Chapter 11

SYLLABUS, BLUE PRINTS AND MODEL QUESTION PAPERS - MAJOR, MINOR, AND MULTIDISCIPLINARY COURSES

11.1 Course 1(Major):Essentials of Maths, Physics, Chemistry,and Comp.Science(w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.1.1 Syllabus of Course 1(Major)

SEMESTER-I

COURSE 1: ESSENTIALS AND APPLICATIONS OF MATHEMATICAL, PHYSICAL ANDCHEMICAL SCIENCES

Theory Credits: 4 5 hrs/week

Course Objective:

The objective of this course is to provide students with a comprehensive understanding of the essential concepts and applications of mathematical, physical, and chemical sciences. The course aims to develop students' critical thinking, problem-solving, and analytical skills in these areas, enabling them to apply scientific principles to real-world situations.

Learning outcomes:

1. Apply critical thinking skills to solve complex problems involving complex numbers, trigonometric ratios, vectors, and statistical measures.

2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations

3. To Explain the basic principles and concepts underlying a broad range of fundamental areas of chemistry and to Connect their knowledge of chemistry to daily life.

4. Understand the interplay and connections between mathematics, physics, and chemistry in various applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.

5 To explore the history and evolution of the Internet and to gain an understanding of network security concepts, including threats, vulnerabilities, and countermeasures.

UNIT I: ESSENTIALS OF MATHEMATICS:

Complex Numbers: Introduction of the new symbol i – General form of a complex number – Modulus-Amplitude form and conversions

Trigonometric Ratios: Trigonometric Ratios and their relations – Problems on calculation of angles **Vectors:** Definition of vector addition – Cartesian form – Scalar and vector product and problems **Statistical Measures**: Mean, Median, Mode of a data and problems

UNIT II: ESSENTIALS OF PHYSICS:

Definition and Scope of Physics- Measurements and Units - Motion of objects: Newtonian Mechanics and relativistic mechanics perspective - Laws of Thermodynamics and Significance- Acoustic waves and electromagnetic waves- Electric and Magnetic fields and their interactions- Behaviour of atomic and nuclear particles- Wave-particle duality, the uncertainty principle- Theories and understanding of universe

UNIT III: ESSENTIALS OF CHEMISTRY: :

Definition and Scope of Chemistry- Importance of Chemistry in daily life -Branches of chemistry and significance- Periodic Table- Electronic Configuration, chemical changes, classification of matter, Biomolecules- carbohydrates, proteins, fats and vitamins.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY:

Applications of Mathematics in Physics & Chemistry: Calculus , Differential Equations & Complex Analysis

Application of Physics in Industry and Technology: Electronics and Semiconductor Industry, Robotics and Automation, Automotive and Aerospace Industries, Quality Control and Instrumentation, Environmental Monitoring and Sustainable Technologies.

Application of Chemistry in Industry and Technology: Chemical Manufacturing, Pharmaceuticals and Drug Discovery, Materials Science, Food and Beverage Industry.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

Milestones of computer evolution - Internet, history, Internet Service Providers, Types of Networks, IP, Domain Name Services, applications.
Ethical and social implications: Network and security concepts- Information Assurance Fundamentals, Cryptography-Symmetric and Asymmetric, Malware, Firewalls, Fraud Techniques- Privacy and Data Protection.

Recommended books:

1. Functions of one complex variable by John.B.Conway, Springer- Verlag.

2. Elementary Trigonometry by H.S.Hall and S.R.Knight

3.Vector Algebra by A.R.Vasishtha, Krishna Prakashan Media(P)Ltd.

4.Basic Statistics by B.L.Agarwal, New age international Publishers

5. University Physics with Modern Physics by Hugh D. Young and Roger A. Freedman

6. Fundamentals of Physics by David Halliday, Robert Resnick, and Jearl Walker

7. Physics for Scientists and Engineers with Modern Physics" by Raymond A. Serway and John W. Jewett Jr.

8. Physics for Technology and Engineering" by John Bird

9. Chemistry in daily life by Kirpal Singh

10. Chemistry of bio molecules by S. P. Bhutan

11. Fundamentals of Computers by V. Raja Raman

12. Cyber Security Essentials by James Graham, Richard Howard, Ryan Olson

STUDENT ACTIVITIES

UNIT I: ESSENTIALS OF MATHEMATICS:

1: Complex Number Exploration

Provide students with a set of complex numbers in both rectangular and polar forms.

