope?
- What is the difference between KPM and RCF?
- What is Beer-Lambert law? Explain.

Q2. Outline the principle, instrumentation and applications of any two of the following [2×4=8] [CO- 4] [BTL 1,2]

- Fluorescent Microscopy
- HPLC
- Scanning Electron Microscope

Q3. Answer the following question. [8] [CO- 4] [BTL 3,4]

- Describe the principle of Chromatography; briefly discuss about the different Chromatographic techniques according to their physical state of the mobile phases.

Q4. Answer all questions [2×4=8] [CO-1, 5] [BTL 3,4]

- Differentiate between preparative and analytical centrifugation and thereby explain the principle and working of a Preparative density-gradient ultracentrifugation.
- For the pelleting of the microsomal fraction from a liver homogenate, an ultracentrifuge is operated at a speed of 50000 r.p.m. What is the angular velocity, ω , in radians per second

P.T.O

Q5. Answer all questions

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[2×4=8] [CO- 4][BTL 3,4]

- a) Discuss about SPR-based immuno-sensing technology
- b) What are DNA sensors? Briefly discuss its working principle and how it can be used in the detection of diseases.

Q6. Answer the following question. [8] [CO-3] [BTL 3,4]

- a) Explain the principle of electrophoresis and its type; describe the factors affecting the electrophoretic mobility, and briefly describe the 2D electrophoresis techniques used in biomolecular separation.

-END-

Total No. of Pages: 2

10-312

Roll No.

Integrated B.Sc.-M.Sc. BT

THIRD SEMESTER

END TERM EXAMINATION

November-2025

IMSBT 203 Molecular Biology

Time: 03:00 Hours

Max. Marks: 40

Note: Answer all the questions.

Assume suitable missing data, if any.

- Q.1 [A] Attempt any TWO of the following [4 marks] [CO 1,2,3] [BTL1,2,4,5]
- (a) Explain Chargaff's rule in DNA structure
 - (b) Compare and contrast the following (2 points for each)
 - (i) Cytidine and Adenosine – structure, type of glycoside
 - (ii) Prokaryotic and Eukaryotic mRNAs – structure, stability
 - (c) A point mutation changes the third base of a codon but does not alter the amino acid. Analyse the statement
 - (d) RNA editing involving deamination of a single base in pre-mRNA can generate diverse proteins. Evaluate the statement giving an example
- [B] Give a flowsheet representation of the elongation phase of translation in prokaryotes. Clearly mention the roles of various proteins involved
[4 marks] [CO3] [BTL1,2,4]
- Q.2 [A] Attempt any TWO of the following [4 marks] [CO2] [BTL1,2,4]
- (a) How does wobble base pairing reduce the number of tRNAs required in a cell? Explain giving a suitable example
 - (b) Give an analysis of mutations induced by base analogs and alkylating agents, taking one example of each
 - (c) Differentiate any TWO of the following (2 points for each)
 - (i) Short-patch and Long-patch BER
 - (ii) UV damage repair by NER and Photoreactivation
 - (iii) RecB and RecD
- [B] Enumerate roles of Ku70/80; RuvC; LigD; MutH proteins and mention in which DNA damage repair process each is involved
[4 marks] [CO2] [BTL1,2]

P.T.O.

- H 313
- Q.3 [A] Attempt any TWO of the following [4 marks] [CO3] [BTL1,2,5]
- (a) Compare and contrast DNA Polymerase I and DNA Polymerase III
 - (b) Evaluate the structure of CTD tail of RNA Pol II for its role in transcription and post-transcriptional processing of pre-mRNA
 - (c) Describe the conserved residues involved in intein splicing. What is the significance of the terminal Asn/Gln cyclization step in intein splicing?
 - (d) Discuss the roles of SD sequence and eIF4G in translation
- [B] Termination of eukaryotic transcription is coupled with cleavage and polyadenylation. Elucidate giving details of enzymes/proteins involved and reaction catalyzed. Also explain the significance of poly A tail [4 marks] [CO3] [BTL3,4]

- Q.4 [A] Attempt any TWO of the following [4 marks] [CO3,4] [BTL1,2,4,5]
- (a) Give a diagrammatic representation of spliceosomal splicing of intron in nuclear pre-mRNA. Mention roles of various proteins involved
 - (b) If bacterium is grown in the presence of lactose, evaluate how lactose uptake and catabolism occurs. ~~Clearly explain the roles and action of~~ various regulatory proteins involved
 - (c) Compare and contrast the essential structural features required for the function of *trans*-acting hammerheaded and hairpin ribozymes
 - (d) Explain four ways of transcriptional gene silencing by antisense RNAs
- [B] Explain steps involved in miRNA-mediated target mRNA degradation. Summarize specific features of miRNA and salient points of each enzyme/protein involved in the process [4 marks] [CO4] [BTL1,2,5]

- Q.5 [A] Attempt any TWO of the following [4 marks] [CO5] [BTL1,2,4,5]
- (a) Give salient points of STR that make them suitable for DNA fingerprinting. Also design strategy for STR-based paternity testing
 - (b) Give a detailed account of the steps involved in a standard PCR reaction. How does it differ from reverse transcriptase PCR (RT-PCR)?
 - (c) Explain how the different chemicals used in Maxam-Gilbert DNA sequencing modify and cleave DNA bases
 - (d) Outline the procedure of Sanger's method of DNA sequencing. Clearly explain the significance of DNA polymerase substrate analogs used
- [B] Evaluate the vector map of pUC18 with respect to cloning of insert DNA and principle for color-based selection of recombinants [4 marks] [CO5] [BTL1,2,5]

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Total no. of Pages: 1 314 12

Roll no.

000 (3rd) SEMESTER

Integrated BSc-MSc Biotechnology

END TERM EXAMINATION

Nov-2025

COURSE CODE- IMSBT205

COURSE TITLE: HUMAN ANATOMY AND PHYSIOLOGY

Time: 03:00 Hours

Max. Marks: 50

Note: All questions are compulsory. Choice has been given in last question only. Assume suitable missing data, if any.

Q1. Discuss in brief

{3X5 =15 marks}[CO1,2][BTL2]

- Action Potential
- Counter Current system
- Mechanism of Temperature regulation
- Na⁺-K⁺ Secondary Active Transport
- Markers of cell organelles

Q2. Discuss in detail about mechanism of urine formation with well labelled diagram.

[7 marks][CO1,2][BTL3]

Q3. Write short note on

[5X4 =20 marks][CO2,3] [BTL3]

- Fluid Mosaic Model
- Chemical Regulation of Respiration
- Draw well labelled Diagram of Antibody
- Neuromuscular Junction

Q4. Draw well labelled diagram of heart. Discuss cardiac cycle.

[4+4=8 marks][CO 3,4][BTL4]

OR

Discuss in detail the mechanism of Muscle contraction with well labelled diagram

[8 marks][CO 3,4][BTL3]

Note: Answer all the questions.

Assume suitable missing data, if any.

- Q.1 [A] Attempt any TWO of the following [5 marks] [CO1] [BTL1,2]
- (a) What is the purpose of calcium chloride treatment in preparing chemically competent *E. coli* cells? Explain the mechanism in detail
 - (b) Comment on the properties of high-pressure source and microprojectiles used in microprojectile bombardment or Explain various methods for immobilization of recipient cells for the purpose of microinjection
 - (c) Explain the reasons for using the following in cloning experiments
 - (i) P2 lysogen *E. coli* host used with λ phage replacement vector
 - (ii) Helper M13 phage used with phagemid vector
- [B] What are the essential functional components of YAC vector and their roles? Outline the procedure for cloning in pYAC3 and explain the strategy for selection of recombinants [5 marks] [CO1] [BTL1,2]
- Q.2 [A] Attempt any TWO of the following [5 marks] [CO2] [BTL1,2,6]
- (a) Describe the procedure of reproductive cloning using SCNT technique
 - (b) Design a strategy for targeted cell death using prodrug ganciclovir. Explain the principle involved
 - (c) Enumerate salient features of target genomic locus, RNA, and enzyme involved in the process of CRISPR-Cas9 mediated gene editing
 - (d) How does Cre recombinase recognize *loxP* sequences? What are the different products formed dependent on the orientation of *loxP* sites? What is meant by a conditional gene knockout?
- [B] Applying Cre-*loxP* system, design a strategy for floxed mouse strain construction. Explain the significance of positive and negative selection marker genes in the targeting vector? [5 marks] [CO2] [BTL1,2,6]

P.T.O.

- 14-316
- Q.3 [A] Attempt any TWO of the following [5 marks] [CO2,3] [BTL1,2,5,6]
- (a) Compare and contrast sequential and simultaneous gene stacking. Also explain advantages of each
 - (b) Outline the principle and procedure of CAR-T cell therapy for cancer and give one example of commercial CAR-T cell therapy
 - (c) Enumerate various methods of gene isolation encoding protein of interest. Explain any one wet lab-based method for isolation of unknown gene in detail
 - (d) Design a strategy for humulin production using recombinant microbes
- [B] Devise a generalized strategy for production of protein of interest / small molecule using recombinant microbes. What strategies are adopted in the cloning step? [5 marks] [CO3] [BTL2,6]
- Q.4 [A] Attempt any TWO of the following [5 marks] [CO4] [BTL1,2,3]
- (a) Write in brief about designing of blue rose
 - (b) What do you understand by 'NSG mice' and 'Gal-KO pigs'? Demonstrate their significance in medical field
 - (c) How are iPSCs produced and what are their advantages? Explain the mechanism involved in homing and engrafting of stem cells
- [B] Describe any TWO of the following [5 marks] [CO4] [BTL1,2]
- (a) Two strategies for raising transgenic plants for delayed fruit ripening
 - (b) Production and advantages of edible vaccines
 - (c) Types of plant bioreactors
- Q.5 [A] Attempt any TWO of the following [5 marks] [CO2,5] [BTL1,2,4]
- (a) Categorize research on ES cells according to the source of stem cells and nature of experiments. Enlist two types of researches in each category
 - (b) Discuss the hierarchy of National Regulatory Bodies for GMOs and enlist roles of each
 - (c) Enlist various methods for transgene integration analysis and explain any one method in detail
- [B] The lack of public acceptance remains a major barrier to the commercialization of GMOs. Explain five health and five environmental concerns that contributed to resistance toward GMOs [5 marks] [CO5] [BTL1,2]

* END *

Total No. of Pages: 2

FIRST SEMESTER

Integrated B.Sc & M.Sc [Physics]

END -SEMESTER EXAMINATION

IMSPH 101 MATHEMATICAL PHYSICS I

Time: 3:00 Hours

Roll No..... -

NOVEMBER-2025

Max. Marks:50

Note: CO is compulsory. Attempt any four from rest of the questions. Each question is to be answered in 100 words. Symbols have their usual meaning. Assume suitable missing data, if any, explicitly is given for the reference.

1. Answer the following [2x5= 10][CO#1-5]
 - a. Evaluate $\Gamma(-3/2)$
 - b. Express $2x^2 + x + 3$ in terms of Legendre's polynomials
 - c. Find $L^{-1}\left\{\frac{5s}{(s^2+1)^2}\right\}$
 - d. Evaluate the Hermite polynomial $H_1(x)$
 - e. Find the volume of the tetrahedron whose vertices are the points A (2,-1,-3), B (4,1,3), C (3,2, -1) and D (1,4,2)
2. Solve
 - a. $z' - \frac{2}{x}z = \frac{2}{3}x^4$ [5][CO#2]
 - b. $\frac{d^2T}{d\theta^2} + 30\frac{dT}{d\theta} + 225T = 0$ [5][CO#3]
3. Using Laplace transform, solve the following
 - a. $y' + y = \sin x; y(0) = 1$ [5][CO#3,4]
 - b. $y'' + 4y = 0; y(0) = 2, y'(0) = 2$ [5][CO#2,5]
4.
 - a. Solve the following system for the unknown functions $u(x)$ and $v(x)$ by Laplace transform:
 $u' + u - v = 0, v' - u + v = 2; u(0) = 1, v(0) = 2$ [5][CO#5]
 - b. i. For the Hermite polynomials, prove $H_\nu(-x) = (-1)^\nu H_\nu(x)$ [2.5][CO#4,3]
ii. Prove that $\beta(m,n) = \beta(m,n+1) + \beta(m+1,n)$ [2.5][CO#4,5]
5.
 - a. Solve the integral using gamma function [5][CO#5]
$$\int_0^\infty y^2 e^{-2y^2} dy$$
 - b. Prove the relation: $J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{x\pi}} \sin x$ [5][CO#4,5]
6.
 - a. Evaluate $\int_0^1 x^3 dx$ using Simpson's 3/8 rule taking $n = 3$ sub-intervals. [5][CO#3,4]
 - b. Compare the results of Trapezoidal and Simpson's 1/3 rules for $\int_0^1 (1 + x^2) dx$ with $h = 0.25$. [5][CO#3,5]

Appendix A

1. $\Gamma(n) = \int_0^\infty e^{-x} x^{n-1} dx = \frac{\Gamma(n+1)}{n} = \frac{n!}{n}$
2. $\beta(m, n) = \int_0^1 x^{m-1} (1-x)^{n-1} dx = \frac{\Gamma(n)\Gamma(m)}{\Gamma(m+n)}$
3. Generating Function for Legendre polynomials
 $\theta(x, t) = \frac{1}{\sqrt{1-2xt+t^2}} = \sum_{l=0}^{\infty} P_l(x) t^l$
4. Recurrence relations for Legendre polynomials
 - a. $(l+1)P_{l+1}(x) = (2l+1)xP_l(x) - lP_{l-1}(x)$
 - b. $P'_{l+1}(x) = P_l(x) + 2xP'_l(x) - P'_{l-1}(x)$
 - c. $xP'_l(x) - P'_{l-1}(x) = lP_l(x)$
 - d. $xP'_{l-1}(x) - lP_{l-1}(x) = P'_l(x)$
5. Generating Function for Hermite polynomials
 $e^{2xt-t^2} = \sum_{v=0}^{\infty} \frac{H_v(x)}{v!} t^v$
6. Recurrence relations for Hermite polynomials
 - a. $2vH_{v-1}(x) = H'_v(x)$
 - b. $2xH_v(x) = 2vH_{v-1}(x) + H_{v+1}(x)$
 - c. $H'_v(x) = 2xH_v(x) - H_{v+1}(x)$
7. Bessel's Function
 $y_1 = J_m(x) = \sum_{n=0}^{\infty} \frac{(-1)^n}{n!(n+m)!} \left(\frac{x}{2}\right)^{2n+m}$
 $y_2 = J_{-m}(x) = \sum_{n=0}^{\infty} \frac{(-1)^n}{n!(n-m)!} \left(\frac{x}{2}\right)^{2n-m}$
8. Bessel's Generating function
 $g(x, t) = e^{\frac{x}{2}(t-\frac{1}{t})} = \sum_{m=-\infty}^{\infty} J_m(x) t^m$
9. Recurrence relations for Bessel's function:
 - a. $J_{m-1}(x) + J_{m+1}(x) = \frac{2m}{x} J_m(x)$
 - b. $J_{m-1}(x) - J_{m+1}(x) = 2J'_m(x)$
 - c. $J_{m+1}(x) = \frac{m}{x} J_m(x) - J'_m(x)$

Appendix B

	$f(x)$	$F(s) = \mathcal{L}\{f(x)\}$
1.	1	$\frac{1}{s} \quad (s > 0)$
2.	x	$\frac{1}{s^2} \quad (s > 0)$
3.	$x^{n-1} \quad (n = 1, 2, \dots)$	$\frac{(n-1)!}{s^n} \quad (s > 0)$
4.	$\sqrt{x}$	$\frac{1}{2} \sqrt{\pi} s^{-3/2} \quad (s > 0)$
5.	$1/\sqrt{x}$	$\sqrt{\pi} s^{-1/2} \quad (s > 0)$
6.	$x^{n-1/2} \quad (n = 1, 2, \dots)$	$\frac{(1)(3)\dots(2n-1)\sqrt{\pi}}{2^n} s^{-n-1/2} \quad (s > 0)$
7.	e^{ax}	$\frac{1}{s-a} \quad (s > a)$
8.	$\sin ax$	$\frac{a}{s^2+a^2} \quad (s > 0)$
9.	$\cos ax$	$\frac{s}{s^2+a^2} \quad (s > 0)$
10.	$\sinh ax$	$\frac{a}{s^2-a^2} \quad (s > a)$

	$f(x)$	$F(s) = \mathcal{L}\{f(x)\}$
11.	$\cosh ax$	$\frac{s}{s^2-a^2} \quad (s > a)$
12.	$x \sin ax$	$\frac{2as}{(s^2+a^2)^2} \quad (s > 0)$
13.	$x \cos ax$	$\frac{s^2-a^2}{(s^2+a^2)^2} \quad (s > 0)$
14.	$x^{n-1} e^{ax} \quad (n = 1, 2, \dots)$	$\frac{(n-1)!}{(s-a)^n} \quad (s > a)$
15.	$e^{bx} \sin ax$	$\frac{a}{(s-b)^2+a^2} \quad (s > b)$
16.	$e^{bx} \cos ax$	$\frac{s-b}{(s-b)^2+a^2} \quad (s > b)$
17.	$\sin ax - ax \cos ax$	$\frac{2a^3}{(s^2+a^2)^2} \quad (s > 0)$
18.	$\frac{1}{a} e^{-x/a}$	$\frac{1}{1+as}$
19.	$\frac{1}{a} (e^{ax} - 1)$	$\frac{1}{s(s-a)}$
20.	$1 - e^{-x/a}$	$\frac{1}{s(1+as)}$
21.	$\frac{1}{a^2} x e^{-x/a}$	$\frac{1}{(1+as)^2}$

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Total Number of Pages 2
FIRST SEMESTER
END-TERM EXAMINATION

Roll. No.....
Integrated B.Sc.-M.Sc. Physics
(NOVEMBER 2025)

IMSPH103: Introduction to Mechanics

Time: 3:00 Hours

Max. Marks: 50



Q1. Answer the following questions. [2×5][CO#1-5][L#1,2,3]

[a] The position of a point in the frame S' moving relative to S , with a constant velocity of 10cm/s along X-axis is given by (11,9,8). Calculate its position with respect to frame S , if the two frames were in coincidence only 0.5 second before.

[b] What are massless particles? Show that their energy E and momentum P must have relation $E=pc$.

[c] Differentiate between elastic and inelastic collision. Give example.

[d] What is the ratio of the force of attraction between two bodies kept in air and the same distance apart in water?

[e] State and explain Hook's law.

Q.2[a] Differentiate between inertial and non-inertial frames of references with suitable examples. Prove that law of conservation of linear momentum is invariant under Galilean transformation equations.

[4][CO#1][L#2,3]

[b] Derive Lorentz transformation equations for space and time. Show that Lorentz transformation equations reduce to Galilean Transformation equations for $v \ll c$

[4][CO#2][L#2,3]

Q.3[a] Show that by introducing the idea of reduced mass a two body problem can be reduced to one body problem.

[4][CO#4][L#2,4]

[b] What do you mean by length contraction. Calculate the percentage contraction of a rod moving with velocity of $0.8c$ in a direction inclined at 60° to its own length.

[4][CO#2][L#3,5]

Q.4 [a] State and prove theorem of conservation of angular momentum for the system of N- particles. [4][CO#3] [L#2,3]

[b] Define moment of inertia of a body. Discuss its physical significance. State and prove theorem of parallel axes of moment of Inertia.

[4][CO#3] [L#1,2]

Q.5 [a] Obtain expression for gravitational potential due to a spherical shell at a point (i) outside (ii) on the surface (iii) inside spherical shell. [4][CO#4] [L#1,2,3]

[b] An artificial satellite revolves around earth at a height of 1000 km, The radius of the earth is 6.38×10^3 km. Mass of earth is 6×10^{24} Kg, $G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ Kg}^{-2}$. Find orbital velocity and period of revolution. [4][CO#4] [L#1,5]

Q.6 [a] Explain the effect of temperature, density and pressure on the viscosity of liquid. A square plate of 10 cm side moves parallel to another plate with a velocity of 10 cm/s, both plates immersed in water. If the viscous force is 200 dyne and viscosity of water is $0.01 \text{ dyne cm}^{-2} \text{ s}$, what is their distance apart?

[4][CO#5] [L#1,5]

[b] Explain Poiseuille's formula. Water is flowing through a horizontal tube 8 cm in diameter and 4 kilometres in length at the rate of 20 litres/s. Assuming only viscous resistance, calculate the pressure required to maintain the flow in terms of mercury column. Coefficient of viscosity of water is 0.001 Pa-s .

[4][CO#5] [L#1,5]

Q.7 [a] Derive the Euler's equations for rotating rigid body.

[4][CO#3] [L#1,2]

[b] What is a perfectly inelastic collision? Show that kinetic energy is invariably lost in such a collision. [4][CO#3] [L#2]

Total No. of Pages: 3

Roll No.

Ist SEMESTER

Integrated B.Sc-M.Sc (Physics)

END TERM EXAMINATION

Nov. 2025

COURSE CODE IMSPH:105 COURSE TITLE: THE ELEMENTS
OF ELECTRICITY & MAGNETISM

Time: 3.0 Hours

Max. Marks: 40

Note: Attempt any five questions. Symbols have their usual meaning.

Q1 (a) If $|\mathbf{a} + \mathbf{b}| = |\mathbf{a} - \mathbf{b}|$ show that $\mathbf{a}$ is perpendicular to $\mathbf{b}$. [3] [CO:2]
[BTL:1,2]

(b) Prove that $\nabla \cdot (\mathbf{A} + \mathbf{B}) = \nabla \cdot \mathbf{A} + \nabla \cdot \mathbf{B}$ [2] [CO:3] [BTL:1,2]

(c) Given $\phi = x^{3/2} + y^{3/2} + z^{3/2}$, find (i) grad ϕ and (ii) a unit normal to the surface ϕ at point (2, -2, 3). [3] [CO:3] [BTL:2]

Q2 (a) Find the electric potential energy and the work done with appropriate figures for two point charges q and q_0 along a (i) straight line and (ii) an arbitrary path from charge q . What would be the effect on the potential energy if the two point charges have the same sign or the opposite signs? [3.5] [CO:5] [BTL:3,4]

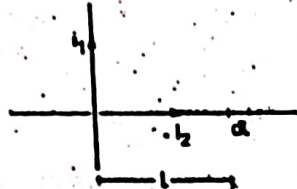
(b) What is the role of a dielectric material placed in between the plates of a parallel plate capacitor? [1.5] [CO:2] [BTL:2]

(c) Derive the Relation between polarization vector ($\mathbf{P}$), displacement ($\mathbf{D}$) and electric field ($\mathbf{E}$) for a dielectric placed in an external field $\mathbf{E}_0$ between the plates of a charged capacitor. [3] [CO:5] [BTL:3]

Q3 (a) Using Biot Savart's law, find the magnetic field due to current in a long, straight wire. Draw an appropriate figure for the same. [3] [CO:5] [BTL:3]

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- (b) A Figure below shows two long wires carrying currents i_1 and i_2 are placed perpendicular to each other in such a way that they just avoid a contact. Find the magnitude force on a small length dl of the 2nd wire situated at a distance l from the 1st wire. [3][CO:3] [BTL:2]



- (c) What are the properties of Dia-, Para- and Ferromagnetic substances? [2] [CO:2] [BTL:2]

- Q4 (a) What are eddy currents & what are its applications? [2] [CO:2] [BTL:2]

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- (b) Write down the Maxwell's equations and state its significant implications [2.5] [CO:5] [BTL:3]

- (c) An average induced emf of 0.20 V appears in a coil when the current in it is changed from 5.0 A in one direction to 5.0 A in the opposite direction in 0.20 s. Find the self-inductance of the coil. [1.5] [CO:3] [BTL:3]

- (d) State main differences between a conduction and a displacement current OR difference between self & mutual induction. [2] [CO:2] [BTL:2]

- Q5 (a) State Faraday's Law of electromagnetic induction and Maxwell's counterpart to Faraday's law. [3] [CO:5] [BTL:2]

- (b) Derive the expression of Ampere-Maxwell Law [3] [CO:5] [BTL:3,4]

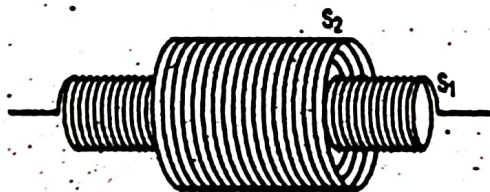
(c) Calculate the energy stored in an inductor of inductance 50 mH when a current of 2.0 A is passed through it. [2] [CO:2] [BTL:3]

Q6 (a) Define the following terms: (i) Electric Potential (ii) Lenz's Law (iii) Energy stored in an inductor and (iv) Dielectric Strength [8] [CO:5] [BTL:2]

Q7. (a) A parallel plate capacitor has plate area A and plate separation d . The space between the plates is filled up to a thickness x ($< d$) with a dielectric of dielectric constant K . Calculate the capacitance of the system. [3] [CO:3] [BTL:3,4]

(b) A long straight wire carries a current of 35 A. What is the magnitude of the field B at a point 20 cm from the wire. [2] [CO:4] [BTL:3]

(c) A solenoid S_1 is placed inside another solenoid S_2 as shown in figure below. The radii of the inner and the outer solenoids are r_1 and r_2 respectively and the numbers of turns per unit length are n_1 and n_2 respectively. Consider a length l of each solenoid. Calculate the mutual inductance between them. [3] [CO:5] [BTL:3]



Total No. of Pages: 4

Roll No:.....

Ist SEMESTER

Integrated B.Sc-M.Sc (Physics)

END TERM EXAMINATION

Nov. 2025

COURSE CODE IMSPH:107 COURSE TITLE:GEC PHYSICS-1

Time:3.0 Hours

Max. Marks:40

Note: Attempt any 5 questions from Q1-Q8. Symbols have their usual meaning. Assume suitable missing data, if any.

**Q 1(a) Derive the equation of conservation of momentum [2] [CO:5]
[BTL:2]**

**(b) State three main differences between a centripetal and a centrifugal force and write down their expressions? [2] [CO:2]
[BTL:1]**

(c) For circular turning on roads, what is the limit to the maximum value of friction for a safe turn? What is the tendency to be overturned by a cyclist if he turns around a curve at 15 miles/hour and if he doubles the speed? OR State key aspects of moment of inertia and give its expression. [2] [CO:5] [BTL:1,2]

**(d) Two bodies of different masses are moving with the same kinetic energy of translation. Which has greater momentum? [2] [CO:2]
[BTL:2]**

Q 2(a) State two postulates of special relativity. [2.5] [CO:3] [BTL:1]

**(b) Explain the concept of Twin Paradox OR Time Dilation [2.5]
[CO:5] [BTL:2]**

**(c) A spaceship is moving away from the Earth with a velocity of $0.5c$ and fires a rocket whose velocity with relative to space is $0.5c$
(i) away from the earth; (ii) towards the earth. Calculate the**

velocity of the rocket as observed from the earth in two cases. [3]
[CO:3] [BTL:3]

Q 3(a) Derive the expression of relativistic kinetic energy of any particle of mass m . [4] [CO:5] [BTL:3]

(b) Derive Lorentz Transformation equations from the perspective of inertial frames in relativity OR Consider a spaceship moving away from you at a velocity of $0.5c$. It fires a rocket that thrusts in the same direction, also away from you, at a speed of $0.5c$ relative to itself. How fast does the rocket move relative to you? Suppose that the spaceship instead fires a pulse of laser light in its direction of travel. How fast does the pulse move in your frame of reference? [4] [CO:5] [BTL:3,4]

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Q 4(a) Derive mirror formula i.e. $1/f = 1/u + 1/v$ either for a concave mirror or convex mirror where f is the focal length; u is the distance of the object from the mirror and v is the distance of the image from the mirror. [3] [CO:5] [BTL:3]

(b) If the distance of the object from the concave mirror is 4 times the focal length, then, the position of the image will be obtained at? [2] [CO:3] [BTL:3]

(c) What conditions are necessary for total internal reflection to occur? [2] [CO:2] [BTL:1]

(d) How does the refractive index affect the total internal reflection of light? [1] [CO:2] [BTL:1]

Q 5(a) Derive the expression of a Lens Maker Formula for a convex lens, i.e. $1/f = (n-1)(1/R_1 - 1/R_2)$ where f is the focal length, n is the refractive index, and R_1 and R_2 are the radii of the curvature of the lens surfaces. [3] [CO:5] [BTL:3]

(b) Define the following terms for both concave and convex lens: (i) Magnification (M) and (ii) Power (P) [2] [CO:3] [BTL:1]

(c) An object of size 3.0 cm is placed 14 cm in front of a concave lens of focal length 21 cm. Describe the image produced by the lens. What happens if the object is moved further away from the lens? [3] [CO:2] [BTL:2,3]

Q 6(a) Derive the expression of a Kinetic energy (K), Potential Energy (U) and Total Mechanical Energy E for a simple harmonic motion (SHM). [2.5] [CO:3] [BTL:3]

(b) Plot (i) Energy vs. Position Graph and (ii) Energy vs. Time Graph. [2] [CO:3] [BTL:1,2]

(c) Find the time average & position average of Kinetic & Potential Energy for a SHM. [3][CO:3] [BTL:2]

Q 7(a) Derive the equations of motion of a Damped Harmonic Oscillator and discuss over-damped, critically damped and under-damped cases OR Define the following terms for a damped oscillator (i) Relaxation Time; (ii) Mean Time and (iii) Quality Factor. What is the relation between these three terms? [5] [CO:5] [BTL:3]

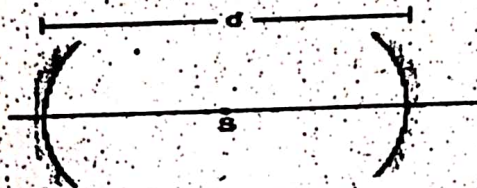
(b) An oscillator has a time period of 3 seconds. Its amplitude decreases by 5% each cycle. (a) By how much does its energy decrease in each cycle? (b) Find the time constant and (c) Find the Q-factor. [3] [CO:5] [BTL:3]

Q8(a) The equation of motion for a damped oscillator is given by

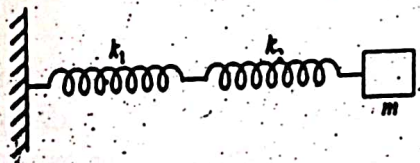
$$4 \frac{d^2x}{dt^2} + b \frac{dx}{dt} + 32x = 0$$

For what range of values for the damping constant will the motion be (i) Underdamped; (ii) Overdamped and (iii) Critically damped? [3] [CO:2] [BTL:3]

- (b) A point source S is placed midway between two converging mirrors having equal focal length f as shown in figure below. Find the values of d for which only one image is formed. [3] [CO:2]
[BTL:2,3]



- (c) Find the time period for the arrangement for the following mass loaded spring having spring constant k_1 and k_2 as shown in the fig. below. [2] [CO:2] [BTL:2,3]



Total Number of Pages: 2

Roll. No.....

THIRD SEMESTER
Integrated B.Sc.-M.Sc.
END-TERM EXAMINATION

November 2025

IMSPH 203: Modern Physics

Time: 3:00 Hours

Max. Marks: 50



Q1. Write short notes on the following

[2.5 × 4 = 10][CO#1-5]

[a] Photoelectric effect

[b] Tunnel effect

[c] Salient features of nuclear forces

[d] Spontaneous and Stimulated emission

Q.2 [a] What is Compton effect? Obtain an expression for the change in wavelength of a photon when it is Compton scattered by a free electron through an angle Φ with respect to the original direction.

[5][CO#1]

[b] Explain the wave-particle duality of matter and light. How was it demonstrated by the Davisson-Germer experiment?

[5] [CO#1]

Q.3 [a] Define the position probability density and probability current density in the context of a quantum mechanical wave function. Obtain the equation connecting these quantities and give the physical interpretation of this equation.

[5][CO#2]

[b] Write down the time-dependent Schrödinger wave equation and obtain the time-independent Schrödinger equation from it.

[5][CO#2]

Q.4 [a] Consider a particle trapped in an infinite potential box of width 'a',

$$V(x) = \begin{cases} 0, & 0 < x < a \\ \infty, & x \leq 0, x \geq a \end{cases}$$

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Write the Schrodinger equation for this particle and hence get the expression for the energy eigen values and eigen functions for the particle. Draw its first three probability densities and wave functions.

[5][CO#3]

[b] For a 3D potential box where $L_x=L_y=L_z=1$ m, explain why the degeneracy of the ground state is 1, and the degeneracy of the first excited state is 3. Also calculate the difference of energy eigenvalues of first excited and third excited state for the same.

[5][CO#4]

Q.5 [a] Starting with the rate equations for matter-radiation interaction, show that the ratio of the Einstein's A and B coefficients is proportional to the third power of the frequency of radiation.

[5][CO#5]

[b] Describe the construction and working of a Ruby laser. What are the characteristics of a laser beam?

[5][CO#5]

Q.6 [a] Derive the semi-empirical mass formula (Bethe-Weizsäcker formula) using the Liquid Drop Model.

[5][CO#4]

[b] Find the activity of 1.00 mg of radon, $^{222}_{Rn}$, whose atomic mass is 222 u.

[5][CO#4]

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Total No. of Pages: 02
THIRD SEMESTER

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Roll No.
Interpreted B.sc/M.Sc

END TERM EXAMINATION

Nov-2025

IMSPH205: OPTICS

Time: 3:00 Hours

Max. Marks: 40

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

1. (a) Explain Huygens principle of wave propagation and apply it to prove the law of reflection of a plane wave at a plane surface.
(b) Explain Electromagnetic nature of light and wavefront? How it is produced?
[4+4 = 8] [CO1]
2. (a) In a Young's double slit experiment, monochromatic light of wavelength $\lambda = 600 \text{ nm}$ is used. The slits are separated by $d = 0.4 \text{ mm}$, and the screen is placed at a distance $D = 1.2 \text{ m}$ from the slits. A thin transparent film of refractive index $\mu = 1.4$ and thickness t is introduced in front of one of the slits. As a result, the central maximum shifts by $y = 3 \text{ mm}$ on the screen.
 - (i) Derive the expression for the shift of the central fringe when a thin film is inserted in front of one slit.
 - (ii) Using this expression, calculate the thickness t of the film.
 - (iii) If the entire apparatus is now immersed in a medium of refractive index 1.33, determine the new fringe width.
 - (iv) Explain physically why the central maximum shifts but fringe width does not change due to insertion of the thin film.
- (b) Derive the condition for constructive and destructive interference of light reflected from a parallel-sided thin film of thickness t and refractive index μ , when monochromatic light of wavelength λ is incident at an angle i .
[4+4=8] [CO2]

3. Derive the expression for the transmitted intensity in a Fabry-Pérot interferometer and obtain the Airy formula. Two identical lossless mirrors (reflectivity $R=0.85$) form a Fabry-Pérot etalon filled with air ($n=1$). Mirror separation is $d=1.6 \mu\text{m}$. Light of wavelength $\lambda=600 \text{ nm}$, is incident normally. Calculate the phase difference δ between successive transmitted beams and find the transmitted intensity ratio I/I_0 using the Airy formula.

[8][CO3]

4. Derive the intensity distribution for Fraunhofer diffraction at a single slit and obtain the condition for minima. A monochromatic light of wavelength $\lambda=600 \text{ nm}$ falls on a single slit of width $a=0.30 \text{ mm}$. If the diffraction pattern is observed on a screen placed 2 m away, calculate the angular position of the first minimum and the linear position of the first minimum on the screen.

[8][CO3]

5. (a) State and derive Fresnel's assumptions and hence obtain the expression for the resultant amplitude at a point due to Fresnel's Half-Period Zones for a plane wave.

(b) A point P is located 2.5 m from a plane wavefront. Calculate the radius of the first Fresnel half-period zone for light of wavelength 550 nm .

[8][CO3]

6. (a) Derive the expression for the fringe width and discuss why the fringes are asymmetric and why a dark fringe appears at the geometrical line of contact.

(b) Derive the expression for the separation of the virtual coherent sources and hence obtain the formula for fringe width.

[8][CO3]

Total No. of Pages 02

FIRST SEMESTER

END SEM EXAMINATION

IMSMA-101

CALCULUS-I

Roll No.

27-32 Integrated B.Sc [Mathematics]

NOV./DEC-2025

Time: 3Hrs.

Max. Marks: 50

Q.1 (a) If $y^{\frac{1}{m}} + y^{-\frac{1}{m}} = 2x$, prove that

$$(x^2 - 1)y_{n+2} + (2n + 1)xy_{n+1} + (n^2 - m^2)y_n = 0.$$

[5M] [CO1, L2]

(b) If ρ_1 and ρ_2 be the radii of curvature at the extremities of any chord of the Cardioid $r = a(1 + \cos\theta)$ which passes through the pole, show that $\rho_1^2 + \rho_2^2 = \frac{16a^2}{9}$.

[5M] [CO3, L4]

Q.2 (a) Find the asymptote of the curve $r = \frac{a}{(1 - \cos\theta)}$.

[5M] [CO3, L3]

(b) If $I_n = \int_0^{\frac{\pi}{2}} x^n \cos x \, dx$, n being a positive integer greater than unity, show that $I_n + n(n+1)I_{n-2} = \left(\frac{\pi}{2}\right)^n$. Hence, evaluate

$$\int_0^{\frac{\pi}{2}} x^4 \cos x \, dx.$$

[5M] [CO4, L3]

Q.3 (a) Find the area bounded by the curve $y^2(2a - x) = x^3$ and its asymptote.

[5M] [CO4, L3]

(b) In a submarine cable the speed of signalling varies as

$x^2 \log_e \left(\frac{1}{x}\right)$, where x is the ratio of the radius of the core to that of the covering. Find the values of x for which the speed of signalling is maximum.

[5M] [CO2, L6]

Q.4 (a) If $f(x) = \begin{cases} e^{-1/x^2} \sin\left(\frac{1}{x}\right), & x \neq 0 \\ 0, & x = 0 \end{cases}$. Discuss the differentiability of $f(x)$ at $x = 0$.

[5M] [CO1, L4]

(P.T.O.)

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- (b) Find the surface area of the solid generated by the revolution of the curve $x^{2/3} + y^{2/3} = a^{2/3}$ about x-axis.

[5M] [CO5, L4]

- Q.5 (a) Trace the curve $x^2 y^2 = a^2 (y^2 - x^2)$.

[5M] [CO3, L4]

- (b) Prove that the length of the equiangular spiral $r = ae^{\theta \cot \alpha}$ between the points with radii vectors r_1 and r_2 is $|r_1 - r_2| \sec \alpha$.

[5M] [CO5, L3]

- Q.6 (a) Prove that $\int_0^{\pi} \frac{x dx}{a^2 \cos^2 x + b^2 \sin^2 x} = \frac{\pi^2}{2ab}$.

[5M] [CO4, L3]

- (b) Find the volume of the solid generated by revolving the lemniscate $r^2 = a^2 \cos 2\theta$ about the line $\theta = \frac{\pi}{2}$.

[5M] [CO5, L5]

Total no. of Pages: 2

FIRST SEMESTER

END TERM EXAMINATION

COURSE CODE: IMSMA 103

COURSE TITLE: ANALYTICAL GEOMETRY

Time: 03:00 Hours

Roll no.....

IMSc.(MATHS)

Nov -2025

Max. Marks: 50

NOTE: Assume suitable data if any is missing.

Q.1 (i) Find the ratios in which the join of the points $A(3,2,1)$ and $B(1,3,2)$ is divided by the locus of the equation $3x^2 - 72y^2 + 128z^2 = 3$.

[5][CO1] [L3,L5]

(ii) A plane passes through the points $A(0,1,3)$, $B(1,0,-4)$, $C(1,1,-1)$. Find its equation and the length of the perpendicular to it from $D(2,4,-3)$.

[5][CO1] [L2,L5]

Q.2 (i) A line makes angles $\alpha, \beta, \gamma, \delta$ with four diagonals of a cube. Prove that

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma + \cos^2 \delta = \frac{4}{3}$$

[5][CO2] [L4,L5]

(ii) A variable plane passes through a fixed point (a,b,c) and meets the co-ordinates axes in A, B, C . Show that the locus of the point common to the planes through A, B, C parallel to the co-ordinate planes is

$$\frac{a}{x} + \frac{b}{y} + \frac{c}{z} = 1.$$

[5][CO2] [L2,L3,L5]

Q.3 (i) Find the length and the equations of the shortest distance between the lines

$$\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4} \text{ and } \frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}$$

[5][CO3] [L3,L5]

(ii) Show that the lines $\frac{x+1}{-3} = \frac{y-3}{2} = z+2$ and $x = \frac{y-7}{-3} = \frac{z+7}{2}$ intersect. Find the co-ordinates of the point of intersection and the equation to the plane containing them.

[5][CO3] [L3,L5]

OR

Show that the lines $x + y + z - 3 = 0 = 2x + 3y + 4z - 5$ and $4x - y + 5z - 7 = 0 = 2x - 5y - z - 3$ are coplanar, and find the equation of the plane in which they lie.

[5][CO3] [L3,L5]

Q.4 (i) Find the equation to the sphere which passes through the circle $x^2 + y^2 = 4, z = 0$ and is cut by the plane $x + 2y + 2z = 0$ in a circle of radius 3.

[5][CO4] [L1,L5]

(ii) If the sphere touches the planes $2x + 3y - 6z + 14 = 0$ and $2x + 3y - 6z + 42 = 0$ and if its centre lies on the straight line $2x + z = 0, y = 0$. Find the equation of the sphere.

[5][CO4] [L2,L5]

OR

Show that only one tangent plane can be drawn to the sphere $x^2 + y^2 + z^2 - 2x + 6y + 2z + 8 = 0$ through the straight line $3x - 4y - 8 = 0, y - 3z + 2 = 0$. Find the equation of the plane.

[5][CO4] [L3,L5]

Q.5 (i) Derive the condition for the general equation of the second degree to represent a cone.

[5][CO5] [L1,L2,L3]

(ii) Find the equation of the cone whose vertex is at the point $(1,1,3)$ and which passes through the ellipse $4x^2 + z^2 = 1, y = 4$.

[5][CO5] [L2,L5]

OR

Find the equation to the quadric cone which passes through the three co-ordinate axes and the three mutually perpendicular lines

$$\frac{x}{1} = \frac{y}{2} = \frac{z}{-3}, \frac{x}{1} = \frac{y}{-1} = \frac{z}{-1}, \frac{x}{5} = \frac{y}{4} = \frac{z}{1}$$

[5][CO5] [L2,L5]

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Roll no: _____

1st SEMESTER

Integrated B.Sc. & M.Sc.

END TERM EXAMINATION

November, 2025

COURSE CODE: IMSMA-105 (Abstract Algebra-I)

Time: 03:00 Hours

Max. Marks: 50

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

Q.1

(a) Prove by mathematical induction that

$$(1+x)^n \geq 1+nx + \frac{n(n-1)}{2}x^2, \quad \text{for all } n \in \mathbb{N}, x \geq 0.$$

[5][CO1, L3][L 2]

(b) Let A be the set of all real polynomials $\mathbb{R}[x]$. Define pRq iff $p(1) = q(1)$ and $p'(0) = q'(0)$.

- (i) Prove R is an equivalence relation.
- (ii) Describe the equivalence class of the zero polynomial.

[5][CO1, L4]

Q.2

(a) If

$$A = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 3 & 2 \\ 0 & 2 & 4 \end{bmatrix},$$

then prove that $A^3 - 6A^2 + 5A - 2I = 0$, and hence find A^{-1} .

[5][CO2, L3]

(b) Klein four-group K_4 .

- (i) Prove that K_4 is an abelian group.
- (ii) Explain why K_4 is not a cyclic group.

[5][CO3, L2]

Q.3

(a) Prove that quotient group of an abelian group is abelian.

[5][CO3, L3]

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- (b) Construct the full Cayley table for the dihedral group D_4 , the group of symmetries of a square. [5][CO3, L3]

Q.4

- (a) If in a group G , $a^5 = e$ and $aba^{-1} = b^2$ for $a, b \in G$, then show that $o(b) = 31$. [5][CO4, L4]
- (b) Show that $U(8)$ is a cyclic group. What are all its generators? [5][CO4, L4]

OR

The set $G = \{1, 5, 7, 11\}$ is a group with respect to multiplication modulo 12. Find the order of all elements of G . [5][CO4, L3]

Q.5

- (a) Prove that the set of integers modulo p , written as $\mathbb{Z}_p$, forms a field exactly when p is a prime number. [5][CO5, L2]
- (b) Explain why every field is an integral domain. Also give an example of an integral domain which is not a field. [5][CO5, L2]

OR

If R is a ring with unity satisfying $(xy)^2 = x^2y^2$ for all $x, y \in R$, prove that R is commutative.

[5][CO5, L5]

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Total No. of pages: 02
FIRST SEMESTER

Roll No. _____
Integrated M.Sc. (MATHEMATICS)

END SEMESTER EXAMINATION (NOV. 2023)

MATHEMATICS-I (IMSMA 107)

Time: 3:00 Hrs.

Max. Marks: 50

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

1. (i) State and prove Darboux's theorem or Intermediate value theorem for derivative. [CO 1][BTL1, 2, 3]
 (ii) Find the extreme value of $x^2 + y^2 + z^2$, given that $ax + by + cz = p$. [CO2][BTL3,4]
2. (i) Show that the radius of curvature for the cardioid $r = a(1 - \cos \theta)$ is $\frac{2}{3}\sqrt{2ar}$ and prove that $\frac{\rho^2}{r}$ is constant. [CO3][BTL2, 3, 5]
 (ii) Prove that the function $f(x, y, z) = e^{3x+4y} \cos(5z)$, satisfy the equation $f_{xx} + f_{yy} + f_{zz} = 0$. [CO2][BTL 4, 5, 6]
3. (i) Discuss the maximum or minimum values of u when $u = x^3 + y^3 - 3axy$. [CO2][BTL1, 2, 3]
 (ii) For the curve $y = \frac{a}{a+x}$, if ρ is the radius of curvature at any point (x, y) , show that $\left(\frac{2\rho}{a}\right)^{2/3} = \left(\frac{y}{x}\right)^2 + \left(\frac{x}{y}\right)^2$. [CO3][BTL3,4]

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4. (i) Test the convergence of the integral $\int_0^{\infty} \frac{\cos mx}{x^2+a^2} dx$ and $\int_1^{\infty} \frac{x \tan^{-1} x}{\sqrt{4+x^2}} dx$.

[CO4][BTL5]

(ii) For the power series $\sum_{n=0}^{\infty} \frac{(2x+1)^n}{(2n+1)2^n}$. Find the radius of convergence, center and interval of convergence

[CO4] [BTL3, 4, 6]

5. (i) Evaluate $\iint xy(x+y) dx dy$ over the area between $y = x^2$ and $y = x$.

[CO5] [BTL5]

(ii) Find the volume of a solid bounded by the spherical surface $x^2+y^2+z^2=4a^2$ and the cylinder $x^2+y^2-2ay=0$.

[CO5] [BTL3,4]

6. (i) Evaluate $\int_0^1 \int_0^x \sqrt{x^2+y^2} dx dy$, the transformation is over the area between $x = u$ and $y = uv$.

[CO5] [BTL5, 6]

(ii) Calculate the area which is inside the cardioid $r = 2(1 + \cos \theta)$ and outside the circle $r = 2$

[CO5] [BTL3, 4]

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Total No. of Pages: 02

THIRD SEMESTER

END TERM EXAMINATION

Roll No.: _____

IMSC (Nov. 2025)

IMSMA-201 : LINEAR ALGEBRA

Time: 3 Hrs.

Max. Marks: 50

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

1. (a) Find all real values of k for which the following system of linear equations has
- no solution,
 - a unique solution,
 - infinitely many solutions.

$$\begin{aligned}x + y - z &= 1, \\2x + 3y + kz &= 3, \\x + ky + 3z &= 2.\end{aligned}$$

(6 marks)

- (b) Let $S = \{(0, 1), (1, 0)\}$ be a subset of the vector space $(\mathbb{R}^2, \oplus, \odot)$ where the operations are defined by

$$(x, y) \oplus (u, v) = (x + u, y + v - 1), \quad \alpha \odot (x, y) = (\alpha x, \alpha y - \alpha + 1).$$

Determine whether S is a linearly independent or not.

(4 marks)

2. (a) (a) Let $T : P_2 \rightarrow \mathbb{R}$ be the linear transformation defined by

$$T(at^2 + bt + c) = \int_0^1 (at^2 + bt + c) dt.$$

- Find $\ker(T)$.
- Find $\dim(\ker(T))$.
- Is T one-to-one?

(6 marks)

- (b) Let $T : \mathbb{R}^3 \rightarrow P_2$ be the linear transformation given by

$$T(x, y, z) = x + (x + y - z)t + (x + y + z)t^2.$$

Find T^{-1} , if it exists.

(4 marks)

3. (a) Let

$$A = \begin{pmatrix} 0 & -3 & -3 \\ 1 & 4 & 1 \\ -1 & -1 & 2 \end{pmatrix}.$$

- Find the characteristic equation of A .

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- ii. Find the eigenvalues and bases for the eigenspaces of A .
- iii. Determine whether A is diagonalizable.

(6 marks)

- (b) Find a 3×3 matrix that has eigenvalues $1, -1, 0$ for which the corresponding eigenvectors are

$$\begin{pmatrix} 1 \\ -1 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 \\ -1 \\ 0 \end{pmatrix},$$

respectively.

(4 marks)

4. (a) Let V be an inner product space over a field F . For all $x, y \in V$ and $c \in F$, prove the following inequalities:

i. $|\langle x, y \rangle| \leq \|x\| \|y\|$.

ii. $\|x + y\| \leq \|x\| + \|y\|$.

(6 marks)

- (b) In $\mathbb{R}^4$, let

$$w_1 = (1, -2, -1, 3), \quad w_2 = (3, 6, 3, -1), \quad w_3 = (1, 4, 2, 8).$$

Using the Gram-Schmidt process, compute orthogonal vectors v_1, v_2, v_3 and then normalize them to obtain an orthonormal set.

(4 marks)

5. (a) Let $H : \mathbb{R}^3 \times \mathbb{R}^3 \rightarrow \mathbb{R}$ be the bilinear form defined by

$$H((a_1, a_2, a_3), (b_1, b_2, b_3)) = a_1 b_1 - 2a_1 b_2 + a_2 b_1 - a_3 b_3.$$

- i. Prove that H is a bilinear form.

- ii. Find the matrix representation of H with respect to the ordered basis

$$\mathcal{B} = \{(1, 0, 1), (1, 0, -1), (0, 1, 0)\}$$

(6 marks)

- (b) Let

$$W = \{p(x) \in P_4 \mid p(1) + p(-1) = 0, p(2) + p(-2) = 0\}$$

be the subspace of the vector space P_4 . Find a basis for W and compute dimension of W .

(4 marks)

6. (a) Consider the linear transformation $T : \mathbb{R}^2 \rightarrow P_2$ given by

$$T(a, b) = (-a + 5b)t^2 + (3a - b)t + 2b.$$

with ordered bases $\mathcal{B} = \{(5, 3), (3, 2)\}$ of $\mathbb{R}^2$ and $\mathcal{B}' = \{3t^2 - 2t, -2t^2 + 2t - 1, t^2 - t + 1\}$ of P_2 . Compute the matrix $[T]_{\mathcal{B}', \mathcal{B}}$.

(6 marks)

- (b) Find the rank and nullity of the matrix

$$A = \begin{pmatrix} 2 & -1 & 3 \\ 4 & -2 & 1 \\ 2 & 1 & 0 \end{pmatrix}.$$

(4 marks)

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Total No. of Pages: 02

Roll No.:.....

THIRD SEMESTER
Integrated M.Sc. (Mathematics)
END TERM EXAMINATION
November 2025

Course Code: IMSMA203

Course Title: Probability & Statistics

Time: 3 : 00 Hours

Max. Marks: 50

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

- (1) (a) Let X be a discrete random variable with probability mass function

x	1	2	3	4	5	6	7
$P(X=x)$	k	$2k$	$2k$	$3k$	k^2	$2k^2$	$7k^2 + k$

Compute the following: the value of k , the mean $E[X]$, the variance $\text{Var}(X)$, the probability $P(0 < X < 5)$, and the conditional expectation $E[X | X > 4]$. [5][CO1][BTL-2]

- (b) Let X be a real-valued random variable with finite mean $E[X]$ and finite variance $\text{Var}(X)$. Let a and b be nonzero real constants, and define a new random variable $Y = aX + b$. Prove the relations: $E[Y] = aE[X] + b$ and $\text{Var}(Y) = a^2 \text{Var}(X)$. Further, show that the moment generating function of $Y = aX + b$ is

$$M_Y(t) = e^{bt} M_X(at),$$

where $M_X(t)$ is the moment generating function of X .

[1+2+2][CO3][BTL-2]

- (2) (a) If joint probability distribution of x, y is following:

$$F(x, y) = \begin{cases} 4xy & 0 < x < 1, 0 < y < 1 \\ 0 & \text{otherwise} \end{cases}$$

Find Marginal distributions and conditional distribution of X given Y . [5][CO3][BTL-4]

- (b) For a discrete random variable X with the following probability distribution:

$$P(X = x) = \begin{cases} kx, & x = 1, 2, 3, 4 \\ 0, & \text{otherwise.} \end{cases}$$

Find the value of k and the corresponding cumulative distribution function. [5][CO3][BTL-3]

- (3) (a) Calculate the correlation coefficient between the following paired observations:

X	65	66	67	67	68	69	70	72
Y	61	68	65	68	72	72	69	71

[5][CO4][BTL-3]

- (b) Let X be a discrete random variable with probability mass function

$$f(x) = \frac{(|x| + 1)^2}{9}, \quad x \in \{-1, 0, 1\}.$$

Verify that $f(x)$ is a valid probability mass function. Compute $E(X)$, $E(X^2)$, and $E(3X^2 - 2X + 4)$. [5][CO3][BTL-3]

- (4) (a) In a test a light switch is turned on and off until it fails. If the probability that the switch will fail any time it is turned on or off is 0.001, what is the probability that the switch will fail after it has been turned on or off 1200 times? [5][CO5][BTL-5]

- (b) Let X be the life of a battery with probability density function

$$F(x) = \begin{cases} \frac{40000}{x^3}, & x > 100 \\ 0, & \text{elsewhere} \end{cases}$$

Find the expected life of batteries. [5][CO5][BTL-5]

- (5) (a) Define moment generating function and find moment generating function of normal and poisson distribution. [5][CO3][BTL-1]

- (b) State and prove Chebychev's inequality. [5][CO4][BTL-2]

- (6) (a) For two random variables X and Y . Prove $\text{Cov}(X - Y, X + Y) = 0$. [5][CO3][BTL-4]

- (b) If 5% of bolts produced by a machine are defective. Find the probability that in a sample of 100 bolts, 2 bolts will be defective using (i) binomial distribution, (ii) Poisson distribution. [5][CO5][BTL-2]

-END-

III SEMESTER

B.Sc. M.Sc. (Integrated)

END TERM EXAMINATIONS

November- 2025

IMSMA205 REAL ANALYSIS-II

TIME: 3 hrs

Max. Marks: 50

Note: Attempt two parts of each question. Marks are indicated.

- 1 (a) Show that countable union of measure zero sets is a measure zero set. Give an example to show that uncountable union of measure zero sets need not be a measure zero set.
- (b) Give an example of an uncountable measure zero set. Justify.
- (c) Show that a real function f on an open interval I is convex if and only if $f''(x) \geq 0$ for all x in I . (4,4,4) CO2L2
2. (a) State and prove Taylor's theorem.
- (b) Obtain the expansion of $\log(1+x)$.
- (c) If x is in $[0,1]$ and $n \in \mathbb{N}$, show that

$$|\log(1+x) - (x - \frac{x^2}{2} + \frac{x^3}{3} - \dots + (-1)^{n-1} \frac{x^n}{n})| < \frac{x^{n+1}}{n+1}.$$

(4,4,4) (CO1)(L5)

3. (a) Show that if f and g are integrable on $[a,b]$, then $f+g$ is integrable on $[a,b]$ and $\int_a^b (f+g) = \int_a^b f + \int_a^b g$.
- (b) Show that sequence given by $f_n(x) = x^n$ is uniformly convergent on $[0,k]$, $k < 1$ but not in $[0,1]$.
- (c) State and prove the limit form of the comparison test for improper integrals. (4,4,4) (CO2,3)(L3)
4. (a) Prove that a monotone function on $[a,b]$ is integrable on $[a,b]$.
- (b) State and prove the fundamental theorem of calculus II.

(c) Show that if f is nonnegative continuous function on $[a, b]$ and $\int_a^b f(x) dx = 0$, then $f(x) = 0$ for all x in $[a, b]$. (4,4,4) (CO3)(L4) 39341

5. (a) Prove the convergence of gamma integral.

(b) Test the convergence of the following integrals:

1. $\int_0^1 \frac{\log x}{\sqrt{x}} dx$.

2. $\int_0^\infty \frac{x \log x}{(1+x^2)^2} dx$.

(c) Test the uniform convergence of the sequence given by $f_n(x) = nx/(1+n^2x^2)$ for all real x . (4,4,4) CO4,5 L5

6. (a) Show the limit function f of a uniformly convergent sequence of continuous functions $\{f_n\}$ on $[a, b]$ is continuous on $[a, b]$.

(b) Show that the sequence $\langle f_n \rangle$ defined by $f_n(x) = \frac{x}{x+n}$ is uniformly convergent in $[0, k]$, $k \geq 0$, but not uniformly convergent in $[0, \infty)$.

(c) Show that the sequence $\langle \frac{nx}{1+n^2x^2} \rangle$ converges uniformly to zero for $0 \leq x \leq 1$. (5,5,5) CO5 L6

END TERM EXAMINATION

Nov.-2025

COURSE CODE: IMSMA207 COURSE TITLE: Mathematical Transform

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(a) Find the Fourier transform of

$$f(x) = \begin{cases} 1-x^2, & |x| \leq 1 \\ 0, & |x| > 1 \end{cases}, \text{ and use it to evaluate}$$

$$\int_0^\infty \left(\frac{x \cos x - \sin x}{x^3} \right) \cos \frac{x}{2} dx \quad [5][CO3][L2,L3,L5]$$

(b) Find the Fourier sine transform of $f(x) = \frac{1}{x}$. [5][CO3][L2,L5]

Q.2(a) Express the function

$$f(x) = \begin{cases} 1, & |x| \leq 1 \\ 0, & |x| > 1 \end{cases} \text{ as a Fourier integral and hence evaluate}$$

$$\int_0^\infty \frac{\sin \lambda \cos \lambda x}{\lambda} d\lambda \quad [5][CO4][L2,L3,L5]$$

(b) Find the solution of function $f(x) = \begin{cases} 1, & 0 \leq x \leq \pi \\ 0, & x > \pi \end{cases}$ as a Fouriersine integral, hence evaluate $\int_0^\infty \frac{1 - \cos(\pi \lambda)}{\lambda} \sin(x \lambda) d\lambda$

[5][CO4][L2,L3,L4]

Q.3(a) Find the Z- transform of the discrete unit impulse function $\delta[n]$.

[5][CO5][L2,L5]

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(b) Form the difference equation from $y_n = A.3^n + B.5^n$

[5][CO5][L2,L3]

Q.4(a) Find Z transform of

(i) na^n

(ii) 1

[5][CO5][L2,L4,L5]

(b) Find the solution of difference equation.

$$y_{n+2}(x) - 5y_{n+1}(x) + 6y_n(x) = 4^n$$

[5][CO5][L3,L4]

Q.5(a) Use Fourier transform to solve the boundary value problem

$$\frac{\partial u(x,t)}{\partial t} = k \frac{\partial^2 u(x,t)}{\partial x^2}, \quad t > 0, \quad -\infty < x < \infty$$

Subject to the conditions

(i) $u(x,t)$ and $\frac{\partial u(x,t)}{\partial x} \rightarrow 0$ as $x \rightarrow \pm\infty$

(ii) $u(x,0) = f(x)$

[5][CO3][L3,L4,L5]

(b) Use the inverse Fourier cosine integral to find $f(x)$ if

$$F_c(s) = \begin{cases} 1, & 0 \leq s \leq A \\ 0, & \text{elsewhere} \end{cases}$$

[5][CO4][L4,L5]

Q.6(a) What are the conditions for the existence of the Fourier series of a function? Also, check whether the Fourier series exists for the given function.

$$f(x) = e^x, \text{ on } (0, \infty)$$

[5][CO2][L5,L4]

(b) Find the Laplace transform of

(i) $t^{3/2}$

(ii) e^{2t}

[5][CO1][L2,L5]

Time: 3hrs.

Max. Marks: 50

Note: Answer any five questions. Assume suitable missing data, if any.
Only non-programmable scientific calculator is allowed.

Q.1 (a) Define beta function and Gamma function. Prove that
 $\beta\left(m, \frac{1}{2}\right) = 2^{2m-1} \beta(m, m)$. [5M][CO5, L1,4]

(b) Express $f(x) = x^4 + 3x^3 - x^2 + 5x - 2$ in terms of Legendre polynomials. [5M][CO2, L2]

Q.2 (a) Using generating function, prove that

$$P_n(x) = P'_{n+1}(x) - 2xP'_n(x) + P'_{n-1}(x)$$

[5M] [CO2, L3]

(b) Check for the ordinary or singular point and hence find the series solution of the differential equation

$$2x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - 1)y = 0. \quad [5M][CO1, L3]$$

Q.3 (a) Using Rodrigue's formula, prove that $\int_{-1}^1 x^m P_n(x) dx = 0$, where m, n are positive integers and $m < n$.

[5M] [CO2, L4]

(b) Prove that $\int_0^\infty x^2 e^{-x^4} dx \times \int_0^\infty \frac{e^{-x^2}}{\sqrt{x}} dx = \frac{\pi}{4\sqrt{2}}$ using Beta and Gamma functions.

[5M][CO5, L4]

Q.4 (a) Prove the following integral representation of confluent hypergeometric function.

$${}_1F_1(\alpha, \gamma; x) = \frac{\Gamma(\gamma)}{\Gamma(\alpha)\Gamma(\gamma-\alpha)} \int_0^1 (1-t)^{\gamma-\alpha-1} t^{\alpha-1} e^{xt} dt.$$

[5M][CO4, L3,4]

(P.T.O.)

(b) Show that $\frac{d}{dx}\{xJ_n(x)J_{n+1}(x)\} = x\{J_n^2(x) - J_{n+1}^2(x)\}$.

[5M][CO3, L4]

Q.5 (a) Prove that $\frac{d}{dx}\{ {}_2F_1(a, b; c; x) \} = \frac{ab}{c} {}_2F_1(a+1, b+1; c+1; x)$

[5M][CO4, L3,4]

(b) State and prove the orthogonality of Bessel functions.

[5M][CO3, L3,4]

Q.6(a) Show that

(i) ${}_2F_1\left(\frac{1}{2}, 1; \frac{3}{2}; x^2\right) = \frac{1}{2x} \log\left(\frac{1+x}{1-x}\right), |x| < 1$

(ii) ${}_1F_1(a; b; x) = e^x {}_1F_1(b-a; b; -x)$ [Kummer's relation]

[5M] [CO4, L3]

(b) Prove that $J_{-\frac{5}{2}}(x) \sqrt{\frac{2}{\pi x}} \left\{ \left(\frac{3-x^2}{x^2}\right) \cos x + \frac{3}{x} \sin x \right\}$.

[5M] [CO3, L3]

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Roll No:.....