They will plot the complex numbers on the complex plane and identify their properties

2: Trigonometric Ratios Problem Solving

Give students a set of problems that require the calculation of trigonometric ratios and their relations.

Students will solve the problems using the appropriate trigonometric functions (sine, cosine, tangent, etc.) and trigonometric identities.

3: Vector Operations and Applications

Provide students with a set of vectors in Cartesian form.

Students will perform vector addition and subtraction operations to find the resultant vectors.

They will also calculate the scalar and vector products of given vectors.

4: Statistical Measures and Data Analysis

Give students a dataset containing numerical values.

Students will calculate the mean, median, and mode of the data, as well as other statistical measures if appropriate (e.g., range, standard deviation).
They will interpret the results and analyze the central tendencies and distribution of the data.

UNIT II: ESSENTIALS OF PHYSICS:

1. Concept Mapping

Divide students into groups and assign each group one of the topics.

Students will create a concept map illustrating the key concepts, relationships, and applications related to their assigned topic.

Encourage students to use visual elements, arrows, and labels to represent connections and interdependencies between concepts.

2. Laboratory Experiment

Select a laboratory experiment related to one of the topics, such as motion of objects or electric and magnetic fields.
Provide the necessary materials, instructions, and safety guidelines for conducting the experiment.
Students will work in small groups to carry out the experiment, collect data, and analyze the results.

After the experiment, students will write a lab report summarizing their findings, observations, and conclusions.

UNIT III: ESSENTIALS OF CHEMISTRY

1: Chemistry in Daily Life Presentation

Divide students into groups and assign each group a specific aspect of daily life where chemistry plays a significant role, such as food and nutrition, household products, medicine,or environmental issues.
Students will research and create a presentation (e.g., PowerPoint, poster, or video) that showcases the importance of chemistry in their assigned aspect.
2: Periodic Table Exploration

Provide students with a copy of the periodic table.

Students will explore the periodic table and its significance in organizing elements based on their properties.
They will identify and analyze trends in atomic structure, such as electronic configuration, atomic size, and ionization energy.

3: Chemical Changes and Classification of Matter

Provide students with various substances and chemical reactions, such as mixing acids and bases or observing a combustion reaction.
Students will observe and describe the chemical changes that occur, including changes in color, temperature, or the formation of new substances.
4: Biomolecules Investigation

Assign each student or group a specific biomolecule category, such as carbohydrates,proteins, fats, or vitamins.
Students will research and gather information about their assigned biomolecule category, including its structure, functions, sources, and importance in the human body.

They can create informative posters or presentations to present their findings to the class.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

1: Interdisciplinary Case Studies

Divide students into small groups and provide them with interdisciplinary case studies that involve the interdisciplinary application of mathematics, physics, and chemistry.

Each case study should present a real-world problem or scenario that requires the integration of concepts from all three disciplines.

2: Design and Innovation Project

Challenge students to design and develop a practical solution or innovation that integrates mathematics, physics, and chemistry principles.

Students can choose a specific problem or area of interest, such as renewable energy, environmental conservation, or materials science.
3: Laboratory Experiments

Assign students laboratory experiments that demonstrate the practical applications of mathematics, physics, and chemistry.

Examples include investigating the relationship between concentration and reaction rate, analyzing the behavior of electrical circuits, or measuring the properties of materials.

.4: Mathematical Modeling

Present students with real-world problems that require mathematical modeling and analysis.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

1. Identifying the attributes of network (Topology, service provider, IP address and bandwidth of

2. your college network) and prepare a report covering network architecture.

3. Identify the types of malwares and required firewalls to provide security.

4. Latest Fraud techniques used by hackers**.**

11.1.2 Blue Print for Course 1 at end of Semester-I

Course 1: Essentials of Mathematics, Physics, Chemistry, and Computer Science

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A (5 × 3 = 15)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B (5 × 7 = 35)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.1.1: Blueprint of Semester–I End Examination (Course–1: :Essentials of Mathematics, Physics, Chemistry, and Computer Science)

11.1.3 Model Question Paper for Course-I

Government College (A), Rajahmundry

B.Sc. Mathematics (Honours) Major

I Semester – End Examination

Paper-I: Essentials of Mathematics, Physics, Chemistry, and Computer Science

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Max Marks: 50**

Note: Answer **any FIVE** questions from Part–A and Five questions from Part–B choosing one question from each of five units.