THIRD SEMESTER**END SEMESTER EXAMINATION**

(Nov. 2025)

IMSMA 223:GEC-3, Basic Probability and Statistics**Time: 3 Hr.****Max. Marks: 50**

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

1. (i) Define quantitative, qualitative, discrete and continuous data with two examples each.
(ii) Explain with diagrams the difference between a bar diagram and a histogram. [CO1][BLT 1,2,3]
2. (i) Critically analyze the following statement: "Graphical presentation of data is always superior to tabular presentation." Give arguments for and against this statement with examples.
(ii) A frequency distribution has: Mean=50, Variance=100, $\beta_1 = 0.25$, $\beta_2 = 2.8$. Interpret the nature of skewness. Comment on whether the distribution is leptokurtic, mesokurtic, or platykurtic. [CO2][BLT 2,3,4]
3. (i) The average marks of a class is 100 with a standard deviation of 50. Calculate the coefficient of variation.
(ii) What do you mean by Karl Pearson's coefficient of skewness. Explain with suitable example. [CO2][BLT 2,3,4]

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4. (i) A random variable X has the following probability distribution :
(a) Find k , (b) Evaluate $P(X < 6)$, $P(X \geq 6)$, and $P(0 < X < 5)$.

x	0	1	2	3	4	5	6	7
$p(x)$	0	k	$2k$	$2k$	$3k$	k^2	$2k^2$	$7k^2 + k$

- (c) Determine the distribution function of X .
(ii) Determine the binomial distribution for which the mean is 4 and variance 3 and find its mode. [CO2][BLT 3,4]
5. For the following bivariate probability distribution of X and Y , find
(a) $P(X \leq 1, Y = 2)$, (b) $P(X \leq 1)$, (c) $P(Y = 3)$, (d) $P(Y \leq 3)$.
[CO3][BLT 4,5]

$X \backslash Y$	1	2	3	4	5	6
0	0	0	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$
1	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$
2	$\frac{1}{24}$	$\frac{1}{24}$	$\frac{1}{24}$	$\frac{1}{24}$	0	$\frac{1}{24}$

6. Two discrete random variables X and Y have the joint probability density function :

$$p(x, y) = \frac{\lambda^x e^{-\lambda} p^y (1-p)^{x-y}}{y!(x-y)!}, \quad y = 0, 1, 2, \dots, x; \quad x = 0, 1, 2, \dots$$

where λ, p are constants with $\lambda > 0$ and $0 < p < 1$.

Find (i) The marginal probability density functions of X and Y .

(ii) The conditional distribution of Y for a given X and of X for a given Y . [CO3][BLT 3,4,5,6]

Total No. of Printed Pages: 02

348 46
I SEMESTER

Roll No.....

Integrated B.Sc.-M.Sc. Chemistry

END TERM EXAMINATION

Course Code: IMSAC101

Course Title: Inorganic Chemistry 1

Nov 2025

Time: 03:00 Hours

Max. Marks: 40

Note: Question 5 and 6 are compulsory. Attempt 5 questions in all.

- Ques1.** A) Write electronic configuration of: i) Ag ($Z = 47$), ii) Ce ($Z = 58$)
B) Explain the shape of d_{z^2} orbital?
C) What is Shielding Effect? Compare the shielding effects of s and d orbitals.
D) What do you understand by orthogonality of wave function?

[8][CO1][BTL3]

- Ques2.** A) Why is it more difficult to remove the 4s valence electron from Copper than to remove the 4s valence electron from Potassium.
B) Define Ionization Enthalpy. How does it vary along the period and group in the periodic table?
C) The ionization of Mg to Mg^{2+} is three times higher than Mg to Mg^+ , why?
D) Write short note on Heisenberg's Uncertainty Principle.

[8][CO1][BTL4]

- Ques3.** A) Draw Born-Haber cycle for the formation of MgF_2 . Calculate the enthalpy of formation (ΔH_f) of MgF_2 from the following data

Sublimation Energy of Mg(s)	= 146.4 kJ/mol
Dissociation Energy of F_2	= 158.9 kJ/mol
Ionization Enthalpy of $Mg(g)$ to $Mg^{2+}(g)$	= 2184.0 kJ/mol
Electron gain enthalpy of $F(g)$ to $F^-(g)$	= -334.7 kJ/mol
Lattice energy of MgF_2 (U_0)	= -2922.5 kJ/mol

- B) Calculate the lattice energy of NaCl (in kJ/mol) when $A = 1.75$, $r_0 = 2.8 \text{ \AA}$,
 $n = 9$, $e = 4.8 \times 10^{-10} \text{ esu}$.

[6+2][CO3][BTL5]

Ques4. Explain the following:

47349

- A) Electronegativity and its variation along the period.
- B) F is more electronegative but has less electron affinity than Cl.
- C) Lithium salts are slightly covalent while sodium salts are ionic.
- D) Madelung constant and the factors affecting it.

[8][CO3][BTL3]

Ques5. A) Draw the MO energy level diagram for N_2^+ . Discuss its bond order and magnetic behaviour. Why is the bond order in N_2^+ less than in N_2 molecule?

B) Discuss the geometry and shape of the following molecules/ions on the basis of VSEPR theory.



[8][CO2][BTL6]

Ques6. A) Using LCAO method, draw the shapes of molecular orbitals formed by the combination of a) s-s atomic orbital b) s-p atomic orbitals.

B) Despite the same hybridization, explain why Bond angle of CH_4 is higher than NH_3 .

[8][CO2][BTL6]

Total No. of Printed Pages: 02

48350

Roll No.....

Ist SEMESTER

Integrated B.Sc.-M.Sc. (Chemistry)

END TERM EXAMINATION

Course Code: IMSAC 103

Nov 2025

Course Title: Organic Chemistry 1

[Time: 3H]

[Max. Marks: 40]

Instructions: Attempt any 5 questions.

Q1 a) In halogenation of alkanes why chlorination is more reactive but less selective than bromination, justify with an example.

b) Draw the Newman Projection formulae (conformations) for butane and explain giving reason, which conformation is most stable.

[4,4][CO1,CO4][L4,5,6]

Q2 a) Draw the Fischer projection for all the possible stereoisomers of 2,3-dibromobutane. State the correlation among these stereoisomers? Comment of the optical activity of these stereoisomers.

b) Discuss the stereochemistry of addition of bromine to *E*-But-2-ene.

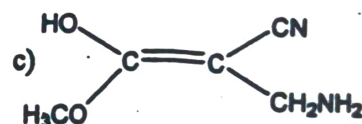
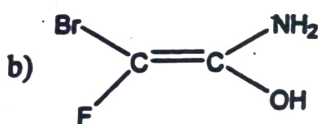
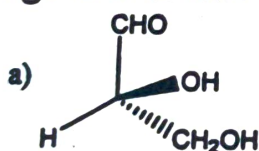
[4,4][CO2,CO4][L2,6]

Q3. a) What is the major product obtained when Ph-CH=CH-CH₃ reacts with HBr in the presence of peroxide. Explain with mechanism.

b) An alkene on reductive ozonolysis yields a mixture of two isomers with molecule formula C₃H₆O. Identify the structure of the alkene and the products.

[4,4][CO2][L1,3,4]

Q4. a) Assign E/Z or R/S :

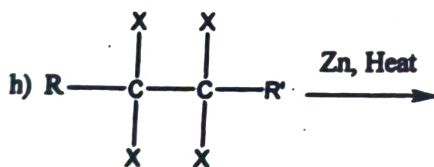
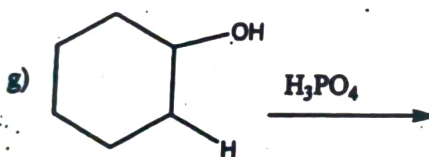
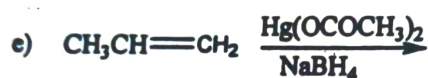
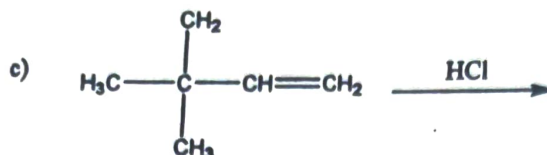
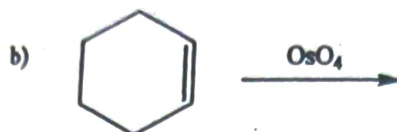


b) Explain resolution of racemic mixture with an example.

[4,4][CO4][L1,2,L4]

Q5. Complete the following reactions:

49-351



[1*8][CO1,CO2,CO3][L1,3]

Q6. Write short notes on the following (any two):

- Acidity of terminal alkynes
- Configuration and Conformation
- Corey-House synthesis

[4,4][CO1,CO3,CO4,][L1,2]

1st SEMESTERIntegrated B.Sc. and M.Sc. in Chemistry

End Term Examination

Nov-2025

IMSAC 105: Physical Chemistry 1

Time: 3:00 Hours

Max. Marks: 40

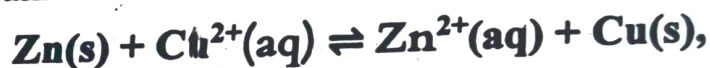
Note: Attempt any five questions. (Assume suitable missing data, if any.)

Q.1 [a] Explain the construction and working of a **Galvanic (Voltaic)** cell using the **Daniell cell** as an example. In your answer, describe:

- (i) The role of electrodes and electrolytes
- (ii) Identification of the anode and cathode
- (iv) The oxidation and reduction half-reactions
- (v) The overall redox reaction occurring in the cell

[4 Marks][CO1][L2]

[b] For the Daniel cell involving the reaction



the standard free energies of formation of Zn(s) , Cu(s) , $\text{Cu}^{2+}(\text{aq})$ and $\text{Zn}^{2+}(\text{aq})$ are 0, 0, 64.4 kJ mol^{-1} and $-154.0 \text{ kJ mol}^{-1}$, respectively. Calculate the standard EMF of the cell.

[4 Marks][CO1][L3]

Q.2 [a] Explain in detail the phenomenon of **Liquid Junction Potential (LJP)** that develops at the interface of two electrolyte solutions of different concentrations.

Using the system $\text{HCl(a}_1\text{)} | \text{HCl(a}_2\text{)}$ as an example, describe how the unequal ionic mobilities of H^+ and Cl^- ions lead to the formation of an electrical double layer at the junction. Further discuss how this potential opposes ionic diffusion, how equilibrium is established, and why **LJP** is considered an unavoidable error in concentration cells.

[4 Marks][CO1] [L3,L4]

[b] Define the rate of a chemical reaction. Draw a plot showing how the concentrations of reactants and products change with time, and explain why the curves of reactant and products show opposite trends.

Consider the reaction: $\text{HBrO}_3 + 6\text{HI} \rightarrow \text{HBr} + 3\text{H}_2\text{O} + 3\text{I}_2$

If the concentration of HBrO_3 decreases from 0.030 mol L^{-1} to 0.018 mol L^{-1} in 6 minutes, calculate the average rate of the reaction with respect to HBrO_3 . Also, write the differential rate expression for all species involved in the reaction.

[4 Marks][CO2][L2, L3, L4]

Q3 [a] Explain the difference between the order of a reaction and molecularity. Discuss at least four points of distinction and state why molecularity cannot be fractional or zero, while order can be.

[4 Marks][CO2][L2, L3]

[b] The rate of the homogeneous gaseous reaction



is doubled when the chlorine concentration is doubled, but increases by a factor of eight when the concentrations of both the reactants are doubled. Determine the overall order of the reaction and the order with respect to NO and Cl_2 .

[4 Marks][CO2][L3]

Q4 [a] Derive the integrated rate law for a zero-order reaction, starting from the differential rate equation. Explain the characteristics of zero-order reactions and mention two examples.

[4 Marks][CO2][L3, L4]

[b] Explain the half-life (fractional change) method for determining the order of a reaction and show how the half-life $t_{1/2}$ varies with the initial concentration. A compound has a half-life of 20 minutes at a concentration of a . When the concentration is doubled to $2a$, the half-life becomes 10 minutes. Using the half-life method, determine the reaction order. [4 marks][CO2][L3]

Q.5 [a] Explain the Arrhenius equation

$$k = Ae^{-E_a/RT}$$

and derive the slope-intercept form of the equation used to plot $\ln k$ vs $1/T$. Explain how this plot is used to determine activation energy experimentally. Calculate the activation energy of a reaction whose rate constant is tripled by a 10°C rise in temperature in the vicinity of 27°C .

[4 Marks][CO2][L3, L4, L5]

[b] Discuss the mechanism of heterogeneous catalysis using the adsorption theory. Explain how factors such as surface area, nature of the catalyst, strength of adsorption, porous structure, cracks, active sites, promoters, and catalyst poisons influence the efficiency of solid catalysts.

[4 Marks][CO3][L2, L3]

Q6 [a] Explain the process of enzyme catalysis with reference to the formation of the enzyme-substrate complex. Describe the steps involved in enzymatic action and discuss the Michaelis-Menten mechanism, explaining the significance of the parameters K_m and V_{max} in understanding enzyme efficiency.

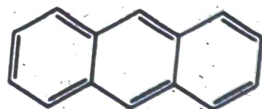
[4 Marks][CO3][L3, L4]

[b] Describe the different types of catalysts with suitable examples. Explain how catalyst specificity and selectivity help in determining which catalyst is appropriate for a given chemical reaction.

[4 Marks][CO3][L2]

-END-

(c) Explain in detail the criteria for aromaticity. Analyze the following compounds and justify in each case whether the π -electron system favors aromaticity, anti-aromaticity, or non-aromatic character.



(i)



(ii)



(iii)



(iv)

[5][CO5][L2, L4]

Total no. of Pages: 4

1st SEMESTER

END TERM EXAMINATION

COURSE CODE: IMSAC-107: Basic Chemistry-1

Time: 03:00 Hours

Roll no.

ISC/SEC

Nov-2025

Max. Marks: 50

Note: All questions carry equal marks except question no. 1. Assume suitable missing data, if any. Attempt All questions.

Q.1 [a] Draw the molecular orbital diagram of N_2 and O_2 molecules and explain their magnetic behaviour. [4][CO1][L3]

OR

Evaluate the reliability of the radius ratio rule, explain why it sometimes fails, and mention its limitations. [4][CO1][L5]

[b] Explain the following:

(i) NF_3 has a dipole moment while BF_3 has zero dipole moment.

(ii) Bond angle of OF_2 is less than H_2O .

[2][CO1][L2]

Q.2 [a] What is hyperconjugation effect? Explain the order of stability of primary, secondary and tertiary carbocations on the basis of this effect. [3][CO2][L2]

[b] Explain, why benzylic and allylic carbocations are unusually stable compared to alkyl carbocations. [3][CO2][L2]

[c] Differentiate between the following with suitable examples.

(i) Inductive effect and Electromeric effect.

(ii) Electrophile and nucleophile.

[5][CO2][L4]

Q.3 [a] Evaluate under what conditions S_N1 is favored over S_N2 .

[3][CO3][L5]

[b] Give reasons, arrange the following in increasing order of reactivity towards alkaline hydrolysis by S_N1 reaction.

CH_3Cl , Ph_2CHCl , Ph_3CCl , $PhCH_2Cl$ [3][CO3][L4]

[c] Compare the mechanisms of $E1$ and $E2$ elimination reactions. How is the $E1cb$ mechanism different from the $E1$ mechanism?

[5][CO3][L4]

Q.4 [a] An alkyl halide A undergoes reaction with sodium metal in dry ether, giving compound B with the molecular formula $C_{10}H_{22}$. When compound B is brominated in the presence of sunlight ($Br_2/h\nu$), the product C is formed. On treatment of C with alcoholic KOH, it undergoes elimination to yield an alkene D. The compound D is further converted into compound E. Identify A, B, C, D, and E, and write the complete sequence of reactions involved. [5][CO4][L4, L6]

[b] Give the reagent and condition for the following conversions;

Chloromethane $\rightarrow$ n-Butane $\rightarrow$ 2-Bromobutane $\rightarrow$ But-2-ene

[3][CO4][L3]

OR

List any three standard methods used for the laboratory or industrial preparation of alkanes.

[3][CO4][L1]

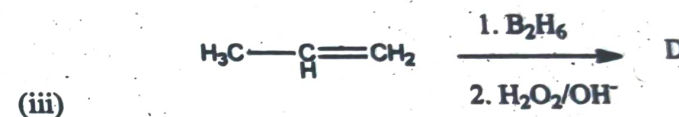
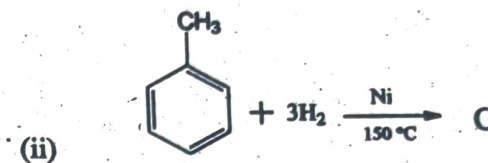
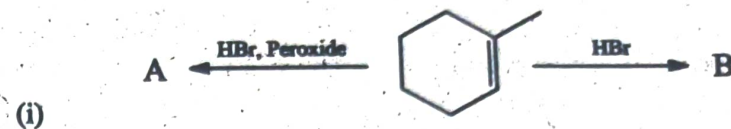
[c] Write short note on the following;

(i) Wurtz-Fittig reaction

(ii) Free radical substitution reactions of alkanes.

[3][CO4][L2]

Q.5 [a] Complete the following;



[3][CO5][L3]

[b] How would you carry out the following organic conversions? Write the reagents and major steps involved in each case.

(i) Conversion of ethylene $\rightarrow$ acetylene

(ii) Conversion of acetylene $\rightarrow$ 1-butyne

(iii) Conversion of isopropyl bromide $\rightarrow$ n-propyl bromide

[3][CO5][L3, L6]

OR

Explain in detail the mechanism of the peroxide effect (Kharasch effect) involved in the anti-Markovnikov addition of HBr to alkenes.

[3][CO5][L2]

Total No. of Printed Pages: 02

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III SEMESTER

Roll No.....

Integrated B.Sc.-M.Sc. Chemistry

END TERM EXAMINATION

Nov 2025

Course Code: IMSAC201

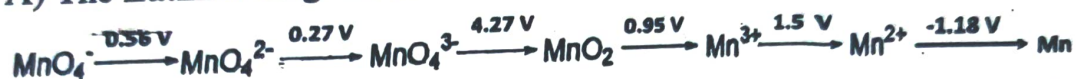
Course Title: Chemistry of *d* and *f*-block Elements and Quantitative Inorganic Analysis

Time: 03:00 Hours

Max. Marks: 40

Note: Attempt 5 questions in all.

Ques1. A) The Latimer diagram of Mn in acidic solution is given below:



- Which oxidation states of Mn are unstable w.r.t. disproportionation in aqueous medium and why?
- Can Mn(s) act as a reducing agent?
- What is the oxidation state of Mn in HMnO_4^- ?

B) A strong oxidizing agent (A) on heating with KCl and conc. H_2SO_4 gives red coloured gas (B) which on passing through NaOH solution gives yellow solution (C). Identify A, B, C and write the reactions involved. [8][CO2][BTL5]

Ques2. Give reasons for the following:

- Mn(II) ion shows maximum magnetic character among the bivalent ions of first transition metal series.
- Transition elements and their compounds are good catalysts.
- Colour of KMnO_4 solution disappears upon addition of oxalic acid to it in acidic medium.
- Ce^{4+} is a good oxidizing agent whereas Sm^{2+} is a good reducing agent. [8][CO1][BTL4]

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Ques3. A) Aqueous solution of Cu(II) salts are blue while that of Cu(I) salts are white. ss

B) UV-visible absorption bands of transition metal ions are broad whereas those of f-block metal ions are sharp.

C) What is the principle of gravimetric analysis?

D) What types of crucibles are used to dry precipitates in the muffle furnace in gravimetric analysis? [8][CO1,3][BTL4]

Ques4. A) i) Explain supersaturation and nucleation in the context of gravimetric analysis.

ii) Give the names of any two organic precipitating agents and draw the structure of any one of them.

B) What is lanthanide contraction and what are its consequences?

[8][CO3][BTL2]

Ques5. A) Explain the following in the context of transition elements:

i) Alloy formation ii) Complex formation

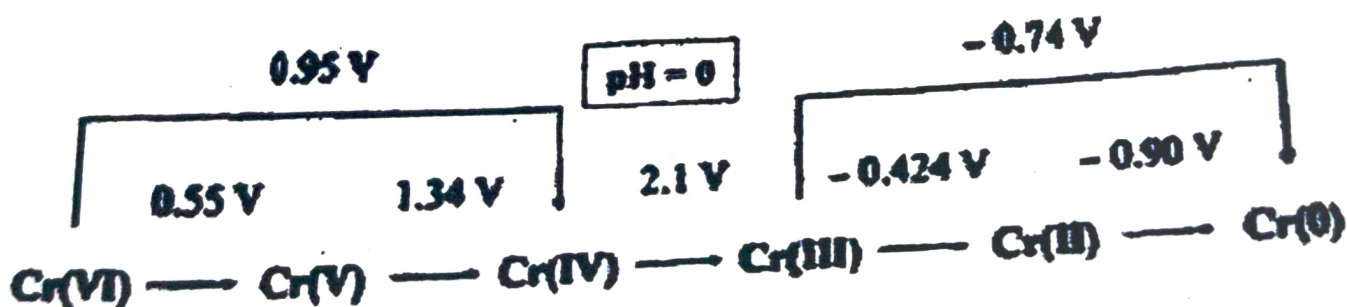
B) Discuss the principle and method of ion exchange process for the separation of lanthanides.

[8][CO1][BTL4]

Ques6. A) Calculate the magnetic moment of Eu(III). Explain the discrepancy between observed and calculated magnetic moment. (Atomic number of Eu is 63).

B) Using the given Latimer diagram for Chromium in acidic medium, construct the Frost diagram to determine the most stable oxidation state of chromium. Explain your reasoning based on the diagram.

[8][CO1,2][BTL3]



Total No. of Printed Pages: 03

Roll No.....

IIIrd SEMESTER

Integrated B.Sc.-M.Sc. (Chemistry)

END TERM EXAMINATION

NOV 2025

Course Code: IMSAC 203

Course Title: Organic Chemistry III

[Time: 3H]

[Max. Marks: 40]

Instructions: Attempt any 5 questions.

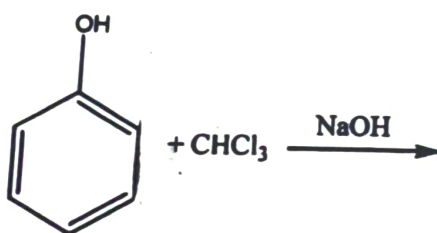
Q1 a) Justify the statement that aryl and vinyl halides show low reactivity towards nucleophilic substitution reaction compared to alkyl halides.

b) S_N2 reactions of alkyl halides proceed with complete stereochemical inversion of configuration. Explain with mechanism.

[4,4][CO1][L5,2]

Q2 a) Write down the mechanism of formation of phenol from cumene.

b) Complete the reaction with mechanism:



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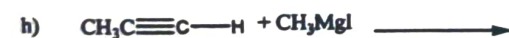
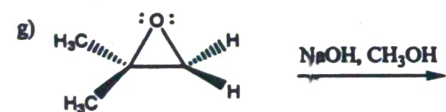
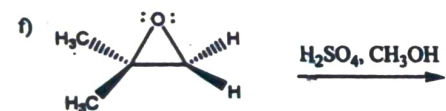
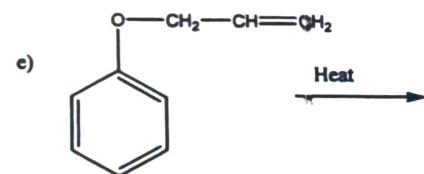
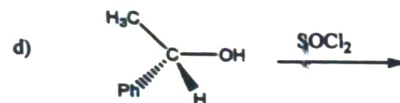
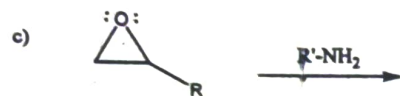
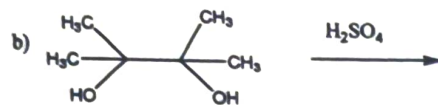
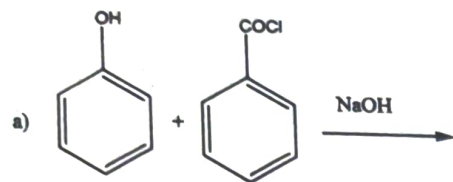
[4,4][CO2][L1,6]

Q3. a) Explain why Williamson's synthesis of *tert*-butyl ether using *tert*-butyl bromide and sodium ethoxide is not a good synthesis?

b) How many moles of HIO_4 are consumed by one mole of 2,4-dimethyl-2,3,4-hexanetriol? Write down the products obtained in this reaction.

[4,4][CO3,CO4][L2,3,4]

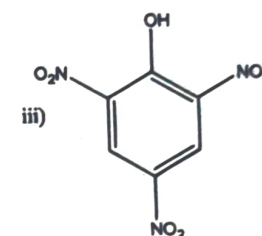
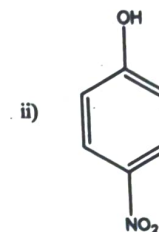
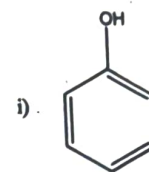
Q4. Complete the following reactions:



[1*8][CO4,CO5][L1,4]

Q5. a) Give a visible test with suitable reaction to differentiate between *n*-Propanol and *iso*-Propanol.

b) Arrange the following in order of their decreasing acidity and explain the order.



[4,4][CO3,CO5][L3,4,5]

Q6. Write short notes on the following (any two):

a) Benzyne mechanism.

b) Application of Grignard reagent in the synthesis of primary, secondary and tertiary alcohols.

c) E1 and E2 reactions with mechanism.

[4,4][CO1,CO2][L1,6]

Total No. of Pages:02

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Roll No.

Third Semester

B.Sc. and M.Sc. (Integrated)

END TERM EXAMINATION

Nov/Dec-2025

IMSAC- 205: Physical Chemistry 3
(Solutions, Colligative properties and Colloids)

Time: 3 Hours

Max. Marks: 40

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

Useful Physical constants: $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$; $\pi = 3.14$; $N = 6.022 \times 10^{23} \text{ mol}^{-1}$.

Q1a. Why did the term activity coefficient introduce for real solutions? Explain. Comment on the variation of its value from low to very high concentrations of solution. [2.5 Marks] [CO2, L₁, L₂]

b. The vapor pressure of an aqueous solution of urea ($\text{CO}(\text{NH}_2)_2$) at 298 K is 20.4 mmHg. Find out its molality in this solution assuming it to be non-volatile obeying Raoult's law. Given, the vapor pressure of pure water at 298 K is 23.8 mmHg. [2.5 Marks] [CO1, L₅]

c. Why does the Brownian movement occur in colloids and not in true solution? Predict the effect of size, viscosity and temperature on Brownian motion. [2.5 Marks] [CO3, L₂]

d. Explain the application of colloids in artificial rain. Discuss the mechanism of this process. [2.5 Marks] [CO5, L₁, L₂]

Q2a. What is the origin of electric charge on hydrophobic colloids? Explain the structure and stability of hydrophobic colloidal dispersion by drawing the electrical double layer model. [3 Marks] [CO2, L₁, L₂]

b. For a non-ionic surfactant the following osmotic pressure (π) data is obtained as a function of its concentration:

[Non-ionic Surfactant]: (mM)	1.0	2.0	3.0	4.0	5.0	6.0	7.0
$\pi (\times 10^{-2} \text{ atm})$:	2.45	4.89	7.34	9.78	10.01	10.24	10.48

From this data, determine the critical micelle concentration graphically. Also explain the observed variation in osmotic pressure. [3 Marks] [CO2, CO3, L₄, L₅]

Q3a. What is hydrophile-lyophile balance (HLB)? How does the HLB values used to predict the surfactant properties? Explain. [3 Marks] [CO3, L₁, L₄]

b. What is the basic principle of electrophoresis? How does the gel electrophoresis technique work for the separation of colloidal species based on their size and charge? Explain. 59 361
[3 Marks] [CO3, L2, L3]

Q4a. Define emulsion giving its types. Identify the emulsion type in milk and cold cream. Also discuss the mechanism of emulsification.

[3 Marks] [CO3, L2, L3]

b. Stearic acid, a saturated long chain fatty acid, forms a surface film, obeying 2-D ideal gas law. If its surface excess concentration at 25 °C is 3.5×10^{-6} mol m⁻², calculate the surface film pressure.

[3 Marks] [CO4, L4, L5]

Q5a. Giving the schematic diagram of Langmuir-Blodgett apparatus, explain briefly the Langmuir monolayer formation from an amphiphilic substance at the air-water interface.

[3 Marks] [CO4, L2]

b. Differentiate between aerosol(s) and foam(s) giving an example of each. Also point out some major health hazards of civil and industrial aerosols.

[3 Marks] [CO4, L1, L2]

Q6. From the statements given below, choose any four, and state whether each is correct or incorrect, providing the appropriate justification for your answer.

- a. The freezing point of depression of aqueous 0.01 M Na₂SO₄ is nearly twice to that of 0.01 M glucose. [1.5 Marks] [CO1, L2, L3]
- b. The thermodynamic basis of change in colligative properties lies in the increase of chemical potential of solvent upon addition of a non-volatile solute. [1.5 Marks] [CO1, L2]
- c. The magnitude of zeta potential for the hydrophobic colloids is reduced significantly upon the addition of an electrolyte with an oppositely charged ion of a higher valence. [1.5 Marks] [CO3, L2]
- d. The transmission electron microscopy allows visualizing the colloidal nanoparticles but not the optical microscope. [1.5 Marks] [CO5, L2, L3]
- e. Efficacy of medicine and pharmaceutical is enhanced significantly in colloidal formulation. [1.5 Marks] [CO5, L2, L4]
- f. Colloid chemistry is extensively used for purification of water.

[1.5 Marks] [CO5, L2, L4]

—End—

Total no. of Pages: 2

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Roll no.....

THIRD SEMESTER

Integrated B.Sc.-M.Sc. Chemistry

END TERM EXAMINATION

Nov-2025

COURSE CODE: IMSAC 207

COURSE TITLE: Basic Chemistry-III

Time: 03:00 Hours

Max. Marks: 50

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

Q.1 (A) Differentiate between cationic and anionic polymerization mechanisms with suitable examples.

[5 Marks] [CO1] [L4]

(B) Explain the difference between fillers and reinforcements, and give examples of how each affects mechanical properties.

[5 Marks] [CO1] [L2]

Q.2 (A) What are the antioxidants? Explain the mechanism of primary antioxidants (especially phenolic amines) in protecting the polymer from thermal and oxidative degradation.

[5 Marks] [CO1] [L2, L4]

(B) What is the role of nucleating agents in polymer, and how do they influence cell structure and final product properties?

[5 Marks] [CO1] [L3, L4]

Q.3 (A) How do plasticizers work in modifying the mechanical properties of polymers? Describe their types with suitable examples.

[5 Marks] [CO1] [L4, L2]

(B) Describe the mechanisms of common flame retardant systems, especially halogenated and phosphorus-based compounds.

[5 Marks] [CO1] [L4]

Q.4 (A) Differentiate between fiber-reinforced composites, particle-reinforced composites, and structural composites.

[5 Marks] [CO2] [L3]

(B) What are the key mechanical and physical characteristics that make composite materials superior to conventional materials?

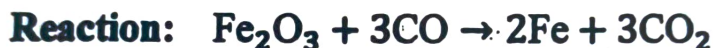
[5 Marks] [CO2] [L4]

Q.5 (A) What are the 12 Principles of Green Chemistry, and explain the design of safer chemical processes with suitable examples.

[5 Marks] [CO3] [L2, L3]

(B) (i) Define the atom economy and how does the atom economy differs from reaction yield?

(ii) Calculate the percentage atom economy for the production of iron (Fe) from iron (III) oxide (Fe_2O_3) in a blast furnace reaction, assuming iron is the only desired product.



(Given: molar mass Fe=56 g/mole)

[5 Marks] [CO3] [L5]

Q 6. (A) Define the material composites. How are composite materials classified based on the type, shape, and orientation of reinforcement?

[5 Marks] [CO2] [L1, L2]

(B) What is meant by green solvent? And explain its important role in green chemistry.

[5 Marks] [CO3] [L2, L4]

Total no. of Pages: 02 364 62

Roll no.

1st SEMESTER

B.Sc./DEC-1

END TERM EXAMINATION

Nov-2025

COURSE CODE -IMSAC-209

COURSE TITLE- Metallurgy and s and p block elements

Time: 03:00 Hours

Max. Marks: 50

Note : All questions carry equal marks.
Attempt all questions

Q.1 a) Explain the Ellingham diagram. Draw a typical Ellingham diagram for metal oxides and explain how it helps in choosing a reducing agent.

OR

b) Describe the role of carbon monoxide as a reducing agent in metallurgy, with an example and reaction mechanism. [5][CO1][BTL4]

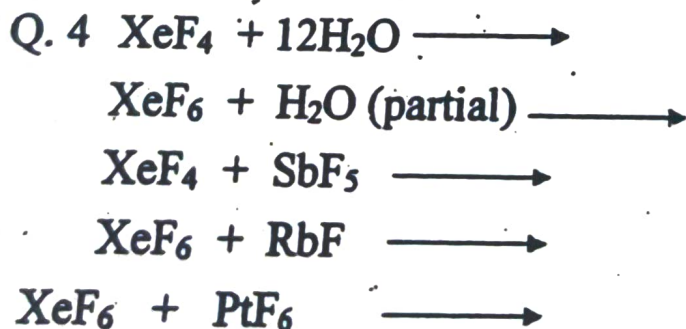
Q.2 a) What is zone refining? Explain how it is used to purify metals.