PART – A (5 × 3 = 15 Marks)

Q1. Write the modulus–amplitude form of a complex number and convert $3 + 4i$ into this form. (Unit–I, L1)

Q2. If $\sin\theta = \frac{3}{5}$, find $\cos\theta$ and $\tan\theta$. (Unit–I, L2)

Q3. Define Newton's First Law of Motion. Give one example. (Unit–II, L1)

Q4. State the First Law of Thermodynamics. Mention one application. (Unit–II, L2)

Q5. Write the electronic configuration of sodium (Na). (Unit–III, L1)

Q6. What are carbohydrates? Give two examples. (Unit–III, L1)

Q7. Explain any one application of Calculus in Physics or Chemistry. (Unit–IV, L3)

Q8. What is a firewall? Mention its purpose in computer networks. (Unit–V, L2)

PART – B ($5 \times 7 = 35$ Marks)

Unit–I

Q9. (a) Express $z = 1 - i\sqrt{3}$ in modulus–amplitude form. (b) Solve: If $\tan A = \frac{3}{4}$, find $\sin A$ and $\cos A$. (L2)

OR

Q10. (a) Find the scalar product of $\vec{a} = (2, 1, -1)$ and $\vec{b} = (1, 0, 3)$. (b) Find the mean of the data: 10, 20, 30, 20, 10. (L3)

Unit–II

Q11. Explain the difference between Newtonian mechanics and relativistic mechanics with examples. (L3)

OR

Q12. Describe acoustic waves and electromagnetic waves. Mention two applications of each. (L2)

Unit–III

Q13. (a) Explain the importance of Chemistry in daily life. (b) Write a short note on vitamins and their role in human body. (L2)

OR

Q14. State the Modern Periodic Law. Explain how elements are classified in the Periodic Table. (L2)

Unit–IV

Q15. (a) Discuss applications of differential equations in Chemistry. (b) Write notes on applications of Physics in the semiconductor industry. (L3)

OR

Q16. Explain how Physics and Chemistry contribute to Environmental Monitoring and Sustainable Technologies. (L4)

Unit–V

Q17. (a) Write a short note on symmetric and asymmetric cryptography. (b) Explain the role of Internet Service Providers (ISPs). (L2)

OR

Q18. What are the ethical and social implications of cybersecurity? Explain with suitable examples. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.2 Course 2(Major):Advances in Math, Physical & Chemical Sciences (w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.2.1 Syllabus of Course 2(Major)

SEMESTER-I

COURSE 2: ADVANCES IN MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

Theory Credits: 4 5 hrs/week

Course Objective:

The objective of this course is to provide students with an in-depth understanding of the recent advances and cutting-edge research in mathematical, physical, and chemical sciences. The course aims to broaden students' knowledge beyond the foundational concepts and expose them to the latest developments in these disciplines, fostering critical thinking, research skills, and the ability to contribute to scientific advancements.

Learning outcomes:

1. Explore the applications of mathematics in various fields of physics and chemistry, to understand how mathematical concepts are used to model and solve real-world problems.

2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations.

3. Understand the different sources of renewable energy and their generation processes and advances in nanomaterials and their properties, with a focus on quantum dots. To study the emerging field of quantum communication and its potential applications. To gain an understanding of the principles of biophysics in studying biological systems. Explore the properties and applications of shape memory materials.

3. Understand the principles and techniques used in computer-aided drug design and drug delivery systems, to understand the fabrication techniques and working principles of nanosensors. Explore the effects of chemical pollutants on ecosystems and human health.

4. Understand the interplay and connections between mathematics, physics, and chemistry in various advanced applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.

5 Understand and convert between different number systems, such as binary, octal, decimal, and hexadecimal. Differentiate between analog and digital signals and understand their characteristics. Gain knowledge of different types of transmission media, such as wired (e.g., copper cables, fiber optics) and wireless (e.g., radio waves, microwave, satellite)..