OR

b) Describe the different zone of blast furnace and reaction occurring in each zone and explain the role of coke and limestone in extraction of iron.

[5][CO1][BTL2]

Q.3 Describe the steps involved in the froth floatation method used for concentration of sulphide ores. [5][CO1][BTL3]



[5][CO3][BTL3]

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Q. 5 Describe the preparation, properties and structure (cyclic and linear) of phosphazenes.

[5][CO3][BTL3]

Q. 6 Explain the formation, structure, and uses of silicones (polysiloxanes). Why are they important in modern applications?

[5][CO3][BTL4]

Q. 7 (i). Arrange the hydrides NH_3 , PH_3 , AsH_3 , SbH_3 , BiH_3 in the order of: (a) increasing basic strength (b) decreasing reducing character.

(ii) What are Caro's acid and Marshall's acid? Write their chemical formulas, and explain their structural difference.

[5][CO3][BTL1]

Q. 8 (i) Explain why fluorine forms only one stable oxoacid (HOF) whereas chlorine, bromine, and iodine form several oxoacids with oxidation states +1, +3, +5, +7.

[5][CO3][BTL4]

Q. 9 Compare and contrast the stability, bond character, and reactivity of the hydrides of s-block elements (e.g., LiH , NaH , CaH_2 , BaH_2). Why do some hydrides decompose more readily? How do lattice energy and bond nature influence their behavior?

[5][CO2][BTL4]

Q. 10 Describe the main allotropes of sulphur. Explain how the viscosity of liquid sulphur changes with temperature, and rationalize this behavior on the basis of molecular (structural) changes."

[5][CO3][BTL4]

Total number of pages: 1

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Roll No.

3rd SEMESTER

End Term Examination

Time: 03:00 Hours

Note: All questions carry equal marks. Do any five questions.

Nov-2025

Max. Marks:40

IMSAC - 213

Environment Science

Q1 (a) Why is EVS considered multidisciplinary? Give two clear examples.

(b) Define sustainable development and describe any two practices that promote it.

[CO#1]

Q2 (a) Explain how over-use of groundwater affects local hydrology.

(b) Describe any two methods of water conservation practiced in India.

[CO#2]

Q3 (a) What are secondary air pollutants? Explain with suitable examples.

(b) Describe the process of composting and its environmental benefits.

[CO#4]

Q4 (a) Briefly discuss the role of the Forest Conservation Act (1980) in protecting natural habitats.

(b) Illustrate how climate change has led to the formulation of international environmental agreements.

[CO#3]

Q5 (a) Explain the structure of a pond ecosystem, highlighting any three components.

(b) What is an ecological pyramid? Explain any one type with a simple diagram.

[CO#2]

Q6 (a) Discuss the environmental impacts of rapid urban population growth.

(b) Write a short note on the concept of environmental justice.

[CO#5]

Q7 (a) Identify any small-scale environmental issue in a village or town (noise, waste, water, etc.) and describe its major cause.

(b) Suggest two simple, community-based solutions that are practical and sustainable.

[CO#1][CO#5]

END SEMESTER EXAMINATION

Nov- 2025

Integrated B.Sc-M.Sc.

COURSE CODE: IMSHU101

COURSE TITLE: Introductory Microeconomics

Time: 03:00 Hours

Max. Marks: 50

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

1. a) Explain how prices, property rights, and profit act as key institutions in allocating scarce resources in a competitive economic system. (5marks)(CO1)
b) Discuss how the scientific method, assumptions, and economic models are used in economic analysis. Why do economists sometimes disagree? (5marks)(CO1)
2. a) What is consumer and producer surplus? Explain how changes in equilibrium price affect both surpluses and justify why competitive markets are considered efficient. (5 marks)(CO2)
b) Explain how elasticity of demand and supply influence the allocation of resources in a competitive market. Illustrate your answer with relevant diagrams and real-world examples. (5marks)(CO2)
3. a) With the help of a properly labeled demand–supply diagram, compare the equilibrium of a small country under no trade and free trade. Clearly show the change in equilibrium price, quantity, and the volume of imports. Based on the diagram, briefly explain who gains and who loses when the country opens up to international trade. (5marks)(CO2)
b) A consumer purchases 10 units of a product when its price is ₹20 per unit. When the price increases to ₹25 per unit, the quantity demanded falls to 8 units.

i) Calculate the price elasticity of demand using the mid-point (arc) method.

ii) Interpret the elasticity value and classify the type of demand.
(5marks)(CO2)

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4. a) Define the Marginal Rate of Substitution (MRS). Explain how MRS changes along an indifference curve and why it is diminishing. Illustrate your answer with a diagram.

(5marks)(CO3)

b) A consumer consumes two goods, X and Y. The marginal utility of X (MU_x) is 30 and that of Y (MU_y) is 15. If the price of X (P_x) is ₹5 and price of Y (P_y) is ₹2, determine whether the consumer is in equilibrium or not. Use the utility-maximizing condition to justify your answer.

(5marks)(CO3)

5. a) Explain Samuelson's Revealed Preference Theory and state its key axioms. How does this theory differ from the indifference curve approach?

(5marks)(CO3)

b) A consumer consumes two goods, X and Y. The marginal utility from consuming these goods at a given bundle is:

i) $MUX=20$

ii) $MUY=10$

- i) Calculate the Marginal Rate of Substitution of X for Y MRS_{xy} .

- ii) Interpret the meaning of this MRS value in terms of willingness to substitute between goods.

(5marks)(CO3)

a) Differentiate between increasing, constant, and decreasing returns to scale with the help of a production isoquant map.

(5marks)(CO3)

b) With the help of a properly labeled diagram, explain the short-run cost curves (AFC, AVC, ATC, MC). Describe the relationship between MC and ATC/AVC and explain why the curves are U-shaped.

(5marks)(CO3)

FIRST SEMESTER

Integrated M.Sc. Economics

END TERM EXAMINATION

Nov-Dec 2025

IMSHU-103 Mathematical Methods for Economics-I

Time: 03:00 Hours

Max. Marks: 50

Note : Attempt any FIVE questions from the given questions.
Assume suitable missing data, if any.

Q.1. (a) Test the following for their convergence:

(i) The sequence $a_n = \frac{n^4+1}{n^3+2}$. [2][CO1][BTL5](ii) The series $\sum \left[\left(\frac{n+1}{n} \right)^{n+1} - \frac{n+1}{n} \right]^1$. [3][CO1][BTL5](b) Find if $((PVQ) \rightarrow R) \vee \neg((PVQ) \rightarrow R)$ is a tautology.

[5][CO1][BTL5]

Q.2. (a) Given the function $f(x) = x^2 + 1$ and $g(x) = \frac{1}{x}$. Find the domain and range of $g(f(x))$.

[5][CO1][BTL3]

(b) Find if the vectors $v_1 = \begin{bmatrix} 2 \\ 7 \end{bmatrix}$, $v_2 = \begin{bmatrix} 1 \\ 8 \end{bmatrix}$, and $v_3 = \begin{bmatrix} 4 \\ 5 \end{bmatrix}$ are linearly dependent. If so, write the vectors in linear combination. [5][CO5][BTL4]Q.3. (a) Suppose the firm is selling x units of goods. Find the profit maximizing level of output if the total revenue (TR) and total cost (TC) functions are:

$$TR(x) = 1200x - x^2,$$

$$TC(x) = x^3 - 61.25x^2 + 1582.5x + 2000$$

[5][CO2][BTL3]

(b) Determine the concavity / convexity of $f(x) = -\frac{1}{3}x^2 + 8x - 3$.

[2][CO3][BTL5]

(c) Find the points of inflection of the function $f(x) = \frac{2x}{x^2+1}$.

[3][CO3][BTL5]

Q.3. (a) Find all the stationary points for the function $f(x) = x^2 e^{2x}$.

[4][CO2][BTL2]

(b) A news item is spread by word of mouth to a potential audience of 10,000 people. After t days, $f(t) = \frac{10000}{1+50e^{-0.4t}}$ people will have heard the news. 68 370

(i) How many people knew about the news at $t = 0$? [1][CO4][BTL3]

(ii) When will the news spread at the greatest rate? [2][CO4][BTL4]

(iii) Show that $f'(t) = 0.4f(t) \left[1 - \frac{f(t)}{10000}\right]$. Use this to calculate $f'(t)$ when $f(t) = 5000$. [2+1][CO4][BTL1]

Q.4. (a) Write the quadratic form

$Q(x_1, x_2, x_3) = 3x_1^2 + 2x_2^2 + 3x_3^2 - 2x_1x_2 - 2x_2x_3$ in matrix form.

Then, determine the definiteness of the quadratic form $Q(x_1, x_2, x_3)$.

[1+4][CO3][BTL2]

(b) Determine the eigenvalue and eigenvector of matrix $B = 2A^2 - \frac{1}{2}A + 3I$,

where $A = \begin{bmatrix} 8 & -4 \\ 2 & 2 \end{bmatrix}$.

[5][CO5][BTL4]

Q.6. Show that $x + 2y - z = 3$; $3x - y + 2z = 1$; $2x - 2y + 3z = 2$;

$x - y + z = -1$ are consistent and solve them.

[5+5][CO5][BTL3]

first component functions well, what is the probability that the second one also functions well?

CO 4 (3)

(C)

A company has two projects A and B. Let E_1 be the event that Project A is successful, and E_2 be the event that Project B is successful. Suppose E_1 and E_2 are independent events with $P(E_1) = 0.4$ and $P(E_2) = 0.7$.

- If Project A is not successful, what is the probability that Project B is also not successful? Why?
- What is the probability that at least one project is successful?

CO 4 (4)

6. (A)

Write down the formulae for each of the following types of probability distribution functions. Give one real life example for each.

- Binomial
- Poisson

CO 5 (2)

(B)

Define a Random Variable x as the flight time (in minutes) of an airplane traveling from Chicago to New York. x can be any value in the closed interval 120 minutes to 140 minutes. Assume that every 1-minute interval within $[120, 140]$ is equally likely.

- Determine the probability density function.
- Sketch the probability density function, and show the probability of $x \leq 125$.
- What is the probability that the flight time is between 120 and 130 minutes?
- What is the probability of a flight time between 128 and 136 minutes?

CO 5 (4)

(C)

A survey of 300 restaurants was done. Each restaurant received a rating on its meal price (x) (1 least expensive, 2 average, and 3 most expensive) and quality (y) (1 lowest quality, 2 average, and 3 best quality).

Below is the rating data.

	Meal Price			
Quality	1	2	3	Total
1	42	39	3	84
2	33	63	54	150
3	3	15	48	66
Total	78	117	105	300

- Derive the bivariate probability distribution from the above data.
- What is the probability of a restaurant getting $x=1$ and $y=2$?
- What is the expected value for quality rating, x ?
- What is the expected value for meal price, y ?

CO 5 (4)

Total no. of Pages:4

END SEMESTER EXAMINATION

Integrated B.Sc-M.Sc.

Roll no.....

Nov- 2025

COURSE CODE: IMSHU105

COURSE TITLE: Statistics for Economics I

Time: 03:00 Hours

Max. Marks: 50

Note: All questions carry equal marks.

Answer any 5 out of the given 6 questions.

Assume suitable missing data, if any.

Attempt any five of the following six questions

1. (A)

Five observations are taken for two variables as shown in the table below:

x_i	5	6	7	12	10
y_i	70	60	50	40	30

- Compute and interpret the sample covariance.
- Compute and interpret the sample correlation coefficient.
- What can you interpret about the relationship between the two variables?

CO 2 (6)

(B)

The following table provides a probability distribution for the random variable x .

x	$f(x)$
4	0.25
6	0.4
10	0.35

- Compute $E(x)$, the expected value of x .
- Compute s^2 , the variance and compute s , the standard deviation of x .

CO 4 (4)

2. (A)

Consider the following data on the number of visitors to a zoo:

Visitor Category	2011	2012	2013	2014
General	153,000	158,000	163,000	169,000
Member	115,000	104,000	98,000	81,000
School	82,000	79,000	81,000	81,000
Total	350,000	341,000	342,000	331,000

- Construct a bar chart of total attendance over time. Do you notice any trend in the data?

- b. Construct a side-by-side bar chart showing attendance by visitor category with year as the variable on the horizontal axis.
- c. Construct a pie chart for the attendance in years 2011 and 2014 and comment on the change in composition, if any.

CO 1 (6)

(B) The following data records the number of people waiting in line at the RTO office for 50 days:

People in queue	0	1	2	3	4	5	6	7	Total
Days observed	1	2	4	9	10	12	7	5	50

- a. Construct a histogram using relative frequency on the y axis.
- b. Comment on the shape of the histogram.
3. (A) Consider the following data on exam scores of 20 students (1 is the lowest, 100 is the highest):

42	61	62	63
66	64	61	68
67	61	76	69
71	54	71	81
78	83	67	53

- a. Compute the mean, median, and mode.
- b. Compute the first and third quartiles.
- c. Compute the 90th percentile. What can you say about the performance of 90% of the class?

CO 2 (6)

(B) The following data is the exam scores for 8 subjects of one student for two years:

2011	74	78	79	77	75	73	75	77
2012	71	70	75	77	85	80	71	79

- a. Compute the mean and the population standard deviation for the two years.
- b. Has the student's average score improved in 2012? What can you say about the student's consistency in performance across all subjects for the two years?

CO 2 (4)

4. (A) Consider the following data:

Items	Base Year		Current Year	
	Prices (Rs.)	Quantity (kg.)	Prices (Rs.)	Quantity (kg.)
A	1	6	5	8

B	2	7	4	7
C	3	8	3	6
D	4	9	2	5

- a. From the above data compute and interpret the Laspeyre's index number for the current year.
- b. From the above data compute and interpret the Paasche's index number for the current year.

CO 3 (4)

- (B) Compute the Laspeyres' price index number for the following data for 2021 with 2019 as the base

Item	Price (Rs.) per unit		Total Value (Rs.)
	2019 (P_0)	2021 (P_1)	2019 ($P_0 Q_0$)
A	12.50	14.00	112.50
B	10.50	12.00	126.00
C	15.00	14.00	105.00
D	9.40	11.20	47.00

CO 3 (2)

- (C) Consider the following data:

Item	Quantity		Price	
	2009	2011	2009	2011
A	1500	1800	7.50	7.75
B	2	1	630.00	1500.00

- a. Compute price relatives for each item in 2011 using 2009 as the base period.
- b. Compute an unweighted aggregate price index for the two items in 2011 using 2009 as the base period.

CO 3 (4)

5. (A) Four candidates A, B, C, and D are called for a job interview at a company. The hiring manager has scheduled for the four candidates to be interviewed in room no. 1, 2, 3, and 4 respectively. But, the manager's secretary does not know this, and has assigned candidates A-D to the rooms 1-4 randomly.

- a. What is the probability that all candidates end up in their correct rooms?
- b. What is the probability that none of them end up in the correct room?

CO 4 (3)

- (B) A system consists of two components. The probability that the second component functions well is 0.9. The probability that at least one of the two components functions well is 0.96. The probability that both components function well is 0.75. Given that the

END SEMESTER EXAMINATION

Nov-2025

Integrated B.Sc-M.Sc.

COURSE CODE: IMSHU201

COURSE TITLE: Intermediate Microeconomics

Time: 03:00 Hours

Max. Marks: 50

Note: All questions carry equal marks.

Attempt any five questions.

Assume suitable missing data, if any.

1. a) When price are $(p_1, p_2) = (1, 2)$ a consumer demand $(x_1, x_2) = (1, 2)$, and when price are $(q_1, q_2) = (2, 1)$ the consumer demand $(y_1, y_2) = (2, 1)$. Is this behaviour consistent with the model of maximizing behaviour?

(5marks)(CO1)

- b) Suppose Ram's indifference curve are given by the following formula:

$$\frac{2}{3}\sqrt{F_S} + \frac{1}{3}\sqrt{F_H} = C$$

Where C is a constant (the value of which differs from one indifference curve to another). Ram receives 36kg of food when it's rainy and 81kg when there's a drought. If the probability of rainy weather, π , equals $2/3$, what is her expected food consumption? What is the certainty equivalent of the risk bundle? What is the risk premium?

(5marks)(CO2)

2. a) Which of the following utility function have expected utility property?

i) $u(c_1, c_2, \pi_1, \pi_2) = \alpha(\pi_1 c_1, \pi_2 c_2)$

ii) $u(c_1, c_2, \pi_1, \pi_2) = \pi_1 c_1 + \pi_2 c_2^2$

iii) $u(c_1, c_2, \pi_1, \pi_2) = \pi_1 \ln c_1 + \pi_2 \ln c_2 + 17$

Where (c_1, c_2) are consumption, (π_1, π_2) are probabilities.

(5marks)(CO2)

b) Show graphically that risk-loving consumer would never purchase actuarially fair insurance.

(5marks)(CO2)

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3. a) Using the Slutsky Equation, explain the decomposition of the price effect into substitution and income effects for a Giffen good.

(5marks)(CO2)

b) Explain the concept of consumer's equilibrium using indifference curve analysis. Illustrate your answer with a clearly labelled diagram. Also state the necessary and sufficient conditions required for equilibrium.

(5marks) (CO3)

4. a) Discuss the key features of a monopoly market and explain how a monopolist determines the level of output and price to maximize profit. Use a suitable diagram in your explanation.

(5marks)(CO3)

b) Define returns to scale and explain its three main types with suitable examples. How do increasing, constant, and decreasing returns to scale influence a firm's long-run production decisions?

(5marks) (CO3)

5. a) Define an isoquant and explain its main properties. Using a diagram, show how different combinations of inputs can produce the same level of output and briefly describe the concept of Marginal Rate of Technical Substitution (MRTS)

(5marks) (CO3)

b) Explain the differences between short-run and long-run cost concepts. With the help of labelled diagrams, describe the shapes and behaviour of short-run cost and long-run cost curves.

(5marks)(CO3)

6. a) Explain the key features of a perfectly competitive market and discuss how price and output are determined in the short run.

(5marks)(CO4)

b) Discuss Cournot's duopoly model and explain how firms decide output under this model.

(5marks) (CO4)

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Total no. of pages: 02

Roll No.....

Intermediate Macro Official (BSc-MSc Economics DTU) III- Semester

END-TERM EXAM

November, 2025

CODE: IMSHU 203

Subject: Intermediate Macroeconomics

Time: 3.00 hours

Maximum Marks: 50

NOTE:

- Attempt any FIVE questions.
- Attempt all parts of the question in one flow.

Q. 1. Consider two countries: Japan and Korea. In 1996 Japan experienced relatively slow output growth (1%), while Korea had relatively robust output growth (6%). Suppose the Bank of Japan allowed the money supply to grow by 2% each year, while the Bank of Korea chose to maintain relatively high money growth of 12% per year. For the following questions, use the simple monetary model (where L is constant). You will find it easiest to treat Korea as the home country and Japan as the foreign country. [CO2] [BTL-344]

- a) What is the inflation rate in Korea? In Japan? (2)
- b) What is the expected rate of depreciation in the Korean won relative to the Japanese yen (¥)? (2)
- c) Suppose the Bank of Korea increases the money growth rate from 12% to 15%. If nothing in Japan changes, what is the new inflation rate in Korea? (2)
- d) Suppose the Bank of Korea wants to maintain an exchange rate peg with the Japanese yen. What money growth rate would the Bank of Korea have to choose to keep the value of the won fixed relative to the yen? (2)
- e) Suppose the Bank of Korea sought to implement policy that would cause the Korean won to appreciate relative to the Japanese yen. What ranges of the money growth rate (assuming positive values) would allow the Bank of Korea to achieve this objective? (2)

Q. 2. Explain why monetary policy is most effective under a floating exchange rate regime but becomes largely ineffective under a fixed exchange rate regime. In your answer, discuss the mechanisms of exchange rate adjustment, the role of capital mobility, and the impact on output levels. Illustrate your answer with the help of appropriate diagrams. (10) [CO2] [BTL-244]

Q. 3. Discuss the roles of price rigidity, interest rate differentials, and expectations in determining the short-run and long-run adjustment of the exchange rate. Explain this with appropriate diagram(s). (10) [CO2] [BTL-244]

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- Q. 4. How does stabilization bias arise under discretionary monetary policy in the New Keynesian Phillips Curve framework, and why does commitment to a price-level targeting rule lead to superior welfare outcomes following an inflation shock? Illustrate your answer with the help of appropriate diagrams and formal modelling. (10) [CO2] [BTL-2 & 5]
- Q. 5. Milton Friedman argued that there is always a temporary trade-off between inflation and unemployment, but no permanent trade-off. Explain this statement using a formal model and an appropriate diagram. (10) [CO1] [BTL-2 & 4]
- Q.6. How does the permanent-income hypotheses resolve the seemingly contradictory pieces of evidence regarding consumption behaviour? (5, 5) [CO1] [BTL-2 & 4]

SEMESTER-III

B.Sc. B.Ed. Integrated

END TERM EXAMINATION

Nov/Dec-2025

IMSHU-205 Econometrics

Time: 03:00 Hours

Max. Marks: 50

Note : Attempt any five questions.
 Assume suitable missing data, if any.
 Tables for t Distribution, F Distribution and Chi-square
 Distribution may be allowed

- 1.a What do you mean by Econometrics? Discuss steps in an Econometric model with suitable examples. 6
[CO#1 and 2]
- 1.b A pre-test and post-test were conducted during a survey to find the study hours of XYZ on weekends. Calculate the t-score and determine (for $\alpha = 0.25$) if the pre-test and post-test significantly different. 4
[CO #3]
- | | | |
|---------------|---|---|
| Pre-test (X) | 1 | 2 |
| Post-Test (Y) | 2 | 4 |
- 2.a Difference between confidence level and confidence interval, and what are their significance in Econometrics analysis. Discuss 6
[CO #2]
- 2.b A departmental store gives in-service training to salesmen followed by a test. It has been observed that the performance of any salesman regarding sales is linearly related to the scores he secures. The following data gives test scores and sales made by nine salesmen during a fixed period. Draw a regression line of test score on sales. 4
[CO #3]
- 75 = 50
4.5 = 3.75

Test Score	16	22	28	24	29	25	16	23	24
Sales	35	42	57	40	54	51	34	47	45

- 3.a What do you mean by Omitted Variable Bias? Why is it a problem? Discuss. 6 [CO #1 and 4]

- 3.b A manufacturing company sold their item in three package large (economy), Normal and Handy (small). Experience has shown that they sell in the ratio 3:5:2. Sales return from particular region show that 40, 45 and 15 dozen respectively of different package sizes have been sold. Is this pattern of sales significantly different from the previously established one? 4 [CO #3]

- 4.a How to detect and correct Serial Correlation? Discuss. 6 [CO #4]

- 4.b A company Alpha is producing two types of component i.e. M and N. Both M and N have normal population. Data on unit of M and N sold by various outlets are given below: 4 [CO #3]

M	N	M	N	M	N
65	64	82	82	92	93
66	66	84	85	-	95
73	74	88	87	-	97
80	78	90	92	-	-

Test Whether the two population, M and N have same variance at the 5% level of significance.

5. a What do you mean by Multicollinearity? Discuss its different types. 6 [CO #1 and 4]
- 5.b The mean of 200 items is 48, and their standard deviation is 3. Find the sum and the sum of squares of all items 4 [CO #3]

- 6.a What is heteroscedasticity? Differentiate Pure heteroscedasticity and Impure heteroscedasticity with examples. 6 [CO #1 and 4]

- 6.b Obtain a straight-line trend equation and find out expected sale for the year 2027. 4 [CO #3]

Year	2020	2021	2022	2023	2024
Sales in Rs.000)	45	56	78	46	75

- 7.a The OLS method relies on several assumptions to be valid. Discuss those assumptions. 6 [CO #2]

- 7.b From a group of 5,000 workers, the monthly wages range from ₹20,000 to ₹80,000. The wages of 4 per cent of the workers are under ₹ 25, 000 and those of 10 per cent are under ₹ 30,000. 15 per cent of the workers earn ₹ 60,000 and over and 5 per cent of them get ₹ 70 000 and over. The 1st and 3rd quartile wages are ₹ 40,000 and ₹ 54000 and 6th decile is ₹ 50000. Put this information in a frequency table of ₹ 20,000 and under, ₹ 30,000, ₹ 30,000 and under, ₹ 40,000 and so on. 4 [CO #3]

Total no. of Pages 2

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Roll no. _____

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Thrd SEMESTER

B.Tech./B.Des./BBA/BAE/M.Sc./M.Des./M.Tech./MBA/Ph.D/ B.Tech.(Env)

END TERM EXAMINATION

Dec-2025

COURSE CODE – IMSHU207 COURSE TITLE – Financial
Management & Corporate Finance

Time: 3:00 Hours

Max. Marks: 50

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

Q.1 Define various factors determining capital structure.

[10][CO1] [BTL 1]

Q.2 Elaborate the key objectives of corporate finance and the concept of time value of money with appropriate examples.

[10][CO2] [BTL 3]

Q.3 XYZ Ltd. has an Earnings Before Interest and Tax (EBIT) of ₹20,00,000. The company is considering different capital structures. Its cost of debt (K_d) is 8%, and its cost of equity (K_e) is 12%.

Calculate the total value of the firm (V) and the Overall Cost of Capital (WACC) under the following scenarios using the Net Income Approach:

a) Plan I: No debt.

b) Plan II: ₹50,00,000 debt.

c) Plan III: ₹80,00,000 debt.

[10][CO3] [BTL 3]

Q.4 Describe the Net Operating Income Approach Theory with appropriate examples.

[10][CO5] [BTL 2]

Q.5 Define cost of debt (K_d), cost of equity (K_e) and cost of preference (K_p) with suitable examples.

[10][CO4] [BTL 3]

2.6 Describe any three methods of capital budgeting along with examples.

[10] [CO 2] [BTL 2]

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2.7 Enumerate the EBIT-EPS analysis with suitable example.

[10] [CO 5] [BTL 2]

END TERM EXAMINATION

Nov/ Dec-2025

IMSHU209: Agricultural Economics

Time: 03:00Hours

Max.Marks:50

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

- Q.1 Explain the recent developments in food processing in India and their implication for value addition and farmer's income.
[10][CO3][BTL2]
- Q.2 Critically evaluate the role of agritech start-ups in transforming production, processing and marketing simultaneously.
[10][CO4][BTL5]
- Q.3 Discuss the significance of organic and natural farming as emerging farming system in India
[10][CO2][BTL2]
- Q.4 "The new agriculture strategy laid the foundation for the Green Revolution in India."Discuss.
[10][CO5][BTL2]
- Q.5 How can consolidation of landholdings, cooperative farming, and FPOs improve productivity among small farms?
[10][CO2][BTL4]

Total no. of Pages: 02

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Roll no.....

1st SEMESTER

B.Sc.-M.Sc. Integrated

END TERM EXAMINATION

Dec-2025

IAEC 5: Communication Skills

Time: 2 Hours

Max. Marks: 50

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

Q.1. Write an essay discussing the statement - "The impact of artificial intelligence on modern society"

[10] [CO2, CO4] [BTL 2, 6]

Q.2. Analyse how *Animal Farm* by George Orwell serves as a political allegory.

[10] [CO3] [BTL 5, 4]

Q.3. What are barriers to communication? Analyse any three types of barriers with examples.

[10] [CO2] [BTL 1, 4]

Q.4. Give the IPA transcription (any 5) -

1. Queen

2. Shot

3. Jump

4. Jet
5. Ink
6. Cook
7. Sell
8. Culture
9. Listen
10. Now

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[2*5=10] [CO2, CO4] [BTL 3, 2]

Q.5. Write short note on any 2 of the following

- i) Argumentative Writing
- ii) Vowels
- iii) Features of Communication
- iv) Napoleon (from Animal Farm)

[5*2=10] [CO2, CO4] [BTL 1]

Total no. of Pages: 2

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Roll no.....

1st SEMESTER

END TERM EXAMINATION

Dec-2025

IAEC 19: Technical Communication

Time: 2 Hours

Max. Marks: 50

Note : All questions carry equal marks.

Assume suitable missing data, if any.

Q.1 Write a short note on the following (any two)-

- 1) Formal communication
- 2) Netiquettes
- 3) Importance of Written Communication

[5*2 -10] [CO2, CO4] [BTL 1]

Q.2 Prepare a cover letter OR resume for applying for a Corporate Finance Internship in a private bank starting January 2026. Include financial projects, academic achievements, and certifications.

[10] [CO2, CO4] [BTL 4, 2]

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Q.3 As the Environmental Club Coordinator, prepare a short report for the Municipal Environment Office on Tree Plantation and Plastic-Free Campus Drive initiated by your institution.

[10] [CO3, CO5] [BTL 1, 6]

Q.4 You are the IT Manager of a mid-sized company. The company needs to purchase 10 high-performance laptops and 5 printers to upgrade its office infrastructure. Write a formal business letter of purchase to the authorized supplier placing the order. Include specifications, quantity, delivery timeline, warranty requirements, and request confirmation of the order

[10] [CO3] [BTL 6]

Q.5 What is Technical communication? What are some tips for effective technical writing?

Or

Define and analyse different types of technical writing, such as reports, emails, notices, agenda of meeting, letters, memorandums, minute of meeting (any 4) highlighting their purpose and use.

[10] [CO2] [BTL 1, 4]

Total No. of Pages: 01

Roll No.....

SEMESTER- I
Integrated BSMS

END-TERM EXAMINATION

DEC-2025

ISECHU101- Financial Literacy

Time: 3:00 Hours

Max. Marks:50

Note: All questions carry equal marks.

Attempt all questions.

Assume suitable missing data, if any.

Q1. What does Financial Literacy mean & why we all should be financially literate? [10](CO1;L2,3)

Q.2 What does Annuity mean? Is it different from Life Insurance? If yes, pls explain. [10] (CO2;L3,4)

Q3. Are Savings & Investment same or different? Explain. [10] (CO3;L4)

Q4. Explain Time Value of Money with an example. [10] (CO4;L5)

Q5. How does Time Value of Money impact investment Decisions? [10] (CO5;L6)

Total No. of Pages: 01

389 87
I/III SEMESTER
Int. B.Sc.+M.Sc

Rollno.....

END TERM EXAMINATION

Dec-2025

COURSE CODE: IVAC5

COURSE TITLE: EMOTIONAL INTELLIGENCE

Time: 2:00 Hours

Max. Marks: 50

Note: All questions are compulsory.

All questions carry equal marks.

Assume suitable missing data, if any.

- Q1. Define the terms 'Feelings', 'Emotions', and 'Moods' with an appropriate example. [10][BT1][CO1]
- Q2. What do you understand about the term Emotional Intelligence? Describe the five main elements of EQ. [10][BT1,BT2][CO2]
- Q3. (i) In your opinion, is EQ more significant than IQ? Support your answer with a relevant example. [05][BT1,BT6][CO2]
- (ii) Explain the concept of Emotional Hijacking with an example.. [05][BT1,BT5][CO3]
- Q4. Since humans are social beings, explain the different methods that assist in managing relationships within society, and present a case study demonstrating the application of social competence skills in relationship management. [10][BT1,BT6][CO4]
- Q5. (i) Describe one component of social competence with an example. [05][BT1,BT5][CO5]
- (ii) Discuss some skills necessary for Social Competence and give an example illustrating the importance of social competence in maintaining societal harmony. [05][BT1,BT6][CO5]

Total No. of pages: 01

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Roll No.....

1st Semester
IMSC

End-Term Examination

Dec 2025

IVAC-16 Professional Ethics and Human Values

Time: 2 hours

Max. Marks: 50

Note: Answer all questions

1. Explain the following concepts with examples:
[5x2= 10 marks] [CO#3]
 - (i) Moral Intuition and Moral Reasoning
 - (ii) Zero Risk
2. How three types of inquiry in engineering ethics makes an engineer more responsible professional?
[10 marks] [CO#3 & CO#5]
3. Differentiate between 'Instrumental Value' and 'Intrinsic Value' in environmental ethics. How does recognizing intrinsic value in nature change our ethical responsibilities as engineers?
[10 marks][CO#5 &CO#1]
4. Critically assess the statement: "Virtue Ethics is too vague to be useful in professional ethics." Do you agree? Support your argument with examples from corporate or scientific practice.
[10 marks] [CO#1 &CO#8]
5. What do understand by Co-Existence? How it ensure harmony within the body and the self ?
[10 marks] [CO#5 &CO#1]

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Total No. of Pages: 01

Roll No.: _____

FIRST SEMESTER
END SEMESTER EXAMINATION

M. Sc
(Nov. 2025)

MSMA-101, Abstract Algebra

Time: 3 Hr.

Max. Marks: 50

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

1. (a) Show that an infinite cyclic group will have only two generators
 (b) Whether the product of two subgroups is a subgroup? Justify. [CO1][BTL 1]
2. (a) State and prove third fundamental theorem of group isomorphism.
 (b) State and prove Cayley's theorem. [CO2][BTL 3]
3. (a) Define centre of a group. Show that G is abelian iff $G = Z(G)$.
 (b) State and prove Sylow's second Theorem. [CO3][BLT 2]
4. (a) Define an integral domain with an example. Show that every finite integral domain is a field.
 (b) Define maximal ideal with an example. Let R be a commutative ring with 1. Show that an ideal M is a prime ideal iff R/M is an integral domain. [CO4][BTL 4]
5. (a) Define ring homomorphism with an example. Prove that the kernel of ring homomorphism forms an ideal.
 (b) Show that every field is a simple ring. Is converse true? Justify. [CO4][BTL 2]
6. (a) Define Unique Factorization Domain with suitable example. Prove or disprove whether each Euclidean domain is an Unique factorization domain.
 (b) Define Principal Ideal Domain. Prove or disprove that $\mathbb{Z}$ is a Principal Ideal Domain. [CO5][BTL 2]

I SEMESTER

M.Sc.

END TERM EXAMINATION

NOVEMBER 2025

MSMA103 REAL ANALYSIS

Time: 3 hrs.

Max. marks: 50

Note: Attempt any two parts of each question. The marks are indicated.

1. (a) Show that the following sequence
- (y_n)
- , where

$$y_1 = \frac{1}{1!}, y_2 = \frac{1}{1!} - \frac{1}{2!}, \dots, y_n = \frac{1}{1!} - \frac{1}{2!} + \dots + \frac{(-1)^{n+1}}{n!},$$

is convergent.

- (b) Show that a bounded real sequence has a convergent subsequence.

- (c) Show that the series
- $\sum_{n=1}^{\infty} \frac{1}{n^p}$
- converges if and only if
- $p > 1$
- .

(CO1)(L2) (4,4,4)

2. (a) Show that the finite intersection of open sets is open in a metric space. Is the arbitrary intersection of open sets open in a metric space? Justify your answer.

- (b) Show that the continuous image of Cauchy sequence need not be Cauchy sequence whereas the uniformly continuous image of a Cauchy sequence is a Cauchy sequence.

- (c) Show that the real line is a connected metric space.

(CO2,3)(L4)(4,4,4)

3. (a) State and prove the location of roots theorem and hence derive the intermediate value theorem.

- (b) Show that none of the assumptions of Rolle's theorem can be relaxed.

- (c) State and prove necessary and sufficient conditions for a function to be integrable on a closed and bounded interval
- $[a, b]$
- . (CO3,5)(L2)(4,4,4)

4. (a) Show that the open interval
- (a, b)
- in the real line is not compact.

- (b) Test the convergence of the following integrals:

a. $\int_0^\pi \frac{dx}{\sin x}$

b. $\int_0^\pi x \log \sin x \, dx$

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(c) Show that if f is integrable on $[a,b]$, then f^2 is integrable on $[a,b]$. Give an example to show that the

converse is not true.

(CO5)(L6) (4,4,4)

5. Test the convergence of the following integrals

(a) $\int_{e^2}^\infty \frac{dx}{x \log \log x}$

(b) $\int_0^\infty \frac{x \log x}{(1+x^2)^2} \, dx$

(c) Show that the integral $\int_a^b \frac{dx}{(x-a)^n}$ converges if and only if $n < 1$.

(CO5)(L5)(4,4,4)

6. (a) Show that a continuous function is integrable on a closed and bounded interval $[a,b]$. Show that a bounded function on $[a,b]$ may not be integrable.

(b) Show that the sequence $\langle f_n \rangle$ defined by $f_n(x) = \frac{x}{x+n}$ is uniformly convergent in $[0, k]$, $k \geq 0$, but not uniformly convergent in $[0, \infty)$.

(c) Show that the sequence is $\langle \frac{nx}{1+n^3x^2} \rangle$ converges uniformly to zero for

$0 \leq x \leq 1$.

(CO4)(L6) (5,5,5)

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Total No. of Pages: 2

Roll No. _____

Ist Semester

END TERM EXAMINATION

M.Sc. (Math)

PAPER CODE : MSMA-105

November/December-2025

TITLE OF PAPER - Ordinary Differential Equations

TIME: 03 HRS.

MAX. MARKS: 50

Note: Attempt any five questions. Each question carries equal marks. Write legibly, avoid over-writing and unnecessary scribbles. Assume suitable data, if any.

1. (a) Consider the initial-value problem $\frac{dy}{dx} = 1 + y^2$, $y(0) = 0$ and find the largest interval $|x| \leq h$ on which the Picard-Lindelöf theorem guarantees the existence of a unique solution. Also, find the unique solution and show that it actually exists over a larger interval than that guaranteed by the theorem. (5)
CO-1
L2
- (b) Define the method of successive approximations for initial value problems. Hence, obtain the first three successive approximations to the solution of the differential equation $\frac{dy}{dx} = 1 + xy$ subject to the initial condition $y(0) = 1$. (5)
CO-1
L3
2. (a) Define generating function for Legendre polynomial $P_n(x)$. If n is a non-negative integers then show that $\int_{-1}^1 P_n^2(x) dx = \frac{2}{2n+1}$. (5)
CO-2
L2, L5
- (b) Determine the singular points of the differential equation
$$2x(x-2)^2 \frac{d^2y}{dx^2} + 3x \frac{dy}{dx} + (x-2)y = 0$$

and classify them as regular or irregular. (5)
CO-2
L5
3. (a) Show that there exist fundamental sets of solutions of the homogeneous linear vector differential equation $\frac{dx}{dt} = A(t)x$. (5)
CO-3
L6

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- (b) Find the unique solution ϕ of the nonhomogeneous differential equation (5)

CO-3

$$\frac{dx}{dt} = \begin{pmatrix} 6 & -3 \\ 2 & 1 \end{pmatrix} x, \text{ that satisfies the initial condition } \phi(0) = \begin{pmatrix} 9 \\ 4 \end{pmatrix}. \quad \text{L2,L5}$$

4. (a) Consider the differential equation $\frac{d^2x}{dt^2} + q(t)x = 0$ where q is continuous (5)
and $q(t) > 0$ on $a \leq t \leq b$. Let q_m denote the minimum value of $q(t)$ on
 $a \leq t \leq b$. Show that if $q_m > \frac{k^2\pi^2}{b^2 - 2ab + a^2}$, then every real solution of the L2,L4
given equation has atleast k zeros on $a \leq t \leq b$.

- (b) Show that the cross-ratio of any four distinct particular solutions of a (5)
Riccati equation is a constant. CO-4

L3

5. Find all real critical points of the nonlinear system

(10)

CO-5

$$\begin{cases} \frac{dx}{dt} = 8x - y^2 \\ \frac{dy}{dt} = -6y + 6x^2 \end{cases} \quad \text{L3,L5}$$

and determine the type and stability of each of the critical point.

6. (a) State and prove Sturm separation theorem.

(5)

CO-4

L1,L2

- (b) Define Wronskian of the n vector functions $\phi_1, \phi_2, \dots, \phi_n$. Further, (5)
if these vector functions are linearly dependent on the interval $a \leq t \leq b$, CO-3
prove that their Wronskian $W(\phi_1, \phi_2, \dots, \phi_n)(t)$ is identically zero for all L1,L4
 $t \in [a, b]$.

x x x

Total no. of Pages: 03

Roll no.....

I SEMESTER **B.Sc.**

END TERM EXAMINATION

NOV-2025

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) Define Lattice as a Poset and also as an algebraic structure. Show that these two definitions are equivalent.

(5) (CO3)

(b) Show that in a distributive lattice $(L, +, \cdot)$

$a \cdot b = a \cdot c$ and $a + b = a + c$ imply that $b = c$
for all $a, b, c \in L$.

(5) (CO3)

Q2(a) Let x and y be elements of a Boolean algebra. Then prove that

$$x \cdot y = x \text{ iff } x \cdot y' = 0$$

(5) (CO3)

(b) Give an example of a Boolean algebra in which $x \cdot y = 0$ does not necessarily mean that $x = 0$ or $y = 0$.

(5) (CO3)

Q3(a) Prove that a graph is disconnected iff its vertex set can be partitioned into two subsets such that there exists no edge whose one vertex is in one subset and the other in another subset.

(5) (CO4)

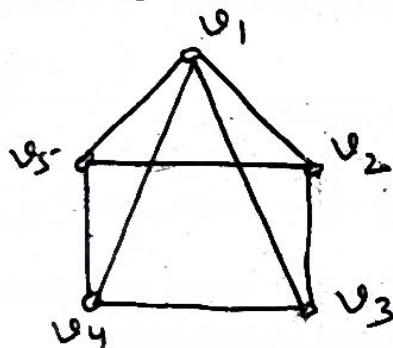
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- (b) Draw the graph whose adjacency matrix is given below. How many spanning trees are there for this graph. Draw all of them.

$$\begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix}$$

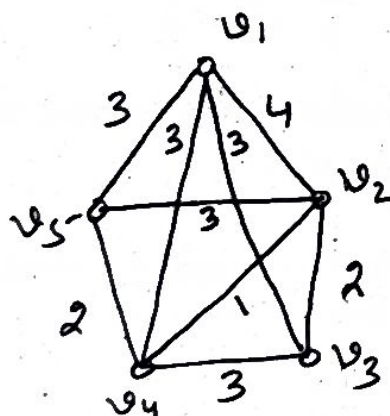
(5) (CO4)

- Q4(a) Find the chromatic polynomial $P(G, \lambda)$ of the graph given below by describing each step.



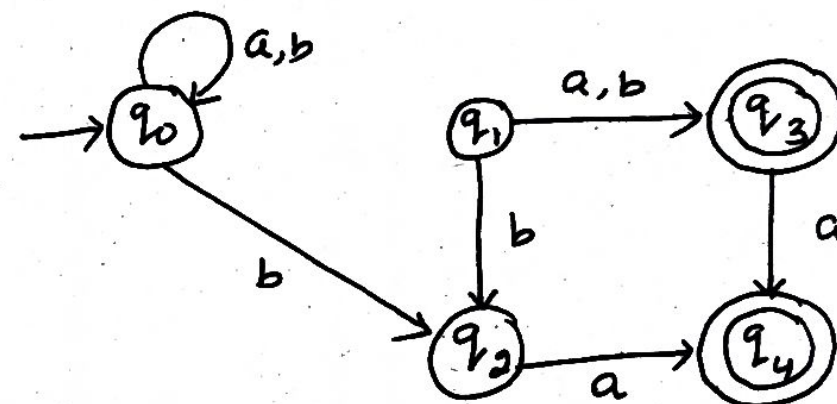
(5) (CO4)

- (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) Draw transition table of the NDFA whose transition diagram is given below. Also construct a DFA equivalent to the given NDFA.



(5) (CO5)

- (b) Consider the Grammar G given by
 $S \rightarrow 0SA2, S \rightarrow 012, 2A \rightarrow A2, 1A \rightarrow 11$
 Test whether (a) $00112 \in L(G)$ and (b) $001122 \in L(G)$

(5) (CO5)

- Q6(a) Solve the following recurrence relation using method of characteristic roots

$$a_{n+2} - a_{n+1} - 2a_n = n^2$$

(5) (CO1)

- (b) Show by algebra of proposition

- (i) $[\sim(p \vee q)] \vee [(\sim p) \wedge q] \equiv (\sim p)$
 (ii) $(\sim p) \Rightarrow (p \Rightarrow q)$ is a tautology.

(5) (CO2)

END TERM EXAMINATION

Nov -2025

COURSE CODE: MSMA 109

COURSE TITLE: MATHEMATICAL STATISTICS

Time: 03:00 Hours

Max. Marks: 40

- Q.1 (i) State and Prove Baye's Theorem. [4][CO1] [L1,L2]
(ii) Two boxes contain respectively 4 white and 2 black, and 1 white and 3 black balls. One ball is transferred from the first box into the second, and then one ball is drawn from the latter. It turns out to be black. What is the probability that the transferred ball was white? [4][CO1] [L2,L5]
- Q.2 (i) State and Prove Schwarz's inequality for expectations. Hence deduce that $-1 \leq \rho(X,Y) \leq 1$, where $\rho(X,Y)$ denote the correlation coefficients between the random variables X and Y . [4][CO2] [L1,L4,L5]
(ii) If the regression lines are given by
$$x + 6y = 6 \text{ and } 3x + 2y = 10$$
then find the means and correlation coefficient. [4][CO2] [L2,L3,L5]
- Q.3 (i) Find the standard deviation and moment generating function of Poisson distribution. [4][CO3] [L1,L5]
(ii) In a certain factory turning razor blades, there is a small chance that $\frac{1}{500}$ for any blade to be defective. The blades are in packets of 10. Use poisson distribution to calculate the approximate number of packets containing two defective blades in one consignment of 10,000 packets.
[Given $e^{-0.02} = 0.9802$] [4][CO3] [L3,L5]
- OR
- Six coins are tossed 6400 times. Using the Poisson distribution, find the approximate probability of getting six heads 8 times. [4][CO3] [L3,L5]
- Q.4 (i) Estimate the parameters of the normal distribution using the method of maximum likelihood. [4][CO4] [L1,L3]

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(ii) If the weekly wage of 10,000 workers in a factory follows normal distribution with mean and S.D. Rs. 70 and Rs. 5 respectively, find the expected number of workers whose weekly wages are between Rs. 66 and Rs. 72. [Given that $\frac{1}{\sqrt{2\pi}} \int_0^t \exp\left(-\frac{t^2}{2}\right) dt = 0.1554$ and 0.2881 according as $z=0.4$ and $z=0.8$].

[4][CO4] [L2,L5]

OR

The length of bolts produced by a machine is normally distributed with mean 4 and S.D. 0.5. A bolt is defective if its length does not lie in the interval (3.8, 4.3). Find the percentage of defective bolts produced by the machine.

[Given that $\frac{1}{\sqrt{2\pi}} \int_0^t \exp\left(-\frac{t^2}{2}\right) dt = 0.7257$, $\frac{1}{\sqrt{2\pi}} \int_0^t \exp\left(-\frac{t^2}{2}\right) dt = 0.6554$].

[4] [CO4] [L2,L5]

Q.5 (i) The monthly income of 175 workers in a factory were recorded. This give sample mean as Rs. 3440.65 and the S.D. as Rs. 125.32. Find 95% confidence interval of the average monthly income.

[Given that $\frac{1}{\sqrt{2\pi}} \int_0^t \exp\left(-\frac{t^2}{2}\right) dt = 0.25$]

[4][CO5] [L4,L5]

(ii) Show that $E(\bar{X}) = \mu$, $E(S^2) = \sigma^2$, where the symbols have their usual meaning.

[4][CO5][L2,L5]

OR

A researcher wants to study whether there is a significant difference in the average marks obtained by students taught using three different teaching methods (A, B, and C). The data below represent marks (out of 100) of students under each method:

A	B	C
78	85	82
74	88	79
69	90	84
72	83	80
75	87	81

Using one-way ANOVA test to determine whether there is a significant difference among the three teaching methods at a 5% level of significance.

[4][CO5][L2,L5]

THIRD SEMESTER
M.Sc. Mathematics
END TERM EXAMINATION
November 2025

Course Code: MSMA201

Course Title: Functional Analysis

Time: 3 : 00 Hours

Max. Marks: 50

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) Define the n -fold shift $S^n : \ell^2 \rightarrow \ell^2$ by

$$S^n(x_1, x_2, x_3, \dots) = (\underbrace{0, \dots, 0}_{n \text{ zeros}}, x_1, x_2, \dots).$$

Then, $\|S^n\| = 1$ and (S^n) does *not* converge uniformly to 0.

[2] [CO2][BTL3]

(b) $L^p[0, 1]$ is a Hilbert space if and only if $p = 2$.

[2] [CO1][BTL2]

(c) If V is an infinite dimensional normed space and $T : V \rightarrow V$ is a compact linear operator, then $0 \in \sigma(T)$.

[2] [CO5][BTL2]

(d) For a compact linear operator $T : V \rightarrow V$ on a normed space V , the null space of $T - \lambda I$, for every $\lambda \neq 0$, is finite dimensional.

[2] [CO3][BTL2]

(e) For a bijective continuous linear operator $T : V \rightarrow W$ (V, W being Banach spaces), T need not be an isomorphism.

[2] [CO4][BTL2]

(2) (a) Prove that if the dual space V' of a normed space V is separable, then V itself is separable.

[5] [CO2][BTL3]

(b) Let $\mathcal{H}$ be a Hilbert space where $u, v \in \mathcal{H}$ are linearly independent, and $P : \mathcal{H} \rightarrow \mathcal{H}$ is defined 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][BTL3]

- (3) (a) Let V and W be normed linear spaces such that V is complete. Let $\{T_n\}$ be a sequence of bounded linear operators from V to W such that $\{\|T_n v\|\}$ is bounded for every $v \in V$. Prove that the sequence $\{\|T_n\|\}$ is bounded. [5] [CO3][BTL4]

- (b) Let V and W be Banach spaces and let $T : V \rightarrow W$ be a bounded linear operator. If T is bijective, then the inverse map $T^{-1} : W \rightarrow V$ exists and is bounded. [5][CO4][BTL3]

- (4) (a) State and prove the closed graph theorem. [5] [CO4][BTL3]

- (b) Show that a sequence $\{\phi_k\}_{k=1}^{\infty}$ 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 $\{\|\phi_k\|\}_{k=1}^{\infty}$ is bounded, (ii) the sequence $\{\phi_k(v)\}_{k=1}^{\infty}$ is Cauchy for every v in a total subset W of V . [5] [CO3][BTL5]

- (5) (a) Let V and W be two Banach spaces and $\{T_k\}_{k \geq 1}$ be a sequence of bounded linear operators between V and W , and $\mathcal{D}$ a dense subset of V . Suppose that (i) there exists $T(v) = \lim_{k \rightarrow \infty} T_k(v)$ for all $v \in \mathcal{D}$, and (ii) $\{T_k(v)\}_{k \geq 1}$ is bounded for all $v \in V$. Then $T : \mathcal{D} \rightarrow W$ defined by $T(v) = \lim_{k \rightarrow \infty} T_k(v)$ extends to a bounded linear operator $T : V \rightarrow W$ such that

$$\|T\| \leq \liminf_{k \rightarrow \infty} \|T_k\|.$$

- (b) Let $S : \ell^2(\mathbb{N}) \rightarrow \ell^2(\mathbb{N})$ be the left shift $S(x_1, x_2, x_3, \dots) = (x_2, x_3, \dots)$, and let S^* be the adjoint right shift $S^*(x_1, x_2, \dots) = (0, x_1, x_2, \dots)$. Determine $\sigma_p(S)$, $\sigma_p(S^*)$, $\sigma_r(S^*)$, $\sigma_c(S)$, and $\sigma_c(S^*)$. (Here σ_p , σ_c , and σ_r denote the point, continuous, and residual spectra.) [5][CO3][BTL4]

- (6) (a) Let the operator $T : \ell^2 \rightarrow \ell^2$ be defined by

$$T(x_1, x_2, \dots, x_k, \dots) = (0, x_1, x_2, \dots, x_k, \dots).$$

Show that T is linear and bounded. Find the adjoint operator T^* . [5] [CO4][BTL4]

- (b) Let V be a normed space and $T : V \rightarrow V$ a compact linear operator. Prove that $\lambda = 0$ is the only possible point of accumulation of E . [5] [CO5][BTL4]

-END-

- (b) Calculate the expected variances for each
 (c) Find the expected project completed time
 (d) Calculate the probability that the project will be completed at least 3 weeks than expected

[CO2,CO4][BTL1,3]

End Term Examination
 II Semester (M.Sc.), Nov-Dec 2025
 Operations Research (MSMA-203)

Max Marks: 50

Time: 3 Hours

Note: Attempt any 5 Questions. All questions carry equal marks.

Q 1. Consider the following LPP:

$$\begin{aligned} \min \quad & 4x_1 + 4x_2 \\ \text{s.t.} \quad & 2x_1 + x_2 \geq 6 \\ & x_1 + x_2 \geq 2 \\ & x_1 + 2x_2 \geq 0 \\ & x_1, x_2 \geq 0. \end{aligned}$$

- (a) Give the dual of the given LPP.
 (b) Give optimal solution for Dual as well as Primal problems.

[CO1][BTL2,4,5]

Q 2. (a) Solve using Gomory cutting-plane method
 Minimize $f = -3x_1 + 4x_2$
 subject to

$$\begin{aligned} 3x_1 - x_2 + x_3 &= 12, \\ 3x_1 + 11x_2 + x_4 &= 66, \\ x_i &\geq 0, \quad i = 1, 2, 3, 4, \\ x_2 &\in \mathbb{Z}. \end{aligned}$$

- (b) Consider the Assignment problem AP(C) where rows are the supply and columns are demand and find its optimal solution with the restriction that S_3 cannot assign to D_5 .

$$C = \begin{bmatrix} 14 & 4 & 10 & 16 & 8 & 2 \\ 21 & 6 & 15 & 24 & 12 & 3 \\ 35 & 10 & 25 & 40 & 20 & 5 \\ 56 & 16 & 40 & 64 & 32 & 8 \\ 42 & 12 & 30 & 48 & 24 & 6 \\ 28 & 8 & 20 & 32 & 16 & 4 \end{bmatrix}$$

[CO1,CO2][BTL2,4,5]

Q 3. In a maintenance shop, the inter-arrival times at tool crib are exponential with an average time of 10 minutes. The length of the service (i.e. the amount of time taken by the tool crib operator to meet the needs of the maintenance man) time is assumed to be exponentially distributed with a mean 6 minutes. Find

- (a) The probability that a person arriving at the booth will have to wait.
- (b) The average length of the queue that forms and the average time that an operator spends in the queuing system.
- (c) The probability that an arrival will have to wait for more than 12 minutes for service and to obtain his tools.
- (d) The estimate of the fraction of the day that the tool crib operator will be idle.
- (e) The probability that there will be six or more operators waiting for the service.
- (f) The manager of the shop will install a second booth when an arrival would expect to wait 10 minutes or more for the service. By how much must the rate of arrival be increased in order to justify a second booth?

[CO4,CO5][BTL3,5,6]

- Q 4. (a) In a maintenance shop mechanics has to perform jobs A, B, C and D on 5 machines P, Q, R, S, and T in the order PQRST. The time required to assemble in hours is given in the matrix below. Find the optimal sequence.

Jobs ↓/Machine →	P	Q	R	S	T
A	7	5	2	3	9
B	6	6	4	5	10
C	5	4	5	6	8
D	8	3	3	2	6

- (b) Use graphical method to minimize the time needed to process the following jobs on the machines as shown. For each machine find which job is to be loaded first. Calculate the total time required to process the jobs. The time given is in hours. Find the sequence of job 1 and 2 on four machines for the given technological order.

Job 1	Order of machining	A	B	C	D
	Time (hours)	2	3	3	4
Job 2	Order of machining	A	B	C	D
	Time (hours)	2	3	3	4

[CO2,CO3][BTL1,2,3,4,6]

- Q 5. (a) Use the graphical method to solve the following game problem, where Row represents the strategies for the player A and Column represents the strategies for player B.

$$\begin{bmatrix} 2 & 4 & 11 \\ 7 & 4 & 2 \end{bmatrix}$$

The aim of the player A is to select a set of strategies to maximize his minimum expected gain. While the player B is to select a set of strategies to minimize his maximum expected loss.

- (b) Two firms are competing for business under the conditions so that one firm's gain is another firm's loss. Find A's pay off matrix is given below:

Firm B

Firm A	No adverting	Medium advertising	Heavy advertising
No adverting	10	5	-2
Medium advertising	13	12	15
Heavy Advertising	16	14	10

Suggest optimal strategies for the two firms & the net outcome there off.

[CO1,CO2][BTL2,4,6]

- Q 6. A small project is composed of 7 activities whose time estimates are listed below. Activities are being identified by their beginning (i) and ending (j) node numbers.

Activity		Time (weeks)		
i	j	t_o	t_L	t_P
1	2	1	1	7
1	3	1	4	7
1	4	2	2	8
2	5	1	1	1
3	5	2	5	14
4	6	2	5	8
5	6	3	6	15

- (a) Draw the network

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Roll No.....

3rd SEMESTER

M.Sc. (Math)

END SEMESTER EXAMINATION

(Nov-Dec 2025)

MSMA 211: Number Theory

Time: 3:00 Hours

Max. Marks: 50

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

Q1. a) If $d \mid n$, then show that $(2^d - 1) \mid (2^n - 1)$. [5] [CO1][BTL2]

b) What is the remainder when following sum is divided by 4?

$$1^5 + 2^5 + 3^5 + \dots + 100^5 + 101^5. \quad [5] [CO2][BTL6]$$

Q2. a) Working modulo 9 or 11, find the missing digits in the calculation given as: $2784x = x.5569$ [5] [CO2][BTL3]

b) If f is a multiplicative function and F is defined by $F(n) = \sum_{d \mid n} f(d)$ then show that F is also multiplicative. [5][CO3][BTL3]

OR

For each positive integer $n \geq 1$, show that $n = \sum_{d \mid n} \phi(d)$

[5][CO3][BTL3]

Q3. a) Find the form of all positive integers n satisfying $\tau(n) = 12$. What is the smallest positive integer for which this is true? [5][CO3][BTL2]

b) Using a table of indices for a primitive root of 17, solve the

congruence: $9x^3 \equiv 8 \pmod{17}$.

[5][CO4][BTL3]

[Hint: 3 is a primitive root.]

Q4. a) If the integer a has order $k \bmod n$ and $h > 0$, then show that a^h has order $\frac{k}{\gcd(h, k)} \bmod n$. [5][CO4][BTL5]

b) Use the fact that each prime p has a primitive root to give a different proof of Wilson's Theorem. [5][CO4][BTL2]

Q5. a) State and prove Euler's criterion for quadratic residue of an odd prime p . [5][CO5][BTL3]

b) Use Gauss lemma to find the Legendre symbol $\left(\frac{11}{31}\right)$. [5][CO5][BTL2]

OR

Determine whether the following quadratic congruence is solvable or not: $2x^2 + 5x - 9 \equiv 0 \pmod{101}$.

[5][CO5][BTL4]

- END -

Total No. of Pages: 03

Roll no.

3rd SEMESTER

M.Sc.

END TERM EXAMINATION Now/Dec-2025

COURSE CODE: MSMA 213

COURSE TITLE: Mathematical Modeling and Simulation

Time: 3 Hours

Max. Marks: 40

Note: All questions are compulsory.

All questions carry equal marks.

Assume suitable missing data, if any.

Q. 1 With the disease malaria, in humans, the disease is carried by mosquitoes who also cannot infect each other. Infectious mosquitoes can only infect susceptible humans and infected humans can only infect susceptible mosquitoes when they are bitten by a susceptible mosquito. Assume the rate of transmission is proportional to both numbers of mosquitoes and number of humans for transmission in both directions and assume once infected, both humans and mosquitoes never recover.

Ignoring any births and deaths develop a mathematical model for susceptible and infected humans $S_h(t), I_h(t)$ and susceptible and infected mosquitoes $S_m(t), I_m(t)$. Also, describe the qualitative behaviour of the developed model.

[CO 1, 2, 3]

Q. 2 Develop a discrete model for the breeding of the rabbits, starting from one pair of the rabbit. Every month, each pair of rabbits produces one pair of offspring. After one month, the offspring is adult, and will start reproduction. Describe the long term behaviour

In detail of the rabbit population by neglecting all kind of effects. Also, find out the population of rabbits and juveniles after 7 months.

[CO 1, 2, 3]

Q. 3 Consider the system

$$\dot{x} = x[x(1-x) - y], \quad \dot{y} = y(x - a).$$

Where $x \geq 0$ is a dimensionless population of the prey, $y \geq 0$ is a dimensionless population of the predator, and $a \geq 0$ is a control parameter.

- Sketch the nullclines in the first quadrant $x, y \geq 0$.
- Show that the fixed points are $(0, 0)$, $(1, 0)$ and $(a, a - a^2)$ and classify them.
- Sketch the phase portrait for $a > 1$, and show that the predators go extinct.
- Show that a Hopf bifurcation occurs at $a_c = \frac{1}{2}$. Is it subcritical or supercritical?

[CO 3, 4, 5]

Q. 4 Consider the characteristic equation

$$s^3 + (k+3)s^2 + (2k+1)s + 5 = 0$$

Using the Routh-Hurwitz criterion, find the range of values of k for which the system is stable.

[CO 3, 4, 5]

Q. 5 Consider the following non-linear model:

$$\dot{x}_1 = -x_1 + x_2^3$$

$$\dot{x}_2 = -x_2$$

Show that the origin is asymptotically stable by proposing a suitable Lyapunov function and verifying all the conditions. [CO 4, 5]

Q. 6 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 4, 5]

Q. 7

- Define Chaos. Also, explain how Chaos is different than instability.
- Solve the linear system $\dot{z} = Az$, where $A = \begin{bmatrix} a & 0 \\ 0 & -1 \end{bmatrix}$. Graph the phase portrait as a varies from $-\infty$ to $+\infty$, showing the qualitatively different case.

[CO 3, 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]

MSMA-221 Integral Transforms and Equations

Time: 3Hrs.

Max. Marks: 50

Note: Answer any five questions. Assume suitable data if any.
Only non-programmable scientific calculator is allowed.

Q.1 (a) Find the eigen values and eigen functions of the homogeneous integral $u(x) = \lambda \int_0^1 \sin \pi x \cos \pi t u(t) dt$.

[5M] [CO3, L5]

(b) Evaluate the following using Laplace/Inverse Laplace transform.

(i) $\int_0^\infty e^{-t} \frac{\sin^2 t}{t} dt$ (ii) $\frac{s}{(s^2+a^2)^2}$

[5M][CO1, L2,3]

Q.2 (a) Using Hilbert -Schmidt theorem to solve the symmetric integral equation

$$u(x) = x^2 + 1 + \frac{3}{2} \int_{-1}^1 (xt + x^2 t^2) u(t) dt, \quad [5M] [CO4, L3]$$

(b) Convert the boundary value problem

$$y'' + 2y = 4, \quad y(0) = 0, \quad y'(1) = 1,$$

into Fredholm integral equation. Also recover the boundary value problem from the integral equation you obtain.

[5M][CO2, L4]

Q.3 (a) Reduce Volterra integral equation

$$u(x) = \sin x - \frac{1}{2} \int_0^x (x-t)^2 u(t) dt,$$

equivalent to initial value problem.

[5M] [CO2, L4]

(b) Find the resolvent kernel of the following Volterra integral equation and hence find the solution using Laplace transform.

$$u(x) = f(x) + \int_0^x (x-t) u(t) dt,$$

[5M] [CO5, L6]

(P.T.O.)