UNIT I: ADVANCES IN BASICS MATHEMATICS

Straight Lines: Different forms – Reduction of general equation into various forms – Point ofintersection of two straight lines

Limits and Differentiation: Standard limits – Derivative of a function –Problems on product ruleand quotient rule

Integration: Integration as a reverse process of differentiation – Basic methods of integration

Matrices: Types of matrices – Scalar multiple of a matrix – Multiplication of matrices – Transpose ofa matrix and determinants

UNIT II: ADVANCES IN PHYSICS:

Renewable energy: Generation, energy storage, and energy-efficient materials and devices. **Recent advances in the field of nanotechnology**: Quantum dots, Quantum Communication- recent advances in biophysics- recent advances in medical physics- Shape Memory Materials.

UNIT III: ADVANCES IN CHEMISTRY:

Computer aided drug design and delivery, nano sensors, Chemical Biology, impact of chemical pollutants on ecosystems and human health, Dye removal - Catalysis method

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

Mathematical Modelling applications in physics and chemistry

Application of Renewable energy: Grid Integration and Smart Grids,

Application of nanotechnology: Nanomedicine,

Application of biophysics: Biophysical Imaging, Biomechanics, Neurophysics,

Application of medical physics: Radiation Therapy, Nuclear medicine

Solid waste management, Environmental remediation- Green Technology, Water treatment.

UNIT V: Advanced Applications of computer Science

Number System-Binary, Octal, decimal, and Hexadecimal, Signals-Analog, Digital, Modem, Codec, Multiplexing, Transmission media, error detection and correction- Parity check and CRC, Networking devices- Repeater, hub, bridge, switch, router, gateway.

Recommended books:

1. Coordinate Geometry by S.L.Lony, Arihant Publications

2. Calculus by Thomas and Finny, Pearson Publications

3. Matrices by A.R.Vasishtha and A.K.Vasishtha, Krishna Prakashan Media(P)Ltd.

4. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle

5. "Energy Storage: A Nontechnical Guide" by Richard Baxter

6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Raghvendra A. Bohara

7. "Biophysics: An Introduction" by Rodney Cotterill

8. "Medical Physics: Imaging" by James G. Webster

9. "Shape Memory Alloys: Properties and Applications" by Dimitris C. Lagoudas

10. Nano materials and applications by M.N.Borah

11. Environmental Chemistry by Anil.K.D.E.

12. Digital Logic Design by Morris Mano

13. Data Communication & Networking by Bahrouz Forouzan.

STUDENT ACTIVITIES

UNIT I: ADVANCES IN BASIC MATHEMATICS

1: Straight Lines Exploration

Provide students with a set of equations representing straight lines in different forms, such as slope-intercept form, point-slope form, or general form.

Students will explore the properties and characteristics of straight lines, including theirslopes, intercepts, and point of intersection.
2: Limits and Differentiation Problem Solving

Students will apply the concept of limits to solve various problems using standard limits.

Encourage students to interpret the results and make connections to real-world applications,such as analyzing rates of change or optimizing functions.

3: Integration Exploration
Students will explore the concept of integration as a reverse process of differentiation andapply basic methods of integration, such as the product rule, substitution method, or integration by parts.

Students can discuss the significance of integration in various fields, such as physics andchemistry
4: Matrices Manipulation

Students will perform operations on matrices, including scalar multiplication, matrixmultiplication, and matrix transpose.

Students can apply their knowledge of matrices to real-world applications, such as solvingsystems of equations or representing transformations in geometry.

UNIT II: ADVANCES IN PHYSICS:

1: Case Studies

Provide students with real-world case studies related to renewable energy, nanotechnology,biophysics, medical physics, or shape memory materials.
Students will analyze the case studies, identify the challenges or problems presented, andpropose innovative solutions based on the recent advances in the respective field.
They will consider factors such as energy generation, energy storage, efficiency, sustainability, materials design, biomedical applications, or technological advancements.
2: Experimental Design

Assign students to design and conduct experiments related to one of the topics: renewableenergy, nanotechnology, biophysics, medical physics, or shape memory materials.
They will identify a specific research question or problem to investigate and design an

experiment accordingly.

Students will collect and analyze data, interpret the results, and draw conclusions based ontheir findings.

They will discuss the implications of their experimental results in the context of recentadvances in the field.

3: Group Discussion and Debate

Organize a group discussion or debate session where students will discuss the ethical, social, and environmental implications of the recent advances in renewable energy, nanotechnology, biophysics, medical physics, and shape memory materials.

Assign students specific roles, such as proponent, opponent, or moderator, and provide them with key points and arguments to support their positions.

UNIT III: ADVANCES IN CHEMISTRY:

1. Experimental Design and Simulation

In small groups, students will design experiments or simulations related to the assigned topic.

For example, in the context of computer-aided drug design, students could design a virtualscreening experiment to identify potential drug candidates for a specific disease target.

For nano sensors, students could design an experiment to demonstrate the sensitivity and selectivity of nano sensors in detecting specific analytes.
Chemical biology-related activities could involve designing experiments to study enzyme-substrate interactions or molecular interactions in biological systems.
Students will perform their experiments or simulations, collect data, analyze the results, and draw conclusions based on their findings.

2. Case Studies and Discussion

Provide students with real-world case studies related to the impact of chemical pollutants on ecosystems and human health.
Students will analyze the case studies, identify the sources and effects of chemical pollutants, and propose mitigation strategies to minimize their impact.

Encourage discussions on the ethical and environmental considerations when dealing with chemical pollutants.
For the dye removal using the catalysis method, students can explore case studies where catalytic processes are used to degrade or remove dyes from wastewater.
Students will discuss the principles of catalysis, the advantages and limitations of the catalysis method, and its applications in environmental remediation.
3: Group Project

Assign students to work in groups to develop a project related to one of the topics.

The project could involve designing a computer-aided drug delivery system, developing anano sensor for a specific application, or proposing strategies to mitigate the impact of chemical pollutants on

ecosystems.
Students will develop a detailed project plan, conduct experiments or simulations, analyzedata, and present their findings and recommendations.
Encourage creativity, critical thinking, and collaboration throughout the project.

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS &CHEMISTRY
1: Mathematical Modelling Experiment

Provide students with a mathematical modelling experiment related to one of the topics. For example, in the context of renewable energy, students can develop a mathematical model to optimize the placement and configuration of solar panels in a solar farm.
Students will work in teams to design and conduct the experiment, collect data, and analyze the results using mathematical models and statistical techniques.
They will discuss the accuracy and limitations of their model, propose improvements, and interpret the implications of their findings in the context of renewable energy or the specific application area.
2: Case Studies and Group Discussions

Assign students to analyze case studies related to the applications of mathematical modellingin nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.
Students will discuss the mathematical models and computational methods used in the casestudies, analyze the outcomes, and evaluate the effectiveness of the modelling approach.
Encourage group discussions on the challenges, ethical considerations, and potential advancements in the field.

Students will present their findings and engage in critical discussions on the advantages and limitations of mathematical modelling in solving complex problems in these areas.

3. Group Project

Assign students to work in groups to develop a group project that integrates mathematical modelling with one of the application areas: renewable energy, nanotechnology, biophysics,medical physics, solid waste management, environmental remediation, or water treatment.

The project could involve developing a mathematical model to optimize the delivery of radiation therapy in medical physics or designing a mathematical model to optimize wastemanagement practices.
Students will plan and execute their project, apply mathematical modelling techniques,analyze the results, and present their findings and recommendations.
Encourage creativity, critical thinking, and collaboration throughout the project.

UNIT V: Advanced Applications of computer Science

Students must be able to convert numbers from other number system to binary numbersystems

1. Identify the networking media used for your college network

Identify all the networking devices used in your college premises.

11.2.2 Blue Print for Course 2 at end of Semester-I

Course 2: Advances in Mathematical, Physical and Chemical Sciences

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A $(5 \times 3 = 15)$	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B $(5 \times 7 = 35)$	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.2.1: Blueprint of Semester–I End Examination (Course–2: :Advances in Mathematical, Physical and Chemical Sciences

11.2.3 Model Question Paper for Course-2

Government College (A), Rajahmundry

B.Sc. Maths (Honours) I Semester – End Examination

Paper: Advances in Mathematical, Physical, and Chemical Sciences

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Max Marks: 50**

Note: Answer **any FIVE** questions from Part–A and Five questions from Part–B choosing one question from each of five units.