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Q.4 (a) Use direct decomposition method to solve the integral equation

$$u(x) = \cos x + \lambda \int_0^{\pi} \sin(x-t) u(t) dt. \quad [5M] [CO3, L3]$$

(b) Construct Green's function for the boundary value problem

$$y''(x) + y(x) = 0, \quad y(0) = 0, y\left(\frac{\pi}{2}\right) = 0. \quad [5M] [CO4, L4]$$

Q.5 (a) Solve the following integral equation using adomain decomposition method.

$$u(x) = e^x - x + x \int_0^1 t u(t) dt. \quad [5M] [CO4, L3,4]$$

(b) Solve the following integral equation by finding resolvent Kernel

$$u(x) = \frac{3}{2}e^x - \frac{3}{2}xe^x - \frac{1}{2} + \frac{1}{2} \int_0^1 t u(t) dt \quad [5M] [CO3, L3,4]$$

Q.6 (a) Using resolvent kernel, find the solution of Volterra integral equation

$$u(x) = 1 + x^2 + \int_0^x \frac{1+x^2}{1+t^2} u(t) dt \quad [5M] [CO5, L3,5]$$

(b) Solve the following Volterra integral equation using Laplace transform.

$$u(x) = e^{-x} + \int_0^x e^{-(x-t)} \sin(x-t) dt. \quad [5M] [CO5, L3,5]$$

III SEMESTER

B.Sc. (Mathematical)

END TERM EXAMINATION

Dec-2025

MSMA219 DATABASE MANAGEMENT SYSTEM

Time: 3:00 Hours

Max. Marks: 40

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

Q.1 Define entity set in an ER diagram. Explain the differences between strong entities and weak entities. Illustrate with the help of an ER diagram. [5][CO2][BTL4]

Q.2 Using the given relational schemas: [2+3][CO2][BTL3]
Student (Sid, Sname, Dept, CGPA)
Enroll (Sid, Cid, Grade)
Course (Cid, Cname, Credits)

Write a relational algebra and SQL query for the following:

- Retrieve the names of the students taking a 4-credit course.
- Retrieve the student names and course names where the student secured grade 'A'.

Q.3 Explain the inference rules for functional dependencies. Provide examples for each rule. [5][CO3][BTL2]

Q.4 Consider the relation $R(W, X, Y, Z, L, M, N, O)$, with all the attributes containing atomic values and set of functional dependencies, $F = \{W \rightarrow XY, X \rightarrow Z, Z \rightarrow LM, M \rightarrow N, N \rightarrow O, O \rightarrow W\}$.

[2+3][CO3][BTL3]

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- a) Determine any four candidate keys of R
- b) Examine and justify the highest normal form of R .

OR

For the relational schema $R(A, B, C, D, E)$, step-wise determine the canonical cover for the given set of functional dependencies:

FD: $\{A \rightarrow BC, C \rightarrow D, BD \rightarrow E, A \rightarrow D\}$. [5][CO3][BTL3]

- Q.6 Insert the keys 5, 28, 19, 15, 20, 33, 12, 17, 10, 55 into a hash table of size 12 using division method hash function and also analyze the number of collisions. [5][CO4][BTL4]

- Q.7 Write a short note on file organization techniques.

[5][CO4][BTL1]

- Q.8 Discuss and illustrate the significance of each state of a transaction in relational database with the help of a diagram. [5][CO1][BTL2]

- Q.9 Define conflict serializable schedule. Evaluate and explain whether the given schedules are conflict serializable or not:

[5][CO5][BTL4]

- i. $S1 = T1: R(A), W(B), R(C), W(D),$
 $T2: W(A), R(C), W(E),$
 $T3: R(B), W(C), R(D),$
 $T4: R(A), W(D), R(E)$

- ii. $S2 = T1: W(X), R(Y), W(Z),$
 $T2: R(X), W(Y), R(Z),$
 $T3: W(Y), R(Z), W(X),$
 $T4: R(X), R(Y), W(Z)$

OR

What are shared and exclusive locks? For the following sequence, determine whether it follows 2PL, strict 2PL, or neither:

[5][CO5][BTL3]

- i. $T1: Lock_S(A), R(A), Unlock(A), Lock_X(B), W(B), Unlock(B)$
 $T2: Lock_X(A), W(A), Unlock(A)$
- ii. $T1: Lock_S(A), R(A), Lock_X(B), W(B), Unlock(B), R(A),$
 $Unlock(A)$
 $T2: Lock_X(B), W(B), Unlock(B)$
 $T3: R(A), Lock_S(B), R(B), Unlock(B)$

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Total no. of Pages: 1

Roll no.....

I SEMESTER

M.Sc. Biotechnology

END TERM EXAMINATION

Nov-2025

COURSE CODE: MSBT 101

COURSE TITLE: Biochemistry

Time: 03:00 Hours

Max. Marks: 40

Note : Assume suitable missing data, if any.

Q.1 State the following:

[2*5=10][CO1, 3,4,5][BTL#1,2]

- Fluid Mosaic Model
- Chemiosmotic theory
- Structural and storage homopolysaccharides
- Central Dogma
- Technique to characterize protein

Q.2 Discuss the structural properties of DNA and functions of nucleotides with relevant examples.

[3][CO4][BTL#1-6]

Q.3 Explain Gibbs free energy.

[3][CO5][BTL#1-4]

Q.4. Summarize the different levels of protein structure. [4][CO1][BTL#1-3]

Q.5 Attempt any four

[5*4=20][CO2,3,4,5][BTL#1-5]

- Illustrate Glycolysis and the enzymes involved.
- Demonstrate Kreb's cycle.
- Distinguish between passive diffusion, facilitated diffusion, and active transport.
- Compare the three major classes of glycoconjugates: proteoglycans, glycoproteins, and glycolipids.
- Classify and discuss structural Lipids.
- Discuss enzyme inhibition.

1. Describe the co-translational translocation and post-translational translocation ER mechanism with suitable figure?
[5 Marks] [CO4] [BTL1]
2. Explain the concept of maternal gene effects in *Drosophila* and compare the expression patterns of these maternal genes in the anterior and posterior part of early embryo?
[5 Marks] [CO4] [BTL2]
3. Differentiate between the principles of image formation in phase-contrast microscopy and fluorescence microscopy?
[5 Marks] [CO1] [BTL2]

OR

Illustrate the developmental hierarchy of hematopoiesis, starting from a hematopoietic stem cell to a mature neutrophil?
[5 Marks] [CO1] [BTL2]

4. Prof. Burton is working with embryonic stem cells and is facing challenges in growing them to form organs at a laboratory level. She sought advice from Prof. Yamanaka, asking which factors she could use to promote stem cell growth (induced pluripotent stem cells (iPSCs) *in-vitro*, please describe these factors?
[5 Marks] [CO5] [BTL4]
5. Briefly Describe the Peroxisomal protein translocation with suitable diagram?
[5 Marks] [CO3] [BTL2]

Total No. of Pages:2

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Roll No.....

First Semester
M.Sc. Biotechnology

END SEMESTER EXAMINATION, NOVEMBER 2025

MSBT103-Cell and Development Biology

Time: 3.00-Hours

Max. Marks: 50

1. Describe the co-translational translocation and post-translational translocation ER mechanism with suitable figure?
[5 Marks] [CO4] [BTL1]

2. Explain the concept of maternal gene effects in *Drosophila* and compare the expression patterns of these maternal genes in the anterior and posterior part of early embryo?
[5 Marks] [CO4] [BTL2]

3. Differentiate between the principles of image formation in phase-contrast microscopy and fluorescence microscopy?
[5 Marks] [CO1] [BTL2]

OR

Illustrate the developmental hierarchy of hematopoiesis, starting from a hematopoietic stem cell to a mature neutrophil?
[5 Marks] [CO1] [BTL2]

4. Prof. Burton is working with embryonic stem cells and is facing challenges in growing them to form organs at a laboratory level. She sought advice from Prof. Yamanaka, asking which factors she could use to promote stem cell growth (induced pluripotent stem cells (iPSCs) *in-vitro*, please describe these factors?
[5 Marks] [CO5] [BTL4]

5. Briefly Describe the Peroxisomal protein translocation with suitable diagram?
[5 Marks] [CO3] [BTL2]

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6. Diagnose a hypothetical scenario where a patient has a mutation in a proto-oncogene and predict its potential consequence on cell differentiation and proliferation?

[5 Marks] [CO5] [BTL4]

OR

Briefly, describe the mechanism of ATPase synthetase enzyme in ATP synthesis with diagram. In your answer, explain the stepwise transport process, the role of ATP, the number of ions exchanged?

[5 Marks] [CO2] [BTL4]

7. What is the Phase switching? Describe the molecular mechanism that controls the reversible switching between the expression of the *fljB* and *fliC* genes in *Salmonella*.

[5 Marks] [CO5] [BTL3]

OR

Differentiate between tight junctions, desmosomes, and gap junctions in animal tissues. Provide an example of a location and function for each.

[5 Marks] [CO2] [BTL3]

8. Describe the formation organization and role of Microtubules in cell organelles movement?

[5 Marks] [CO3] [BTL2]

9. Describe the key steps involved in the import of a nuclear-encoded protein into the mitochondria?

[5 Marks] [CO2] [BTL1]

10. Design an experiment using a specific type of microscopy to track the movement of a newly synthesized protein from the endoplasmic reticulum to the plasma membrane. Justify your choice of microscope?

[5 Marks] [CO1] [BTL5]

Total No. of Pages: 3

Roll No.

M.Sc. BT

FIRST SEMESTER

END TERM EXAMINATION

November-2025

MSBT 105 Molecular Biology

Time: 03:00 Hours

Max. Marks: 40

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

- Q.1 [A] Attempt any TWO of the following [4 marks] [CO1] [BTL2,3,4]
- (a) Compare and contrast the following (2 points for each)
 - (i) Thymidine and Guanosine – structure, type of glycoside
 - (ii) Nucleosome and Chromosome – structure, proteins involved in condensation
 - (b) Demonstrate how is $cot_{1/2}$ used to find repetitive DNA and unique sequence DNA in eukaryotes. What is zero-time binding protein?
 - (c) Analyze DNA intercalating agents and base analogs for their roles in inducing mutations. Give one example of each
- [B] Explain how snRNPs coordinate the removal of introns from nuclear pre-mRNA. Also comment on the accuracy of splicing [4 marks] [CO3] [BTL1,2]

- Q.2 [A] Attempt any TWO of the following [4 marks] [CO2] [BTL1,2,5]
- (a) How does cell ensure accuracy of DNA replication in prokaryotes? Explain any five points
 - (b) Highlight the significance of ATP and iterative sequences located in *oriC* in prokaryotic replication initiation
 - (c) Enumerate roles of DNA glycosylase, Ku70/80, RecA, and MutH proteins in DNA damage repair processes
- [B] Compare any TWO of the following [4 marks] [CO2] [BTL1,2]
- (i) RecD and RecB – enzymatic activities, roles pre-*chi* and post-*chi*
 - (ii) Long-patch and Short-patch base excision repair – number of nts replaced/synthesized, enzymes involved in DNA synthesis
 - (iii) DNA polymerase III and TLS polymerase – their expression, action
- P.T.O.

Q.3 [A] Attempt any TWO of the following

[4 marks] [CO3] [BTL1,2,5]

- (a) Evaluate the structure of CTD tail of RNA polymerase II for its role in transcription and post-transcriptional processing in eukaryotes
- (b) Termination step in eukaryotic transcription is coupled with cleavage and polyadenylation. Elucidate giving details of termination signal, enzymes/proteins and reactions involved
- (c) Analyze the effect of inducer formed in a side reaction catalyzed by β -galactosidase on *lac* operon. What effect does the physiological inducer exert on the structure and function of Lac R?
- (d) Discuss in detail how coupled transcription-translation in bacteria allows attenuation to function in the *trp* operon. How does the availability of charged tRNA^{trp} influence the formation of secondary structures in the leader mRNA?
- [B] Give a detailed account of any two classes of regulatory proteins involved in the initiation phase of eukaryotic transcription. Clearly mention the reason for their requirement and roles in the initiation phase [4 marks] [CO3] [BTL2,4]

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Q.4 [A] Attempt any TWO of the following

[4 marks] [CO4] [BTL1,2,5]

- (a) Post-transcriptional substitution of a single base in mRNA may lead to generation of diverse proteins. Evaluate the statement giving one suitable example
- (b) Enumerate various proteins involved in tRNA intron splicing. Specify roles of each protein / protein subunit
- (c) Discuss the roles of snoRNAs in eukaryotic pre-rRNA post-transcriptional processing
- [B] Discuss the function of editosome complex involved in insertional editing of *Trypanosoma* mitochondrial *cox II* pre-mRNA. Also compare the steps and enzymes involved in insertional RNA editing with deletional RNA editing [4 marks] [CO4] [BTL1,2,5]

Q.5 [A] Attempt any TWO of the following

[4 marks] [CO5] [BTL1,2,5]

- (a) Analyze the statement 'A point mutation changes the third base of a codon but does not alter the amino acid'. Also explain how does wobble base pairing reduce the number of tRNAs required in a cell?
- (b) Explain the roles of SD sequence and eIF4G in the process of translation

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(c) Describe the conserved residues involved in intein splicing. What is the significance of cyclization step in intein splicing?

(d) Give a descriptive account of action of two soluble protein factors involved in prokaryotic translation that exist in two conformations and one of its conformation mimics tRNA

[B] During prokaryotic translation, all three types of RNAs participate in peptide bond formation. Explain the statement giving details of reaction catalyzed and roles of each type of RNA [4 marks] [CO5] [BTL1,2]

* END *

Total no. of Pages: 02

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Roll no.

I SEMESTER

M.Sc Biotechnology

END TERM EXAMINATION

Nov-2025

COURSE CODE: MSBT107

COURSE TITLE: Analytical Techniques

Time: 03:00 Hours

Max. Marks: 40

Note : All questions carry equal marks.

Assume suitable missing data, if any.

Q.1 Attempt any 8 of the following. [$8 \times 1 = 8$; CO1-CO5, L1-L2]

- i. Which spectroscopy method provides information on secondary structure using differential absorption of left- and right-circularly polarized light?
- ii. Name the membrane technique commonly used for concentrating protein samples based on molecular-weight cut-off.
- iii. Which chromatography technique separates molecules based on charge?
 - (a) Gel filtration
 - (b) Ion exchange
 - (c) Hydrophobic interaction
 - (d) Affinity chromatography
- iv. RCF depends on the rotational speed and _____ of the rotor.
- v. SDS-PAGE is primarily used to separate proteins based on _____.
- vi. Cerenkov radiation is emitted when charged particles travel _____ in a medium.
- vii. Match the following:
 - A. MALDI-TOF — i) Soft ionization technique
 - B. API-Electrospray — ii) Peptide mass fingerprinting
- viii. Name any radioactive isotope used in metabolic studies.
- ix. In 2D electrophoresis, the first dimension separates proteins by _____.

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- Q.2 a.** Explain the principle of UV-Visible spectroscopy. Describe the components of a UV-Vis spectrophotometer and discuss any two applications in biochemical analysis. [4 marks, CO1, L2]
- b.** Describe the principle and functioning of HPLC. Mention any three applications of HPLC. [4 marks, CO2, L3]
- Q.3 a.** Describe the principle, functioning, and applications of differential centrifugation. [4 marks, CO3, L2]
- b.** Explain the structural design and operational functioning of an ultracentrifuge. [4 marks, CO3, L2]
- Q.4 a.** Explain the principle, design, and working of a liquid scintillation counter. Add two applications in biochemical research. [4 marks, CO4, L3]
- b.** Explain the concept of radioimmunoassay (RIA). Discuss its principle and applications in clinical diagnosis. [4 marks, CO4, L3]
- Q.5 a.** Explain the hanging drop method of protein crystallization. Compare it with the vapour-diffusion method. [4 marks, CO5, L3]
- b.** Explain the principle and working of MALDI-TOF mass spectrometry. Mention two biochemical applications. [4 marks, CO5, L3]

END TERM EXAMINATION

Nov-2025

COURSE CODE: MSBT 109

COURSE TITLE: Biostatistics and Computer Applications

Time: 03:00 Hours

Max. Marks: 50

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

- Q.1 Attempt any 10 of the following. [10 × 1 = 10; CO1-CO5, L1-L2]
- i. The P-value represents the probability of observing a test statistic at least as extreme as the one observed, assuming the _____ hypothesis is true.
 - ii. Which spectroscopic method is used to determine protein structures in solution?
 - iii. Write the expression for z-transformation.
 - iv. Which of the following is an organism-specific database?
(a) GenBank (b) Swiss-Prot (c) TAIR (d) PDB
 - v. Name a tool used for multiple sequence alignment.
 - vi. PDB files primarily store information about the _____ of macromolecules.
 - vii. Which programming language is known for strong text-processing capability and is widely used in bioinformatics?
 - viii. PCA reduces _____ in high-dimensional microarray datasets.
 - ix. Homology modelling relies on:
(a) protein-protein docking
(b) sequence similarity to a known structure
(c) Monte Carlo sampling
(d) none
 - x. Match the following:
A. EMBL — i) Protein sequences
B. Swiss-Prot — ii) European nucleotide database
 - xi. What is threading?

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- Q.2 a. In a flowering plant, flower colour shows incomplete dominance. Given RR = red, Rr = pink, rr = white, a cross Rr × Rr yields 160 offspring: Red 48, Pink 92, White 20. Test whether these data fit the Mendelian 1:2:1 ratio using chi-square test at 5% significance.

Chi-square Table for reference:

d.f.	$\chi^2_{.999}$	$\chi^2_{.995}$	$\chi^2_{.95}$	$\chi^2_{.90}$	$\chi^2_{.85}$	$\chi^2_{.80}$	$\chi^2_{.75}$	$\chi^2_{.70}$
1	.0000393	.000982	.00393	2.706	3.841	5.024	6.635	7.879
2	.0100	.0506	.103	4.605	5.991	7.378	9.210	10.597
3	.0717	.216	.352	6.251	7.815	9.348	11.345	12.838
4	.207	.484	.711	7.779	9.488	11.143	13.277	14.860
5	.412	.831	1.145	9.236	11.070	12.832	15.086	16.750

[5 marks, CO1, L3]

- b. Write a C program to add two numbers.

[5 marks, CO2, L2]

- Q.3 a. What is cluster analysis? What are the characteristics of a good cluster analysis? Discuss any two methods to calculate inter-point distances.

[5 marks, CO3, L3]

- b. Explain the concept of multiple sequence alignment (MSA). Elaborate the steps of performing MSA using a bioinformatics tool.

[5 marks, CO3, L3]

- Q.4 a. What are the goals of a microarray experiment? Discuss the importance of normalization.

[5 marks, CO4, L2]

- b. Describe the principle of X-ray crystallography. Compare and contrast structure determination by X-ray crystallography and NMR.

[5 marks, CO4, L3]

- Q.5 a. What is protein modelling? Describe how SWISS-MODEL is used to model protein structure via homology modelling.

[5 marks, CO5, L3]

- b. Differentiate between Homology Modelling and Threading.

[3 marks, CO5, L2]

- c. Write a brief note on molecular dynamics simulations and their importance in biophysics.

[2 marks, CO5, L2]

Total No. of Pages 02

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Roll No.

THIRD SEMESTER

M.Sc. [MSBT]

END SEMESTER EXAMINATION

NOV-2025

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) Define the term Del 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] [L1,3]

(b) Explain Monod Kinetics. Illustrate how the rate at which the C source is metabolized can influence the formation of biomass and production of primary or secondary metabolites. [1+3=4] [CO1] [L2]

Q.2 (a) Discuss any 2 bioprocess parameters involved in measurement and control of a bioreactor. [4] [CO2] [L4]

(b) Classify bioreactors on the basis of their mode of operation. [4] [CO2] [L2]

Q.3 (a) Explain the working of rotary vacuum filter press. List the factors which affects the rate of filtration. [3+1=4] [CO3] [L5]

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

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kg/m³. The fluid may be assumed to have properties of water. Find the sigma factor for the centrifuge. [4] [CO3] [L3]

(b) Illustrate the mechanism of drying in freeze dryer. How do you separate particles based on Ion exchange Chromatography.

[2+2=4] [CO3] [L2,1]

Q.4 (a) Discuss the role of microbes in food process industry.

[4] [CO4] [L6]

(b) Elaborate the production and purification steps involved in microbial enzyme synthesis.

[4] [CO4] [L6]

Q.5 (a) Derive an equation for Michaelis Menten kinetics. How K_m and V_{max} changes in Uncompetitive Inhibition [3+1=4] [CO5] [L3]

OR

Discuss the application of enzymes used in starch and sugar conversion processes. Write an equation for Ping-Pong bi-bi substrate reaction.

[3+1=4] [CO4+CO5] [L2]

(b) An enzyme has a K_m of 4.7×10^{-5} M. If the V_{max} of the preparation is $22 \mu\text{moles} \times \text{liter}^{-1} \times \text{min}^{-1}$, what velocity would be observed in the presence of 2×10^{-4} M substrate and 5×10^{-4} M of (a) a competitive inhibitor, (b) a noncompetitive inhibitor, (c) an uncompetitive inhibitor. K_i in all three cases is 3×10^{-4} M. Calculate degree of inhibition in all the 3 cases.

[4] [CO5] [L3]

Total no. of Pages: 2

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3rd SEMESTER

M.Sc Biotechnology

END TERM EXAMINATION

Nov-2025

COURSE CODE: MSBT203

COURSE TITLE: Immunotechnology and Molecular Virology

Time: 03:00 Hours

Max. Marks: 50

Note: Assume suitable missing data, if any.

Q1- 1-MARK QUESTIONS (Answer ALL) — $2 \times 1 = 2$ marks

1. Name any one commonly used fluorescent dye in microarray experiments. [1 mark; CO5; BTL-1]
2. What is a probe in a microarray? [1 mark; CO5; BTL-1]

Q2- 2-MARK QUESTIONS (Answer ALL) — $4 \times 2 = 8$ marks

3. Name any two fluorescent dyes used in immunofluorescence. [2 marks; CO2; BTL-1]
4. What is a virus infectivity assay? Give one example. [2 marks; CO2; BTL-2]
5. What does TEM stand for? What is it used for in virology? [2 marks; CO5; BTL-1]
6. Name any two serological methods used for viral detection. [2 marks; CO5; BTL-1]

Q3- 3-MARK QUESTIONS (Answer ALL) — $3 \times 3 = 9$ marks

7. Analyse how isotype switching affects antigen-antibody interaction strength and immune protection. [3 marks; CO1; BTL-4]
8. What is meant by the "modular genome organization" of bacteriophages? [3 marks; CO4; BTL-2]

9. What is host-jumping in viruses? Give one example from plant or animal viruses. [3 marks; CO4; BTL-3]

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Q4- 4-MARK QUESTIONS (Answer ALL) — $4 \times 4 = 16$ marks

10. Discuss the principles of competitive and non-competitive ELISA. [4 marks; CO2; BTL-4]
11. Describe the replication strategy of retroviruses and highlight how it promotes genetic variation. [4 marks; CO4; BTL-3]
12. Describe the principle of density-gradient ultracentrifugation and its role in virus purification. [4 marks; CO5; BTL-3]
13. Write a short note on viral suppressors of gene silencing with one example. [4 marks; CO5; BTL-4]

Q5- 5-MARK QUESTIONS (Answer ALL) — $3 \times 5 = 15$ marks

14. Describe the steps involved in producing subunit vaccines and discuss their advantages over whole-pathogen vaccines. [5 marks; CO3; BTL-3]
15. Explain why bacteriophages exhibit extreme mosaicism in their genome architecture. Support your answer with mechanisms such as illegitimate recombination, homologous recombination, and modular exchange. [5 marks; CO4; BTL-5]
16. Describe the fundamental principles of PCR by explaining its essential components, cycling conditions, and major applications in biotechnology. [5 marks; CO5; BTL-3]

A. Define patent infringement and explain its different types? Provide one real-world example? (5 Marks) (CO4) (L3)

B. Explain the role of the Budapest Treaty in international patenting of microorganisms? (5 Marks) (CO3) (L2)

Question 5

A. Explain the role of the National Biodiversity Authority (NBA) in India for patent applications involving Indian biological resources? (5 Marks) (CO3) (L4)

B. If India wants to export Bt cotton seeds to Europe, what biosafety steps are required under the Cartagena Protocol? (5 Marks) (CO5) (L3)

Question 6

A. What are the different Biosafety Levels (BSL 1–4)? Discuss the types of microorganisms handled at each level and write one key safety precaution for each? (5 Marks) (CO5) (L2)

B. Describe the stepwise procedure for obtaining approval for a research project involving recombinant DNA (rDNA) technology in India? Include the roles of IBC, RCGM, and GEAC? (5 Marks) (CO5) (L4)

Total no. of Pages: 4

Roll no

Third SEMESTER

M.Sc. Biotechnology

END TERM EXAMINATION

November-2025

COURSE CODE – MSBT205 COURSE TITLE- IPR and BIOSAFETY

Time: 03:00 Hours

Max. Marks: 50

Note: Question 1 is compulsory. Attempt any four questions from question no. 2 to 6. Assume suitable missing data if required.

Question1

(1 × 10 = 10 Marks)

A. Under the Indian Patent Act, a new salt form of an old drug is patentable only if it shows enhanced therapeutic efficacy. Which statement applies?

- a) Automatically patentable
- b) Patent granted only if enhanced efficacy
- c) Never patentable
- d) Must file under PVP Act

(CO3) (L3)

B. India wants to ensure access to an essential medicine patented by a foreign company. Which TRIPS flexibility allows India to manufacture/import the drug without consent?

- a) Parallel import
- b) Compulsory licensing for public health
- c) Patent revocation after 10 years
- d) Exclusive licensing to government lab

(CO1) (L3)

C. A farmer wants to save seeds from a PVP-protected variety for personal cultivation but intends to sell some seeds. Which is legally allowed?

(CO1) (L3)

- a) Saving for personal use

- b) Selling commercially
- c) Exchanging with neighbors
- d) Both b & c

D. A biotech startup has a formula for a microbial enzyme that gives competitive advantage. How should it protect it legally?

- a) File provisional patent
- b) Treat as trade secret and maintain confidentiality
- c) Publish in journal
- d) Apply for GI tag ____

(CO1) (L3)

E. A company wants to patent a genetically modified crop essential for national food security, but patent owner is not supplying seeds reasonably. Which action is consistent with TRIPS flexibilities?

- a) Apply for compulsory license
- b) Wait 20 years for patent expiry
- c) Import seeds only
- d) Modify crop slightly and file new patent

(CO1) (L3)

F. A company produces a machine using a patented design without the patent holder's approval. Which type of patent infringement does this represent?

- a) Direct infringement
- b) Indirect infringement
- c) Contributory infringement
- d) Experimental use exemption

(CO4) (L2)

G. The Plant Variety Protection & Farmers' Rights Act allows breeders to claim rights over a new variety, but farmers are entitled to _____ seeds for personal cultivation?

(CO1) (L2)

H. Under the TRIPS Agreement, member countries must provide a minimum term of _____ years of patent protection for inventions?

(CO1) (L2)

I. Match the international agreement with its focus?

- 1. TRIPS
- 2. Paris Convention
- 3. Budapest Treaty

- a. Protection of industrial property across countries
- b. Minimum IP protection standards
- c. International deposit of microorganisms for patent purposes

(CO1) (L2)

J. TRIPS Agreement requires all member countries to allow patenting of plants and animals? (True/False)

(CO1) (L2)

Question 2

A. Explain the Paris Convention for the Protection of Industrial Property? How does it help inventors and businesses protect their patents, trademarks, and industrial designs in multiple member countries?

(5 Marks) (CO1) (L2)

B. Explain the role of WIPO in facilitating international intellectual property protection?

(5 Marks) (CO1) (L2)

Question 3

A. Explain the procedure for filing a Patent Cooperation Treaty (PCT) application from India? Include the steps involved, the role of the Indian Patent Office, timelines and requirements?

(5 Marks) (CO2) (L2)

B. Explain the stepwise procedure for filing a patent in India, including provisional and complete patent applications, forms, and typical timelines?

(5 Marks) (CO3) (L2)

Question 4

Total no. of pages. 3

Roll No.....

THIRD SEMESTER

M. Sc. (BIOTECHNOLOGY)

END SEMESTER EXAMINATION

NOV-2025

MSBT-217 NANOBIO TECHNOLOGY

Time: 3.00 Hours

Max. Marks: 50

Note: Answer all of the following questions

Assume suitable missing data, if any.

Q 1. All questions are Compulsory, answer briefly [(2×7) CO-2,4, 5]

- a. Write down two biomaterials each for the designing of scaffolds of muscles, neurons, bone and the cardiovascular system.
- b. Describe ROS-induced lipid peroxidation inside the cell.
- c. Discuss the role of Peptide Receptor Radionuclide Therapy (PRRT) in cancer treatment.
- d. Briefly explain the mechanism of Plasma-based synthesis of metallic nanostructures.
- e. Briefly explain the bio-reduction mechanism for the synthesis of silver nanoparticles.
- f. Define LD₅₀ and LC₅₀, and briefly explain the dose response curve.
- g. The LD₅₀ for 20 nm silver nanoparticles is estimated to be about 354 mg/kg.
 - I. Worldwide, the average weight of an adult is 137 lb. What is this weight in kg?
 - II. Calculate the lethal dose of 20 nm silver nanoparticles for an average adult, in mg.

Q 2. Attempt any three of the following questions [(4×3) CO-2, 4, 5]

- a. Describe the term “point-of-care” medical diagnostics; with three suitable examples, explain their applications.

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- b. Describe Microneedles? Schematically illustrate the fabrication process and briefly discuss its various medical applications.
- c. Demonstrate the inert gas condensation (IGC) method in the synthesis of metallic nanoparticles.
- d. Explain the principle of the biobarcode assay. What are its advantages and significance in the current scenario?
- e. Elaborate on the therapeutic application of carbon nanotubes; why only carbon nanotubes out of the tremendous nanocarriers.

Q 3. Attempt any one out of the following questions [(8) CO-3, 5]

- a. Define Biomaterials and, along with its 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.

OR

- b. What is tissue engineering, and how are tissue engineering methods currently being implemented in regenerative medicine? Discuss about strategies applied development of artificial skin?

OR

- c. Demonstrate how the physicochemical characteristics of nanoparticles influence the cellular reactions in a living system. Briefly explain the effect of nanoparticles on the antioxidant defence system

OR

- d. Discuss the application of nanomaterials in targeted drug delivery systems in cancer treatment. Briefly discuss the role of nanomaterials in clinical diagnostics and treatment of Cancer.

[(8) CO-4, 5]

Q 4. Answer any one

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

OR

- b. What are the different modes of detection in biosensors? What are electrochemical transducers, and explain their applications in different types of biosensors with suitable examples of target analytes.

Q 5. Answer any one

[(8) CO-2]

- e. Briefly describe the various techniques involved in liquid-based synthesis of nanomaterials. How can we get 0-D, 1-D, 2-D and 3-D nanostructures using nanosynthesis methods, and explain with suitable examples?

OR

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

-END-

P.T.O

END TERM EXAMINATION

Dec-2025

COURSE CODE MSBT241

COURSE TITLE: MOLECULAR THERAPEUTICS

Time: 03:00 Hours

Max. Marks: 50

Note: All questions are compulsory. Choice has been given in last question only. Assume suitable missing data, if any.

Q.1 Write short note on [4X5 = 20 marks][CO1,2,3][BTL1, 2]

- a. Cellular therapy
- b. Physical barriers of gene therapy
- c. Cloning and its ethical issue.
- d. Gene silencing: siRNA and Antisense therapy
- e. Draw well labelled diagram of Antibody.

Q.2 What is vaccine? Discuss in detail about various types of traditional and recombinant vaccines along with examples.

[2+4+4 = 10 marks][CO3,4][BTL3]

Q.3 Write note on [5X2 = 10 marks][CO2,5] [BTL4]

- a. Hybridoma technology and its application.
- b. Liposomes and nanoparticles as gene delivery vectors

Q.4 What is Gene therapy. Discuss in details about viral and non-viral based methods of gene therapy with clinical example.

[2+4+4 = 10 marks][CO 4,5][BTL4]

OR :

What are transgenic animals? Describe in details Transgenics: Production methods and therapeutic uses. Discuss ethical issues.

[2+5+3 = 10 marks][CO 3,5][BTL5,6]

Total No. of Pages: 1

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Roll No.
M.Sc. Physics
Nov. 2025

FIRST SEMESTER

END SEMESTER EXAMINATION

MSPH-101: MATHEMATICAL PHYSICS

Max. Marks: 50

Time: 3 Hours

Note: Attempt Any Five questions.

Assume suitable missing data, if any.

- Q1 (a) Consider the subspace U of R^4 spanned by the vectors:
 $v_1 = (1, 1, 1, 1)$, $v_2 = (1, 1, 2, 4)$ and $v_3 = (1, 2, -4, -3)$ [7] [CO3]
Find (a) an orthogonal basis of U ; (b) an orthonormal basis of U .
- (b) Find the adjoint of $F: R^3 \rightarrow R^3$ defined by [3] [CO3]
 $F(x, y, z) = (3x + 4y - 5z, 2x - 6y + 7z, 5x - 9y + z)$
- Q2 Find two linearly independent solutions of
 $y'' + xy' + y = 0$
when the series expansion is about the origin, and hence solve the initial value problem for which $y(0) = 1$ and $y'(0) = 0$ [10] [CO4]
- Q3 (a) Prove that $u = x^2 - y^2$ and $v = \frac{y}{x^2 + y^2}$ are harmonic functions of (x, y) . [5] [CO1]
but are not harmonic conjugates.
- (b) Show that the set I of all integers with the operation defined by
 $a \circ b = a + b + 1$
forms an abelian group for the given composition. [5] [CO5]
- Q4 (a) Let Z be set of all integers and R be a relation defined in Z by $(a, b) \in R$ if, and only if, $(a - b = k \cdot 3)$, for some integer k . Show that R is an equivalence relation in Z and determine all the possible equivalence classes in the set Z with respect to relation R . [7] [CO5]
- (b) Let H be the subgroup of a group G and define
 $T = \{x \in G: xH = Hx\}$.
Prove that T is a subgroup of G . [3] [CO5]
- Q5 Solve one dimensional heat equation
 $\frac{\partial u}{\partial t} = k \frac{\partial^2 u}{\partial x^2}$, $x \in (0, L)$,
with initial condition $u(x, 0) = f(x)$ and the boundary conditions
 $u(0, t) = 0, u(L, t) = 0, t \geq 0$. [10] [CO4]
- Q6 (a) Verify Stoke's theorem for the vector field $\vec{F} = (2x - y)\vec{i} - yz^2\vec{j} - y^2z\vec{k}$ over the upper half of the surface $x^2 + y^2 + z^2 = 1$ bounded by its projection on xy plane. [7] [CO2]
- (b) Using Cauchy's Integral Formula, evaluate $I = \int_C \frac{e^z}{(z+1)^2(z-2)} dz$, where C is $|z - 1| = 3$. [3] [CO1]

FIRST SEMESTER

M.Sc. Physics

END TERM EXAMINATION

Nov.- 2025

MSPH-103: CLASSICAL MECHANICS

Time: 3 Hours

Max. Marks: 50

Note: Question 1 is compulsory. Attempt Any four from question 2-6.
All questions carry equal marks.
Assume suitable missing data, if any.

1. Answer any 5 parts from the following: [2 x 5= 10] [CO# 1-5]
- (i) Explain stable, unstable and neutral equilibrium on the basis of potential function.
 - (ii) The motion of a system during at interval of time may be regarded as an infinitesimal contact transformation generated by Hamiltonian. Explain.
 - (iii) If the Lagrangian of a dynamical system in two dimension ns is given by $L = \frac{1}{2}m\dot{x}^2 + m\dot{x}\dot{y}$, then prove that Hamiltonian of the system is $H = \frac{P_x P_y}{m} - \frac{P_y^2}{2m}$.
 - (iv) What are the generalized coordinates? Show that the generalised momentum corresponding to a cyclic coordinate remains conserved.
 - (v) A particle of mass 'm' moves in a circular orbit of radius 'r₀' under the action of central force whose potential is $-k/r^n$. Show that the circular orbit is stable under small oscillations if $n < 2$. 5
 - (vi) What is a four vector? Show that scalar product of two four vectors is invariant under Lorentz transformations. 4
2. (i) What is meant by variational principle? Prove that the equation of curve for which surface area of rotation is minimum is a catenary $x = a \cosh \frac{(y-b)}{a}$, where a and b are constants. (5) [CO#5]
- (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

(5) [CO#2]

3. (i) Two equal masses (m) are connected to each other with the help of a spring of force constant, k and then the upper mass is connected to a rigid support by an identical spring as shown in Figure 1. Construct T and V matrix for small scale oscillation and discuss the normal modes.

(5) [CO#3]



Figure 1

- 42 (ii) A particle of mass m is in one dimensional potential $U(x) = \frac{A}{x^2} - \frac{B}{x}$ where, $A, B > 0$
- 432 (a) Draw the variation of Potential energy $U(x)$ with position x . Calculate the equilibrium points and the position(s) of minima and maxima the particle.
- (b) Find the angular frequency and time period of small oscillations about the stable equilibrium position.

(5) [CO#3]

4. (i) Define Poisson's Bracket. Show that the transformation defined by:
 $q = \sqrt{2P} \sin Q$ and $p = \sqrt{2P} \cos Q$ is canonical. (5) [CO#2]
- (ii) What are action-angle variables? Setup the action variables of a simple harmonic oscillator in two dimensions and obtain its fundamental frequencies. (5) [CO#5]

5. (i) Derive the differential equation of orbit of a particle moving under the influence of a central force consistent with the inverse square law. A particle describes the circular orbit given by $r = 2a \cos \theta$ under the influence of an attractive central force directed towards a point on the circle. Show that the force varies as inverse fifth power of the distance.

(5) [CO#3]

- (ii) Derive the general expression for the frequency of light in a frame that is in relative motion with respect to the light source. Also, determine the frequency when both the source and observer are moving in the same direction.

(5) [CO#4]

6. (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) [CO#2]

- (ii) Explain Length contraction. The proper life of π^+ -mesons is 2.5×10^{-8} sec. If a beam of these mesons of velocity $0.8c$ is produced, find the distance, the beam can travel before the flux of the meson beam is reduced to $1/e^2$ times the initial flux.

(5) [CO#4]

FIRST SEMESTER
M.Sc. Physics

END SEMESTER EXAMINATION

December 2025

MSPH105: QUANTUM MECHANICS

Time: 3:00 Hours

Max. Marks: 50

Note: Attempt five (05) questions. There is an internal choice between question no. 3 and 4. All questions carry equal marks. Assume suitable missing data, if any.

Q.1 (a) Solve the Schrödinger equation of the hydrogen atom for its radial part and sketch first four radial wave functions $R_{nl}(r)$. [5] [CO1] [BLT2]

(b) An electron is moving freely inside a one-dimensional infinite potential box with walls at $x=0$ and $x=a$. If the electron is initially in the ground state ($n=1$) of the box and if we suddenly quadruple the size of the box (i.e. the right-hand side wall is moved instantaneously from $x=a$ to $x=4a$, calculate the probability of finding the electron in: [5] [CO1] [BLT3]

(i) The ground state of the new box.

(ii) The first excited state of the new box.

Q.2 (a) (i) Expand $|\psi\rangle = \frac{1}{\sqrt{14}} \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ in the eigen basis of $A = \begin{pmatrix} 3 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 5 \end{pmatrix}$ whose eigen vectors are unit vectors inherently of unit length. [3] [CO2] [BLT2]

(ii) Calculate the probabilities of measuring each eigen value using the expansion coefficients. [2] [CO4] [BLT3]

(b) Find the eigenvalues and normalized eigen vectors of the matrix

$$\begin{pmatrix} 1 & 3 & 1 \\ 0 & 2 & 0 \\ 0 & 1 & 4 \end{pmatrix}$$

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Also, verify the Hermitian character of this matrix. Are the eigenvectors orthogonal?

[5] [CO2] [BLT3]

Q.3 (a) Derive the matrices for the operators J^2 , J_x , J_y and J_z for $j = 3/2$.

[5] [CO3] [BLT4]

(b) Evaluate the Clebsch-Gordan coefficient associated with the addition of two angular momenta $j_1 = 1/2$ and $j_2 = 1$.

[5] [CO3] [BLT5]

OR

Q.4 (a) Explain the physical meaning of identical particles and the principle of indistinguishability. Define the exchange operator $\hat{P}_{12}$ and show its eigenvalues are ± 1 .

[5] [CO3] [BLT4]

(b) For a system of two spin- $1/2$ particles, construct the total spin states using addition of angular momentum, and show that the combined system splits into a singlet (total spin 0) and a triplet (total spin 1) manifold. Identify which of these states are symmetric and which are antisymmetric under exchange of the two particles.

[5] [CO4] [BLT5]

Q.5(a) Determine the first-order correction to energy and wave function for time-independent non-degenerate perturbation theory.

[5] [CO5] [BLT4]

(b) Suppose we raise the "floor" of the infinite square well by a constant amount V_0 . Calculate the first-order correction to the energy of the n^{th} state.

[5] [CO4] [BLT5]

Q.6 Formulate the concept of Variation method and use this method to estimate the ground state energy of the hydrogen atom.

[10] [CO5] [BLT5]

Total No. of Pages :3

FIRST SEMESTER

END SEM EXAMINATION

MSPH 107 APPLIED OPTICS

Time: 3:00 Hours

Roll No.

M.Sc.(Physics)

(December 2025)

Max. Marks: 50

Note: Question 1 is compulsory.
Attempt any five questions from Q.2-Q.7.
All symbols have their usual meanings
Assume suitable missing data, if any.

1. (a) Calculate the polarising angle for air-glass interface, $n_1=1.0$ and $n_2 = 1.5$; also for air-water interface, $n_1=1.0$ and $n_2 = 1.33$.

[2][CO# 1][L#1]

- (b) A user wants to remove uniform background illumination from the image to achieve good contrast. Suggest the filter used in achieving this. Give reason.

[2][CO#3][L#6]

- (c) The output of a He-Ne laser ($\lambda=0.6328 \mu\text{m}$) can be assumed to be a Gaussian with a plane phase front. Calculate the beam diameter at $z = 20 \text{ m}$ for $w_0 = 1 \text{ mm}$.

[2][CO#2][L#5]

- (d) Consider a diffraction grating of width 5 cm with slits of width 1 micron separated by a distance of 2 micron. What is the corresponding grating element? How many orders would be observable at a wavelength of 550 nm?

[2][CO#2][L#4]

- (e) Calculate the refractive index of an extraordinary wave propagating in an anisotropic medium with its $\mathbf{k}$ at 20° to the optic axis. ($n_o = 1.66$, $n_e = 1.49$)

[2][CO# 1][L#3]

2. a) Write a note on spatial coherence. Consider Young's double hole experiment and derive the expression for the lateral coherence width.

b) In the Fourier Transform Spectroscopy, calculate the normalized transmission $\gamma(\Delta)$ and total intensity expression $I(\Delta)$ for a monochromatic source where Δ is the path difference.

[8] [CO# 4] [L# 1, 2]

3. a) Explain how the phase distribution is converted into the intensity distribution in a Phase contrast microscopy.

b) Consider an object distribution of the form,

$$\tilde{f}(x, y) = 1 + 0.6 \cos(20x + \pi/5) + 0.1 \sin(50y + \pi/8)$$

x, y are in mm. What are the spatial frequencies present in the object?

[8] [CO# 3] [L# 4, 5]

4. a) Using the diffraction integral, derive the far field intensity pattern for N equidistant slits each of width b . The distance between the two consecutive slits is given by d . Also, plot the intensity pattern.

b) What will happen if $b = d$?

[8] [CO# 2] [L# 5, 3]

5. a) Consider a linearly polarized electromagnetic wave propagating in x - z plane from dielectric medium 1 (n_1) to dielectric medium 2 (n_2) incident at an angle θ_1 with interface at $z = 0$. Write the complete electric and magnetic field vectors for the electric vector lying perpendicular to the plane of incidence.

b) Show that there is no power flow along x -direction when incident beam undergoes total internal reflection (TIR).

[8] [CO# 1] [L# 2, 3]

6. a) What is a Hologram? Write down the conditions required for constructing or reconstructing a hologram. Give one application.

b) Using Fourier transform property of a lens, discuss the output on the back focal plane when a long narrow single slit of width a is kept at the front focal plane of a lens.

[8] [CO# 3] [L# 1, 6]

7. a) Derive the resolving power of a scanning Fabry-Perot interferometer for normal incidence.

b) The electric field vector of an electromagnetic wave makes an angle of 45° with respect to y -axis and is given by $\vec{E} = \vec{E}_0 \cos(\omega t - kz)$. What will be the field components before and after it passes through a half wave plate made of calcite. Also give the states of polarisation. [Take optic axis along y -axis]

[8] [CO# 5, 1] [L# 1, 4]

FIRST SEMESTER
M.Sc Physics
END SEMESTER EXAMINATION

Nov/Dec-2025

MSPH-109 ELECTRONICS

Time: 3:00 Hours

Max Marks-50

[REDACTED]

Q1. Answer the following questions:

(10 = 2x5)
BTL#2,3,4

- i) A silicon diode has a saturation current of $I_0 = 10^{-12}$ A. Calculate the current at $V = 0.7$ V and $T = 300$ K. [2] [CO1]
- ii) The pinch off voltage for a n – channel JFET is 4 V, when $V_{GS} = 1$ V at what value of V_{DS} pinch-off will occur. [2] [CO2]
- iii) Define Slew rate of an OPAMP. The output of a particular OP-AMP increases 8V in 12 μ s. Calculate the slew rate. [2] [CO3]
- iv) $(2ED)_{16} = (\dots\dots\dots)_8 = (\dots\dots)_2$ [2] [CO4]
- v) Differentiate between Zener and Avalanche breakdown based on mechanism and voltage range [2] [CO1]

Q2.(a) Derive expressions for the electron and hole concentrations in an intrinsic semiconductor and show that $n_i^2 = N_c N_v e^{-E_g/kT}$. Also draw the carrier concentration profile, density of states and Fermi-Dirac distribution function in conduction and valence band of an intrinsic semiconductor. [6] [CO1]
BTL#2,3

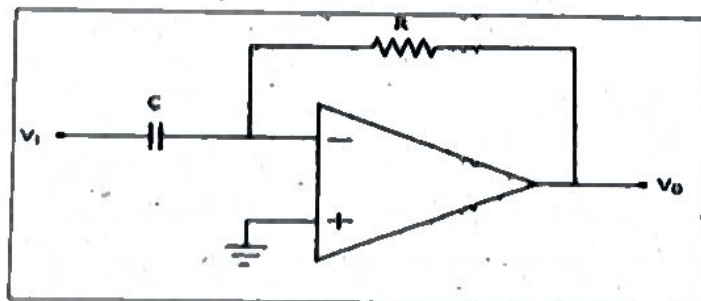
- (b) Explain how doping modifies the Fermi level in p-type and n-type semiconductors. A silicon sample is doped with $N_D = 10^{16} \text{ cm}^{-3}$. Given $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$, calculate the electron and hole concentrations. [4] [CO1] BTL#2,3

- Q3.(a) Draw the basic structure of an n-channel JFET and describe its operation. Also sketch its output characteristics, explaining the different regions. Additionally, discuss how an n-channel JFET functions as a voltage-controlled resistor. [6] [CO2] BTL#2,5

- 48 438 (b) The datasheet of a JFET gives the following information: $I_{DSS} = 3 \text{ mA}$, $V_{GS}(\text{off}) = -6 \text{ V}$ and $g_m(\text{max}) = 5000 \mu\text{S}$. Determine the transconductance for $V_{GS} = -4 \text{ V}$ and find drain current I_D at this point. [4] [CO2] BTL#3

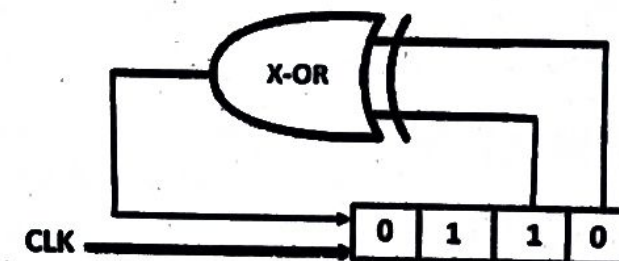
- Q4.(a) Explain the working of OP-AMP as an integrator and derive the expression for the output voltage (V_o) for a given input voltage (V_i). Draw the output voltage for sinusoidal and square wave as input signal. Also explain the limitation of simple integrator circuits and to design the integrator circuit for circumventing the limitations. [6] [CO3] BTL#3,4

- (b) For the circuit given below, If a sine wave of peak value 1 V at 1000 Hz frequency is applied, find the output voltage and the frequency at which the gain will be 0 dB . Also draw the output waveform. [4] [CO3] BTL#3



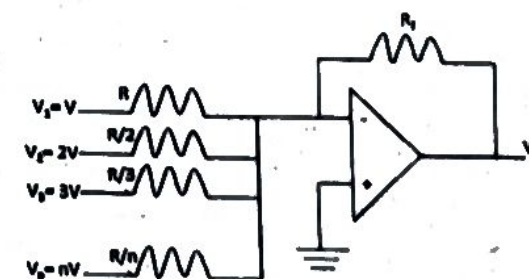
- Q5.(a) Design a synchronous counter that counts up 0, 1, 2, 3, 0, 1, 2, 3, when an input $x = 1$ and down when $x = 0$ using a J-K Flip flop. [6] [CO5] BTL#6

- (b) In a 4-bit right shift register shown below, how many clock pulses are required to change the content of register all to 1's. Also write the output after every clock pulse. [4] [CO5] BTL#4



- Q6.(a) What is a Ring Counter? Design the circuit and explain the working of the Ring counter with a suitable clock diagram. [6] [CO4] BTL #2,4

- (b) Consider the following circuit. If the output voltage V_o is measured to be $V_o = -V$, then the value of the feedback resistance R_f must be [4] [CO3] BTL#3



Total Number of Pages 2 439 49
3rd SEMESTER
END SEMESTER EXAMINATION

Roll. No.....
M.Sc. Physics
Nov-Dec 2025

MSPH201: Atomic and Molecular Physics
Time: 3:00 Hours

Max. Marks: 50

Note: Answer Any Five questions from Part A and Part B.
Assume suitable missing data, if any.

Part A (Atomic Physics)

Q1. (a) Prove that the number of terms for pd configuration is the same for LS coupling as that for jj coupling. [5M][CO#1][BLT#5,6]
(b) Describe the general features of spectra of alkali-like atoms. Draw all four series that are observed in alkali atom emission spectra. Also, show which series are observed in absorption spectra and explain why? [5M][CO#2,3][BLT#2]

Q2. (a) Obtain the Zeeman pattern arising from a principal series triplet $^3S - ^3P$ and show diagrammatically the different transitions involved. Comment on the intensities and polarisation of these transitions. [5M][CO#2,3][BLT#4]

(b) A mixture of ordinary hydrogen and tritium (a hydrogen isotope whose nucleus is approximately three times more massive than ordinary hydrogen) is excited and its spectrum studied. Calculate the shift in wavelength for the H_α lines of two kinds of hydrogen isotopes. ($m_p = 1.67 \times 10^{-24}$ g). [5M][CO#1,2][BLT#3]

Q3. (a) (i) Explain the characteristic X-ray spectra in emission and absorption. What is the importance of absorption edge in X-ray spectra?
(ii) How much energy goes into the quantum emitted when an L-electron drops into the empty K-state in copper ($Z = 29$)? Given $R = 109737 \text{ cm}^{-1}$ and $1 \text{ cm}^{-1} = 1.239 \times 10^{-4} \text{ eV}$. [5M][CO#1,4][BLT#2,3]

(b) (i) A beam of electrons enters a uniform magnetic field of 1.2 Tesla. Calculate the energy difference between electrons whose spins are parallel and antiparallel to the field.

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- (ii) Find the spectroscopic terms for N^+ and arrange them in increasing order of energy.
[5M][CO#1,2][BLT#3,4]

Part B (Molecular Physics)

Q4. (a) (i) Describe the various frequency regions of the electromagnetic spectrum and their origins. Briefly discuss the interaction of electromagnetic radiation with matter in the microwave and infrared regions.

(ii) The rotational constant for $H^{35}Cl$ is observed to be 10.5909 cm^{-1} . What is the value of B for $D^{35}Cl$?
[2.5+2.5M][CO#4,5][BLT#3,4]

(b) Describe Kasha's rule and intensity of vibronic (vibrational-electronic) spectra, i.e., the Franck-Condon principle, with suitable diagrams.

[2+3M][CO#4][BLT#2,4]

Q5. (a) Derive the energy expression for a diatomic vibrating rotator and discuss the resulting spectrum.
[5M][CO#4,5][BLT#4,6]

(b) The equilibrium vibration frequency of the iodine molecule is 215 cm^{-1} and the anharmonicity constant is $x_e = 0.003$. What is the intensity of the hot band ($v=1 \rightarrow v=2$) relative to that of the fundamental ($v=0 \rightarrow v=1$), if the temperature is 300 K ?
[5M][CO#4,5][BLT#3,4]

Q6. (a) Describe types of luminescence, fluorescence lifetime and quantum yield along with the relevant mathematical expressions.
[5M][CO#3,4][BLT#2]

(a) Sketch a diagram of a spectrophotometer and a spectrofluorometer, and discuss their essential optical and electronic components.
[5M][CO#3,4][BLT#2,4]

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Total no. of Pages:

THIRD SEMESTER

END TERM EXAMINATION

44/51

Roll no.....

M.Sc.(Physics)

Nov.-2025

Course code MSPH 203

Course title: Nuclear & Particle Physics

Time: 03:00 Hours

Max. Marks: 50

Note : Q1 is compulsory. Attempt five questions in total. Symbols have their usual meanings. Assume suitable missing data, if any.

- Q.1 a) Give two fundamental differences between carriers of weak and strong forces.
- b) How do neutrinos and antineutrinos differ from photons which also have no charge and almost no rest mass.
- c) An α particle is emitted from the decay of Americium (Am) at rest: ${}^{241}_{94}\text{Am} \rightarrow {}^{237}_{92}\text{U} + \alpha$. The rest masses of ${}^{241}_{94}\text{Am}$, ${}^{237}_{92}\text{U}$ & α are 224.544 GeV/c², 220.811 GeV/c², 3.728 GeV/c² respectively. What is the kinetic energy (in MeV/c²) of α particle?
- d) Why would we not expect electric dipole moments for nuclei?
- e) Classify the nuclear reactions based on incoming and outgoing particles. [2x5=10][CO#1-5][BTL2,5,6]
- Q.2 a) According to the nuclear shell model, the absolute value of the difference in magnetic moments of ${}^{15}_8\text{O}$ & ${}^{15}_7\text{N}$, in the units of nuclear magneton (μ_N) is $a/3$. Find the magnitude of a . [5][CO#4][BTL#5]
- b) Show that, for a nucleon potential of radius $r_d = 2F$, the maximum value of the orbital angular momentum quantum number is $l_{\max} = 1$ unless the kinetic energy of each nucleon exceeds 30 MeV in the centre of mass frame of reference. [5][CO#2][BTL#4]
- Q.3 a) An even even nucleus decays by emission of a gamma ray from a first excited state of spin-parity 2^+ to the ground state. If pure electric quadrupole type radiation is emitted. Find the spin and parity of ground state. Also, what happens in case this nucleus transitions from second excited state (2^+) to first excited state? [5][CO#5][BTL#5]

b) What do you understand by ⁴⁴² parity violation. How the Wu experiment concluded that parity is not conserved in β decay. Explain with the help of schematic diagram. [5][CO#3][BTL#2]

Q.4 a) Discuss the underlying assumptions and theory behind collective model of the nucleus. The energy (in keV) and spin parity: $E(I^P)$ values of the low-lying excited states of a nucleus are $0(0^+)$, $122(2^+)$, $366(4^+)$, $707(6^+)$. Identify whether these energy states are due to vibrational or rotational excitations? Predict energy & spin parity (I^P) for next energy state. [5][CO#3,4][BTL#5,6]

b) i. A pion (at rest) decays, $\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$. Take the rest masses of a muon and a pion to be 105 MeV and 140 MeV respectively. What is the probability that the muon spin is along the direction of its momentum. Give reason with diagram. [2.5][CO#4,5][BTL#5]

ii. A particle has a composite state of three quarks u, d and s. Calculate net charge, net spin and strangeness of this particle. Identify this particle(s). [2.5][CO#4][BTL#4]

Q.5 a) i. Why decay of $\Lambda \rightarrow p + \pi^-$ is much slower (longer lifetime) than the decay of $\Delta^{++} \rightarrow p + \pi^+$. Explain. [2.5][CO#3][BTL#4]

ii. Do Kaon particles form an isospin quartet or doublet? Support your answer with reasons. Also determine their isospin quantum no. [2.5][CO#3,4][BTL#4]

b) Why an additional degree of freedom (color) was introduced in a quark model. Explain with the help of a suitable example. [5][CO#5][BTL#2]

Q.6 a) Identify allowed/ forbidden processes and find the dominant interaction, with reasons. [5][CO#4][BTL#5]

i. $\pi^+ + n \rightarrow \Lambda^0 + K^+$

ii. $\Delta^+ + K^0 \rightarrow p + n$

iii. $K^0 + \pi^0 \rightarrow \bar{K}^0 + \pi^+ + \pi^-$

iv. $\Sigma^0 \rightarrow \Lambda^0 + \gamma$

v. $\Sigma^0 \rightarrow p + \pi^0$

b) Explain principle and working of solid state detector. List three uses of solid-state detector. [5][CO#4][BTL#2]

Total No. of Pages :2

THIRD SEMESTER

END SEM EXAMINATION

MSPH 213 ADVANCED NUMERICAL PHYSICS

Time: 3:00 Hours

Roll No.

M.Sc. (Physics)

(November 2025)

Max. Marks: 50

Note: Question no.1 is compulsory
Attempt any five questions
Assume suitable missing data, if any.

1. (a) Explain the sources of error that are nearly unavoidable in numerical solution of problems.
 - (b) Express $10 \sin(\omega t - kz) \hat{a}_x + 20 \cos(\omega t - kz) \hat{a}_y$ in phasor form.
 - (c) Illustrate the typical finite elements used in the finite element method.
 - (d) A triangular element has nodes at (0,1), (1,0) and (0,1). Determine the shape functions α_1 , α_2 and α_3 .
 - (e) Explain the way of choosing the weighting functions leading to collocation method and galerkin method.
- [2*5=10] [CO# 1,2,3,4] [BTL#1,2,3]

2. Using the series expansion technique, solve the Poisson's equation in a cube

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = -e^{-x}$$

If the sides of the cube are equal to π (i.e. $a = b = c = \pi$) subject to the boundary conditions

$$V(0,y,z) = V(a,y,z) = V(x,0,z) = 0$$

$$V(x,b,z) = V(x,y,0) = V(x,y,c) = 0$$

3. Obtain the finite difference time domain equations to solve Maxwell's equations as per the Yee's algorithm.

[10] [CO#1] [BTL#3]

[10] [CO#2] [BTL#3]

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4. Consider the wave equation of the form

$$u^2 \frac{\partial^2 \phi}{\partial x^2} = \frac{\partial^2 \phi}{\partial t^2}, \text{ where } u \text{ is the speed of the wave.}$$

Write the equivalent finite difference formula. Rewrite the equation by choosing the aspect ratio $r = (u\Delta t/\Delta x)^2$

Further draw its computational molecule. Use the von Neumann approach to determine its stability condition.

[10] [CO# 2] [BTL#4]

5. For the boundary value problem

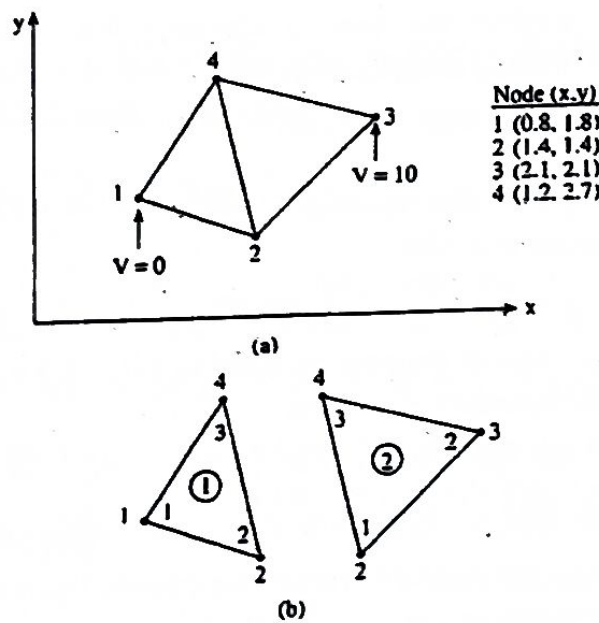
$$\phi'' + \phi + x = 0, \quad 0 < x < 1$$

with homogeneous boundary conditions $\phi = 0$ at $x = 0$ and $x = 1$, determine the coefficients of the approximate solution function

$$\phi(x) = x(1-x)(a_1 + a_2 x) \text{ using the least squares method.}$$

[10] [CO#3] [BTL# 3]

6. Consider the two element mesh shown in the figure.



Using the finite element method, determine the potentials within the mesh.

[10] [CO#4] [BTL#4]

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 technique? [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. What are the plasma waves / space charge waves? Show that the dispersion relation for electrostatic waves in a magnetized plasma is given by

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

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

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

Q.6. 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

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

Q.7. What is Cerenkov free electron laser (CFEL)? Explain the physical mechanism using suitable schematic diagram. [10] [CO#5]

MSPH-217 CHARACTERIZATION TECHNIQUES

Time: 3:00 Hours

Max. Marks: 50

Note: Answer Any FIVE questions. Question No. 1 is Compulsory.
Assume suitable missing data, if any

1. Answer all the questions.

[2 x 5]

- [a]. Define dead time in detectors. Explain the proportional counter of X-ray detection with proper diagram. #L1, (CO2)
- [b]. Draw a graph of thickness varying from 0 to 1 mm of Lead filter vs. transmission factor for $\text{CuK}\alpha$ radiation. #L3, (CO1)
- [c]. Write the advancement in Field emission scanning electron microscopy (FE-SEM) over scanning electron microscopy (SEM). #L3, (CO4)
- [d]. Briefly, explain 'finger print and characteristic regions' in FTIR. #L2, (CO3)
- [e]. Differentiate among thermogravimetric analysis (TGA), differential thermal analysis (DTA) and differential scanning calorimetry (DSC)? #L4, (CO5)
- 2[a]. Explain the Imaging and Diffraction modes in TEM. Drawing a schematic diagram, describe working and principle of transmission electron microscope (TEM) to study the internal structure of materials. How HR-TEM provide better results than conventional TEM? #L2, L4 (CO4) [6]
- [b]. The crystal structure of SrTiO_3 is cubic with space group, $\text{Pm}\bar{3}\text{m}$ and its lattice constant is 3.0 Å. Calculate the expected 2θ positions of the first five peaks in the diffraction pattern, if the X-ray radiation of $\text{MoK}\alpha_1$ is used #L5, (CO2) [4]
- 3[a]. Discuss the basic principle and instrumentation of X-ray photo electron XPS. Write the different characteristics using spin – orbit

coupling analyzed by XPS. What type of ion is used for depth profiling and why? #L2, L5 (CO3) [6]

- [b]. Name various types of optical microscopes (OMs). Explain the working principle of the Interference-type microscope using a proper ray diagram. #L1, L2 (CO4) [4]
- 4[a]. List scanning probe microscopy (SPM) techniques. Discuss the working and principle of scanning tunnelling microscopy (STM). Why STM cannot characterize non-conductive sample? #L1, L2 (CO3) [6]
- [b]. Write the process of adhesion/ cohesion force measurement by Atomic Force Microscope (AFM) on a surface using various tip-cantilever positions. Why is contact mode not useful for the characterization of biological samples? #L3, (CO4) [4]
- 5[a]. Explain the measurement of sample's heat capacity and its formula in differential scanning calorimetry (DSC). Describe the working principle and instrumentation of DSC with a proper diagram. Write the physical and Chemical properties analysed by DSC. #L2, L3 (CO5) [6]
- [b]. Create a TGA thermogram (weight loss vs temperature) for calcium oxalate monohydrate to make calcium oxide. Discuss various transition temperatures and weight loss using proper chemical reactions. #L6, (CO5) [4]
6. Discuss briefly any *FOUR*. [2.5 x 4]
- [a]. Magnetic Force Microscopy (MFM) and its application #L3, (CO3)
- [b]. Evaluation of the structure factor of CsCl #L5, (CO1)
- [c]. Bright field optical microscopy (BFOM) #L2, (CO4)
- [d]. Analysis by Energy Dispersive X-ray (EDX) #L4, (CO2)
- [e]. Raman Spectroscopy (RS) #L2, (CO3)
- [f]. Differential Thermal Analysis (DTA) #L3, (CO5)
- [g]. Creation of image by secondary electrons (SEs) and back scattered (BSEs) electrons in SEM #L6, (CO4)

Total No. of Printed Pages: 02

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I SEMESTER

Roll No.....

MSc Chemistry-I

END TERM EXAMINATION

Nov 2025

Course Code: MSCH101

Course Title: Chemical Bonding, Stability Constant and Supramolecular Chemistry

Time: 03:00 Hours

Max. Marks: 50

Note: Attempt any 5 questions from each section. Attempt one section at a time.

Section A

Ques1. A) Explain the structure of following on the basis of VSEPR theory:

- i) SF_4 ii) XeOF_4

B) Define Bent's rule and apply it to explain the bond angles in CH_2F_2 .
[5][CO1][BTL3,4]

Ques2. Draw the Walsh MO diagram of bent XH_2 molecule. [5][CO1][BTL1]

Ques3. Describe the spectrophotometric method for determination of formation constant of a metal complex. [5][CO1][BTL2]

Ques4. Define the mole fraction (Φ_i) of i^{th} complex species in a solution and derive the following expression using Average ligand number ($\bar{n}$) for the equilibria of mononuclear complex (ML_n). [5][CO2][BTL3]

$$\bar{n} = \sum_{i=0}^N i \Phi_i$$

Ques5. Define stoichiometric equilibrium constant and establish its relation with stepwise equilibrium constant. [5][CO2][BTL3,4]

Ques6. A) Discuss the role of masking and anti-masking agent in complexometric titration.
B) Describe the detection of end point in complexometric titrations using metal indicators. [2+3][CO1][BTL]

Section B

58 448

Ques7. Explain why designing an anion receptor is more challenging than a cation receptor. Discuss the details of anion binding with suitable examples.

[5][CO3][BTL4]

Ques8. Self-assembly is a thermodynamically controlled process, justify with suitable examples. Discuss the differences between molecular and supramolecular self-assembly.

[5][CO3][BTL2]

Ques9. Explain how the 'Soccer Ball' receptor shows versatile binding ability for various types of guests (neutral or ionic).

[5][CO4][BTL3]

Ques10. Explain the following terms:

[5][CO4][BTL2]

a) Hydrogen Bonding

d) Cryptands

b) Calixarenes

e) Template Effect

f) Hydride Sponge

Ques11. Discuss the application of supramolecular chemistry in phase transfer catalysis and molecular sensing devices.

[5][CO5][BTL5]

Ques12. What is supramolecular photochemistry? Explain the functions of a photoswitchable molecular device.

[5][CO5][BTL4]

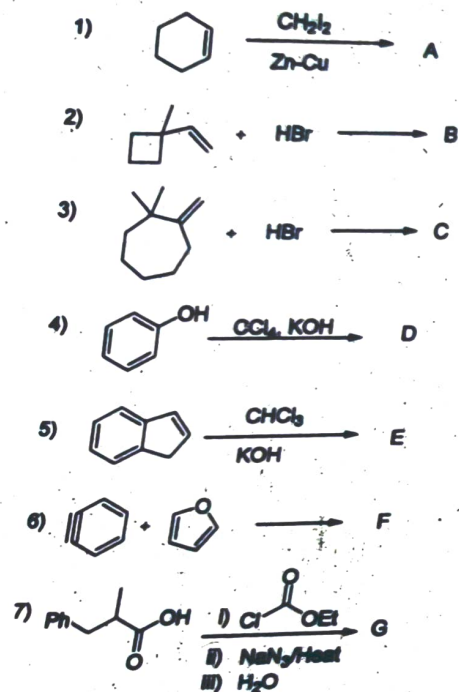
b) Arrange the following on decreasing order of stability.



[1] [CO3, BL4]

8) Complete any five of the following reaction:

[5] [CO3, BL6]



Total No. of Pages 4

Roll No.

First SEMESTER

M.Sc. [CHEM]

END SEMESTER EXAMINATION

Nov/Dec. 2025

MSCH - 103 (Stereochemistry and Reaction Intermediates & Mechanism)

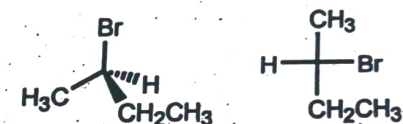
Time: 3 Hours

Max Marks: 50

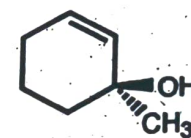
Note: Attempt all questions. All questions carry equal marks.
Attempt Section A and Section B in the same Answer Sheet.

Section A

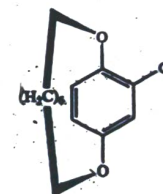
1a) Which of the following terms best describes the pair of compounds shown: enantiomers, diastereomers, or homomers [1] [CO1, BL3]



b) Assign absolute configuration to the following compounds. [2] [CO1, BL3]

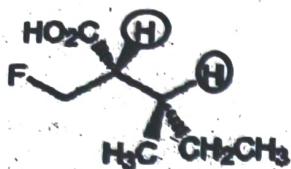


i) (At chiral centre)



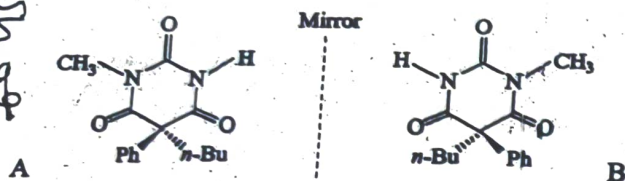
ii)

c) Explain topocity of the encircled hydrogens in the following compound. Also identify the prochiral center and label each ligand as Pro R and Pro S attached to it. [2] [CO1, BL2]



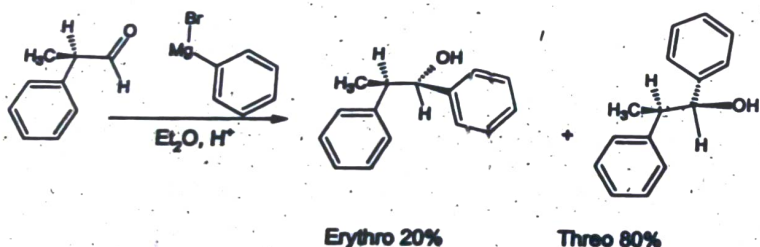
- d) Barbituric acid derivatives A and B exist as enantiomers, which interact differently with chiral receptors in the human body. The R- enantiomer acts primarily as a narcotic, while the S-enantiomer functions as an anticonvulsant. Correlate enantiomers A and B with their respective activity. [2] [CO1, BL4]

en of



- e) Discuss stability and chirality of cis and trans-1,3- dimethylcyclohexane [2] [CO 1, BL2]

2. a) State Cram's Rule. How does it explain the formation of two products in unequal amounts in the following reaction? [1, 4] [CO2, BL 2,4,5]



- b) How does the Felkin-Ahn model address the main objections associated with Cram's Rule? Illustrate your answer considering the above chemical reaction. [2.5] [CO2, BL3]

OR

- b) How does the Curtin-Hammett principle along with stereoelectronic factors justify the observation: "Tropene gives a major product from a less stable conformation when alkylated with methyl iodide"?
- 3 a) What causes plane-polarized light to transform into elliptically polarized light in a chiral medium? [1] [CO2, BL2]
b) What is the axial haloketone rule, and how is it applied in stereochemical analysis of cyclic ketones? [2.5] [CO2, BL3]
- c) What is circular birefringence, and how does it relate to optical activity? What type of ORD curve is obtained for a chiral molecule that does not absorb within the wavelength range being examined? Draw a Cotton effect curve and explain its application in functional group analysis. [1, 1.5, 2.5 =5] [CO2, BL3]

Section B

- 4) Derive the Hammett equation. Explain concave upward deviation with suitable example. [5] [CO4, BL3]
- 5) a) Discuss the physical significance of ρ and σ . [3] [CO4, BL3]
b) Why do ortho isomers and aliphatic compounds not exhibit the straight line relationship? [2] [CO4, BL3]
- 6) Discuss any two of the following name reactions: [5] [CO3, BL2]
a) Tiffeneau-Demjanov Reaction
b) The Hofmann Rearrangement
c) Schmidt Rearrangement
- 7) a) Singlet carbenes add to C=C bonds in a one-step, stereospecific manner. Comment [4] [CO3, BL1]

Total No. of Pages: 02

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First Semester
M.Sc.

Roll No.

END TERM EXAMINATION

Nov-Dec -2025

MSCH 105 Physical Chemistry-I

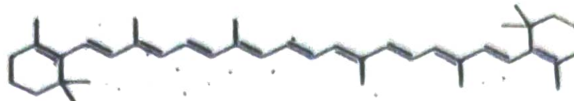
Time: 3 Hours

Max. Marks: 50

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

Part-A

1. Derive wave function (Ψ_1) for 1D simple harmonic oscillator.
[5 Marks] [CO1 L3]
2. a) Demonstrate that the energy of a particle in a 3D box increases as the number of nodes in the wavefunction increases, while the degeneracy of the energy levels is independent of the number of nodes.
[3 Marks] [CO1 L4]
- b) The eigenfunction of the operator $(\frac{d^2}{dx^2} - x^2)$ is $e^{-x^2/2}$.
Calculate the corresponding eigenvalue.
[2 Marks] [CO1 L3]
3. Explain the five postulates of Quantum mechanics.
[5 Marks] [CO2 L2]
4. a) Define Hermitian operators. What are the properties of Hermitian Operator.
[2 Marks] [CO2 L1]
- b) Show that K_x is Hermitian.
[3 Marks] [CO2 L4]
5. a) The parent compound β -carotene has a maximum absorption of light that occurs at 480 nm to this transition corresponds to $n = 11$ to $n = 12$. The transition of electron in a particle of a box system. What is the length of the box.
[3 Marks] [CO1 L5]



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6. According to Virial theorem $KE=PE$ for ground state. Prove that.
[2 Marks][CO1 L2]

Part-B

7. 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 L3]
8. Explain Bockris, Devanathan and Muller model of electrical double layer in detail.
[5 Marks][CO4 L2]
9. Find the concentration of product [Z] in the following consecutive reaction,
 $A \rightarrow X \rightarrow Z$
[5 Marks][CO5 L5]
10. Draw the relaxation curve for simple first order opposition reaction, derive the rate equation and define relaxation time
[5 Marks][CO5 L1 L2 L4]
11. Explain plug flow and derive rate expression for first order reaction.
[5 Marks][CO6 L2]

—End—

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Total no of Pages 02

First SEMESTER

B.Sc. Chemistry

END TERM EXAMINATION

Dec-2025

COURSE CODE: MSCN107

COURSE TITLE: Elementary Topics for Chemists

Time: 3 hrs

Max. Marks: 50

Course A: Biology for Chemists

Q1. Define and classify lipids? Discuss their biological importance.

[5] [CO3, L1,2]

Q2. What are biomolecules? Explain vitamins in detail by taking any two examples (by discussing their source, role and deficiency).

[5] [CO3, L2,3]

Q3. Discuss the fate of carbohydrates in body. Explain any one cycle in detail (Glycolysis or Kreb's Cycle)

[5] [CO4, L2, 3]

Q4. What is a protein? Explain different levels protein structure. Describe biosynthesis of amino acids.

[5] [CO4, L2,4]

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

[5] [CO3, L2,4]

Course B: Standard Laboratory Practices and Chemical Safety

Attempt any FIVE questions from the following.

454 64

Q.1 Write SIX principles of green chemistry. Give Examples of green experiment procedures. [5][CO5, L1,2,4]

Q.2 Define and categorize fire, and describe how fire differs from an explosion. Discuss the various types of fire extinguishers, the situations in which each should be used, and explain the PASS method for operating them. [5][CO6, L2,4-5]

Q.3 What are chemical substances and in which for they can be present at workplace? How can they be hazardous to health? Explain by taking suitable examples. [5][CO5, L1, 2, 4]

Q.4 What do you mean by MSDS of a chemical? Explain the MSDS of any one Chemical. [5][CO5, L1,2]

Q.5 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, L2, 3, 4]

Q.6 Draw and explain any five safety symbols that can commonly be found on the label of a chemical container. [5][CO6, L1, 2, 4]

Q.7 Attempt any TWO [5][CO6, L1, 2, 4]

(i) Differentiate between combustible and flammable material. How can they be a fire or explosion hazard?

(ii) Measures taken into consideration for safe storage of Chemicals.

(iii) Basic routes of disposal of laboratory chemical waste and Laboratory Waste Disposal Procedure Summary

Total no. of Pages: 2

THIRD SEMESTER

END TERM EXAMINATION

MSCH201 (Organic Chemistry – 3)

Time: 3 Hours

Roll no.

M.Sc. (CHEM.)

Nov/Dec-2025

Max. Marks: 50

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

[1] Answer any four of the following. $[2.5 \times 4 = 10]$ [CO 1] [BTL2&3]

(a) Differentiate between Shapiro and Bamford Stevens Reactions.

(b) Explain Prins type Cyclization with the help of an example.

(c) Explain Corey Winter reaction with suitable example.

(d) Explain the reactivity of organocuprates and Grignard reagents on α , β unsaturated carbonyl compounds.

(e) Mention the preparation and uses of Umpolung reaction.

[2] Answer the following questions. $[2 \times 5 = 10]$ [CO2] [BTL3]

(a) Show the mechanism and its application on Wacker reaction.

(b) Explain the synthesis and application of Organo-silyl ethers.

[3] Answer the following questions. $[2 \times 5 = 10]$ [CO3] [BTL3]

(a) Explain Swern Oxidation.

(b) Explain the role of Thallium Nitrate and Manganese Oxide in oxidations reactions.

[4] Answer the following questions. $[2 \times 5 = 10]$ [CO3&4] [BTL2&3]

(a) Write the synthesis of Wilkinson's catalyst. Show its mechanism for reduction reactions. Discuss its stereochemical aspects.

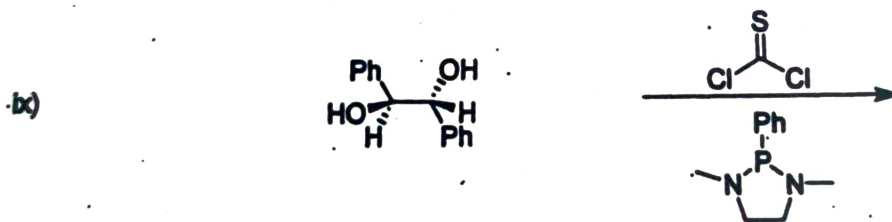
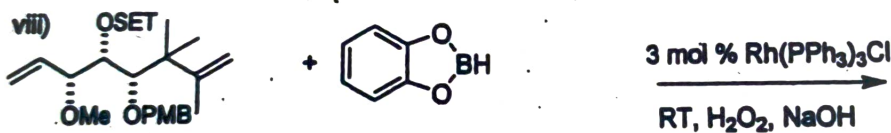
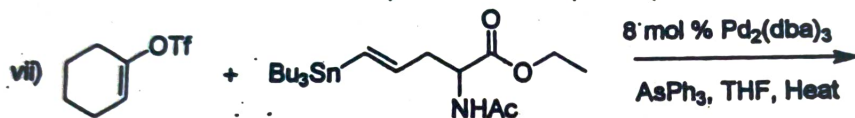
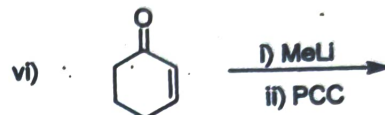
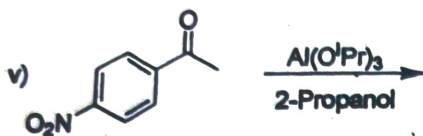
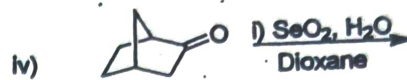
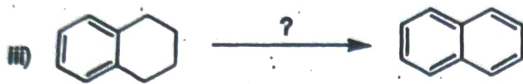
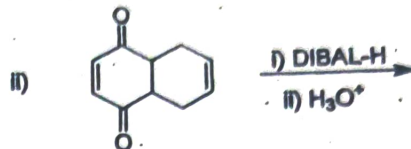
(b) Describe the methods of preparation and one important use of the following reagents (any two).

(a) 9-BBN

(b) Disiamyl borane

(c) NaBH_3CN

[5] Write the missing product(s) or reagents in the following reactions. 66 456
 [1×10 = 10][CO1-4] [BTL3&4]



Total No. of Pages:02

Third Semester
M.Sc.

Roll No.

END TERM EXAMINATION

MSCH 203 Physical Chemistry-III

Nov/Dec-2025

Time: 3 Hours

Max. Marks: 50

Note: Attempt all Questions

Assume suitable missing data, if any

Part A

1. Deduce Einstein co-efficient for various emission processes
[5 marks] [CO2 L2]
2. Assume that the carbon monoxide molecule is a rigid rotor with $r_e = 1.128 \times 10^{-10}$ m. Find the rotational energy (in Joule) for $J = 0$ and $J = 1$ and the wavelength of the transition between the two levels.
[5 marks] [CO5 L4]
3. The intensity of a transition is proportional, to a first approximation, to the population of the originating energy level. For a diatomic molecule treated as a rigid rotor, what is the population of the J^{th} level. (a) Sketch N_J against J and find the most populated J -level. (b) Find approximation for the rotational quantum number of the rotational energy level with the maximum population along with corresponding wavenumber and the rotational energy of most populated state.
[5 marks] [CO5 L4 L5]
4. Given that the stretching frequency of a C-C bond is approximately 1000 cm^{-1} , Calculate the stretching frequencies of C=C and C≡C bonds on the assumption that double and triple bonds have force constants which are, respectively, two or three times those of a single bond.
[5 marks] [CO3][CO5 L5]
5. 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 L3]

MSCH 203

Part B

6. (a) Write the relation between oscillator strength (f) and molar extinction coefficient (ϵ), also give the physical significance of an oscillator strength value $f > 1$ or $f < 1$ [1 marks] [CO3 L2]
 (b) State Koopman's theorem [1 marks] [CO3 L1]
7. Using Hückel Molecular Orbital (HMO) theory, derive the expressions for the π -molecular orbital energies and coefficients for 1,3-butadiene (C_4H_6). Draw the corresponding energy level diagram, indicate the bonding and antibonding orbitals, and calculate the total π -electron energy of the molecule. [4 marks] [CO4 L3]

Or

Derive the selection rules for the $n\pi^*$, $\pi\pi^*$, no^* and πo^* transitions of formaldehyde and distinguish between $n\pi^*$ and $\pi\pi^*$ transitions? [4 marks] [CO3 L4]

8. Derive the Stern-Volmer equation

$$\frac{I_0}{I} = 1 + \frac{k_f}{k_f + k_i} [\text{Q}] = 1 + \tau k_q [\text{Q}]$$

Where τ is the lifetime of the excited state $= (k_f + k_i)^{-1}$ and k_f and k_i are, respectively, the first-order rate constants for fluorescence and internal conversion, and k_q is the second-order rate constant for quenching. Explain the significance of the three rate constants. [4 Marks] [CO3 L3]

9. (a) State the principle of Mossbauer Spectroscopy. [1 marks] [CO3 L1]

(b) A 14.4 keV γ -ray has an energy of 14.4×10^3 eV. Calculate the Doppler velocity corresponding to an energy shift of 10^{-8} eV. [1 marks] [CO3 L4]

(c) In a Mössbauer spectrum of Fe^{2+} (high-spin) and Fe^{3+} (low-spin), which has the larger quadrupole splitting and why? [1 marks] [CO3 L5]

(d) The ground and excited nuclear states of ^{57}Fe have spins $I_g = \frac{1}{2}$ and $I_e = \frac{3}{2}$, respectively. How many transitions are possible between them in a magnetic field? [1 marks] [CO3 L3]

10. Consider an AB spin system made of two coupled spin- $\frac{1}{2}$ nuclei A and B (different chemical shifts, scalar coupling J) (a) Write down the quantum Hamiltonian (isotropic scalar coupling) in frequency units and set up its matrix in the product basis $|\alpha\alpha\rangle, |\alpha\beta\rangle, |\beta\alpha\rangle, |\beta\beta\rangle$ also Diagonalise the Hamiltonian and obtain exact expressions for the four energy eigenvalues and the eigen vectors (show the mixing in the $\{|\alpha\beta\rangle, |\beta\alpha\rangle\}$ subspace) [4 marks] [CO4 L5]

(b) Explain the selection rules for transitions observed in Nuclear Magnetic Resonance (NMR) spectroscopy. Derive the relative intensities of spectral lines for a system of coupled spin- $\frac{1}{2}$ nuclei, and discuss how spin coupling influences the observed multiplet pattern. [2 marks] [CO3 L2]

11. (a) Derive Bragg's Law for X-ray diffraction and explain its physical significance. [1 marks] [CO4 L2]

(b) For a cubic crystal of lattice constant $a = 3.0 \text{ \AA}$, X-rays of wavelength $1.54 \text{ \AA}$ are used. Calculate the Bragg angle for the (111) reflection. [2 marks] [CO4 L4]

(c) Compare X Ray method with electron and neutron diffraction method. [2 marks] [CO4 L3]

—End—

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[Roll No.....]

III Semester

M.Sc.

November 2025

END SEMESTER EXAMINATION

Inorganic Chemistry-3 (MSCH 205)

Course Title: Organometallic Chemistry and its Application

[Time: 3 Hours]

[Max. Marks: 50]

Instructions: Attempt any 10 question. All carries equal marks.
Assume missing data if any.

Question 1. Discuss the Wacker oxidation catalytic cycle with mechanism and also mention advantages and disadvantages in detail.

[CO1, L1] 5

Question 2. Explain the Monsanto process for the synthesis of acetic acid and describe the catalyst, reaction condition and overall reaction mechanism.

[CO4, L1] 5

Question 3. A metal complex having the empirical formula $\text{FeC}_9\text{H}_7\text{O}_3\text{Cl}$, has one ligand as a substituted cyclopentadienyl group. It is an ionic compound and has poor solubility in hydrocarbon solvents. The compound gives a white precipitate on treatment with AgNO_3 solution. Assuming that it obeys the 18-electron rule, suggest it

[CO2, L2] 5

Question 4. In the given pair of complexes pick out the complex having lower energy CO stretching frequency in its infrared spectrum. Rationalise your choice.

(a) Mo(CO)_6 , or $\text{Mo(CO)}_5\text{PPh}_3$, (b) Fe(CO)_5 or $\text{Fe(CO)}_4\text{Br}_2$.

[CO3, L3] 5

Question 5. What are NHC ligand? Discuss the bonding in detail with suitable examples.

[CO4, L3] 5

Question 6. Which among the following alkenes will bind most strongly to a metal? Give reasons.

(a) COD (b) ethylene (c) norbornene (d) cyclohexene

[CO4, L4]5

Question 7. Although the definition of a Fischer carbene says that the carbene carbon should be bound to at least one heteroatom, many metal carbene complexes with the metal in the low oxidation state but having a phenyl group bound to the carbene carbon are also classified as Fischer type. Why? Justify your answer

[CO4, L4]5

Question 8. The complex $(PPh_3)_3Rh-Me$ is cleaved by D_2 and forms methane and $(PPh_3)_2RhD[PPh_2C_6H_4D]$. Suggest a suitable mechanism for the reaction.

[CO2, L4]5

Question 9. Write the catalytic cycle for cyclotrimerisation of acetylene using square planar $Ni(dppe)(C_2H_2)_2$ as the active catalyst. The reaction involves ligand additions, reductive elimination, migratory insertion and oxidative coupling (not in this order). If dppe is replaced by dpme will it make any changes?

[CO3, L2]5

Question 10. Explain ligand substitution reaction in organometallic compounds and discuss the factor affecting the reaction rate.

[CO3, L2]5

Question 11. Photolysis of $[n^5-CpFe(CO)_2]_2$ at $-78^\circ C$ results in the loss of a colourless gas and formation of an iron containing product having a single carbonyl band at 1785 cm^{-1} and containing 14.7% oxygen by mass. Suggest a structure for the product.

[CO4, L5]5

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Roll No.....

III SEMESTER

MSc Chemistry

END TERM EXAMINATION

Nov 2025

Course Code: MSCH207b

Course Title: Inorganic Reaction Mechanisms and Bioinorganic Chemistry

Time: 03:00 Hours

Max. Marks: 50

Note: Attempt any 5 questions from each section. Attempt one section at a time.

Section A

Ques1. Explain the key differences between the associative (SN_2) and dissociative (SN_1) mechanisms in coordination complexes. [5][CO1][BTL2,4]

Ques2. Differentiate between thermodynamic and kinetic stability of metal complexes with the help of suitable examples. [5][CO1][BTL4]

Ques3. Discuss the mechanism of the following reaction and speculate why the rate of electron transfer is slow ($K_{II} = 4.0 \text{ L mol}^{-1} \text{ s}^{-1}$). [5][CO3][BTL3]



Ques4. How will you synthesize *cis*- and *trans*- $[\text{Pt}(\text{Cl})_2(\text{NH}_3)(\text{NO}_2)]^-$? [5][CO2][BTL3,6]

Ques5. What are complementary and non-complementary electron transfer reactions? Explain with example. [5][CO3][BTL2]

Ques6. Describe the theories of Trans Effect. How will you distinguish between *cis*- and *trans*-isomers of $[\text{Pt X}_2\text{A}_2]$ type complexes? [5][CO2][BTL2,4]

Section B

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Ques7. What are the toxic effects of lead? Give reasons for its toxicity. How can it be treated? [5][CO4][BTL2]

Ques8. Discuss the binding of O₂ to hemoglobin highlighting the structural changes accompanying it. [5][CO6][BTL2,4]

Ques9. Describe the chemistry involved in chelation therapy by anticancer platinum complexes. [5][CO4][BTL2,4]

Ques10. Explain the functioning and mechanism of action of the enzyme Carboxypeptidase A? [5][CO5][BTL2]

Ques11. Briefly discuss the role of Calcium in living cells? How is it transported and regulated in human body? [5][CO6][BTL2,3]

Ques12. Write short note on: [5][CO5,6][BTL1,2]

- a) Biological nitrogen fixation.
- b) Biomineralization of iron

Course A

Q1. Write the retrosynthesis and synthesis of any five target molecules:

[5×5 = 25, CO1,2; BT-2&6]



(a)



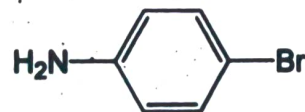
(b)

Heptan-2,6-dione

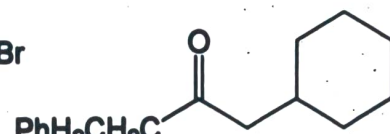
(c)

2-Methyl-2-propanol

(d)



(e)



(f)

Course B

Q2. Give one synthesis and one cycloaddition reaction of thiepine.

[3, CO4, BT-1&3]

Q3. How α - halo - carbonyl compounds react with 1,3-dicarbonyl compounds to give furans? Write reaction and mechanism involved.

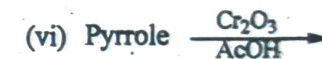
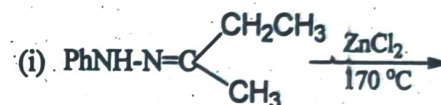
Or

Discuss one synthetic methods for each 3- and 4-membered N-heterocyclic compounds.

[4, CO4, BT-5]

Q4. Write and discuss the Skraup synthesis of quinoline with mechanism.
[5, CO3; BT-1&3]Q5. Write short note on pteridine including two types of synthesis and one reaction.
[5, CO4, BT-1&3]

Q6. Answer the following: [8×1, CO3,4, BT-2-5]



4/5
5/5

[Total No. of Printed Pages: 2]

END SEMESTER EXAMINATION
THIRD SEMESTER

74 464

[Roll No.....]

MSc

November 2023

MSCH207d: Solid State Synthesis

[Time: 3 Hours]

[Max. Marks: 50]

Instructions: All Questions are compulsory
Neat diagrams must be drawn wherever necessary.
Assume missing data if any.

Q1a) How one can carry out the synthesis of Li_2SO_4 using solid state approach. What are the major issues encountered during the synthesis? How can they be overcome? Write down the chemical reactions involved during synthesis

b) Explain hydrothermal method used for synthesis of solid-state materials using suitable examples. Mention the advantages of solid-state reactions over solution phase. **CO1, L1, L2, L4 (10 marks)**

Q2a) Differentiate between ferromagnetism and anti-ferromagnetism. Draw hysteresis loop and explain.

b) State Bragg's Law. What is the significance of $\text{K}\alpha_1$ and $\text{K}\alpha_2$ lines in PXRD? When a certain crystal was studied by the Bragg technique using X-rays of wavelength 229 pm an X-ray reflection was observed at an angle of $23^\circ 20'$ a) What is the corresponding interplanar spacing? When another X-ray was used a reflection was observed at $15^\circ 26'$ What was the wavelength of these X-rays. **CO2, CO4, L1, L3, L5 (10 marks)**

Q3a) Define phase transition. Discuss in detail about the Buerger's and thermodynamic classification of phase transitions.

b) Discuss the kinetics of phase transitions in solids **CO3 L1, L2 (10 marks)**

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Q4 a) Define p-n junction. Give principle and working of p-n junction.

b) Highlight in detail the salient features of BCS theory of superconductivity

CO4 L1, L3 (10 marks)

Q5a) Explain band theory as a function of application of quantum theory. Calculate the value of spin only magnetic moment for FeO, NiO

b) Write a short note on

i) Meissner Effect

ii) Superconductivity

CO4 L1, L5 (10 marks)

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Roll no.....

MSc. (BT, Physics, Chemistry & Maths)

END SEMESTER EXAMINATION

Nov/ Dec. 2025

Time: 03:00 Hours

MSHU-113

Max. Marks: 50

Note: Attempt all Questions carrying 10 marks each.
Assume suitable missing data, if any.

1. Explain major challenges in oral presentations via PPT. Explain how incorporating audio-visual aids can enhance the visual aspect of communication. CO (4) BTL 3

2. Explain how language skills can help in professional communication. CO (3) BTL 2

3. Write short notes on:

iii) Interview Skills

iv) Group Discussions for professional competence

CO (2) BTL

1

4. Examine the role of correct pronunciation at the workplace. CO (4) BTL 4

5. Write an essay on any one of the following

a) Language proficiency for using new-age tools

b) Religion vs Spirituality

CO (3) BTL 3

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FIRST SEMESTER

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Roll no.....
M.Sc. (Geospatial Science)

End-TERM EXAMINATION (Nov. 2025)
MSCG 105-: Introduction to GIS

Time: 03 Hour

Max. Marks: 40

Question 1) Short Question Answer

(2*4 = 8 marks)

- e) What is Topology in vector datasets? Mention any two topology rules relevant to GIS editing?
- f) Describe the difference between Map Projection and Coordinate Reference System (CRS).
- g) Explain the significance of Datum transformation in GIS. Give one example of a datum used in India.
- h) A raster dataset has a cell size of 25 m * 25 m. Calculate the area of 1 Pixel (in sq. meters.), If an AOI covers 1250 pixels, compute the total ground area in hectares.

Question 2) A DEM dataset contains the following elevations(m) with a 3 * 3 window: (5 marks)

120	140	160
150	180	210
190	220	250

a) Reclassify the DEM into 3 categories:

- Class 1: <150m
- Class 2: 150-200m
- Class 3: >200m

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b) Count the number of pixels in each class.

Question 3) Explain the following with examples and applications:
(5 marks)

- d) Primary vs Secondary spatial data sources
- e) Role of GPS/GNSS in improving spatial data accuracy
- f) Importance of metadata in spatial databases

Question 4) A map has an RF scale of 1:15,000.

(5 marks)

- a) What ground distance does 7 cm represent?
- b) If the real – world distance is 3.9 km, What should be the map distance?
- c) Express the same scale in 1 cm = X meters form.

Question 5) Describe in detail the workflow to create a geospatial analysis model for assessing urban expansion using GIS. (10 marks)

Must include.

- Data acquisition (Satellite + Vector + Field)
- Georeferencing and projection selection
- Digitization and data standardization
- Spatial analysis (Buffer, Overlay, Change Detection)
- Raster-based analysis (NDVI, DEM integration)
- Map composition and reporting outputs

Question 6) a) Consider the coordinates of two points. A ($X_1 = 345620.4$ m, $Y_1 = 2678451.2$ m) B ($X_2 = 345980.8$ m, $Y_2 = 2678025.7$ m). Compute the Euclidean distance between A and B. (5 marks)

b) If Buffer radius = 500 m, determine whether point B falls within the buffer of point A. (2 marks)