PART – A (5 × 3 = 15 Marks)

Q1. Find the point of intersection of the lines $2x + 3y = 6$ and $x - y = 4$. (Unit–I, L3)

Q2. Evaluate: $\lim_{x\to 0} \dfrac{\sin x}{x}$. (Unit–I, L2)

Q3. What are quantum dots? Mention one application. (Unit–II, L1)

Q4. Define Shape Memory Materials with one example. (Unit–II, L1)

Q5. What is computer-aided drug design? (Unit–III, L2)

Q6. State two harmful effects of chemical pollutants on human health. (Unit–III, L2)

Q7. Write any two applications of nanotechnology in medicine. (Unit–IV, L2)

Q8. Convert the decimal number 45 into binary and hexadecimal systems. (Unit–V, L3)

PART – B (5 × 7 = 35 Marks)

Unit–I

Q9. (a) Reduce the equation $3x + 4y - 12 = 0$ into slope–intercept form. (b) Find the derivative of $f(x) = \dfrac{x^2+1}{x}$. (L3)

OR

Q10. (a) Integrate: $\int (3x^2 + 2x + 1)\, dx$. (b) Find the determinant of $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$. (L3)

Unit–II

Q11. Explain renewable energy generation and energy storage with suitable examples. (L2)

OR

Q12. Discuss advances in biophysics and medical physics in healthcare. (L2)

Unit–III

Q13. (a) Explain the principle of nano-sensors. (b) Describe the catalysis method for dye removal from wastewater. (L3)

OR

Q14. Explain the effects of chemical pollutants on ecosystems and human health. (L4)

Unit–IV

Q15. (a) Discuss the role of mathematical modelling in physics and chemistry. (b) Write short notes on green technology and solid waste management. (L3)

OR

Q16. Explain applications of medical physics in radiation therapy and nuclear medicine. (L3)

Unit–V

Q17. (a) Differentiate between analog and digital signals with examples. (b) Write notes on parity check and CRC methods of error detection. (L2)

OR

Q18. Explain the working of networking devices: (i) Router (ii) Switch (iii) Gateway. (L3)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Marks (%)
L1 – Remembering	10%
L2 – Understanding	30%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.3 Course 3 (Major): Differential Equations & Problem Solving Sessions (w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.3.1 Syllabus of Course 3 (Major)

SEMESTER-II

COURSE 3: DIFFERENTIAL EQUATIONS

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. solve first order first degree linear differential equations.
2. convert a non-exact homogeneous equation to exact differential equation by using an integrating factor.
3. know the methods of finding solution of a differential equation of first order but not of first degree.
4. solve higher-order linear differential equations for both homogeneous and non-homogeneous, with constant coefficients.
5. understand and apply the appropriate methods for solving higher order differential equations.

Course Content

Unit – 1

Differential Equations of first order and first degree

Linear Differential Equations – Bernoulli's Equations - Exact Differential Equations –Integrating factors - Equations reducible to Exact Equations by Integrating Factors -

i) Inspection Method ii) $\frac{1}{Mx+Ny}$ iii) $\frac{1}{Mx-Ny}$

Unit – 2

Differential Equations of first order but not of first degree

Equations solvable for p, Equations solvable for y, Equations solvable for x – Clairaut's equation - Orthogonal Trajectories: Cartesian and Polar forms.

Unit – 3

Higher order linear differential equations

Solutions of homogeneous linear differential equations of order n with constant coefficients - Solutions of non-homogeneous linear differential equations with constant coefficients by means of polynomial operators.

(i) $Q(x) = e^{ax}$ (ii) $Q(x) = Sin\ ax$ (or) $Cos\ ax$

Unit – 4

Higher order linear differential equations (continued.)

Solution to a non-homogeneous linear differential equation with constant coefficients

P.I. of $f(D)y = Q$ when $Q = bx^k$

P.I. of $f(D)y = Q$ when $Q = e^{ax}V$, where V is a function of x

P.I. of $f(D)y = Q$ when $Q = xV$, where V is a function of x

Unit – 5

Higher order linear differential equations with non-constant coefficients

Linear differential Equations with non-constant coefficients; Cauchy-Euler Equation; Legendre Equation; Method of variation of parameters

Activities

Seminar/ Quiz/ Assignments/ Applications of Differential Equations to Real life Problem /Problem Solving Sessions.

Text Book

Differential Equations and Their Applications by Zafar Ahsan, published by Prentice-Hall of India Pvt. Ltd, New Delhi-Second edition.

Reference Books

1. Ordinary and Partial Differential Equations by Dr. M.D. Raisinghania, published by S. Chand &Company, New Delhi.
2. Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha- Universities Press.
3. Differential Equations -Srinivas Vangala&Madhu Rajesh, published by Spectrum University Press.

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11.3.2 Blue Print for Course 3 at end of Semester-II

Course 4: Differential Equations & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.3.1: Blueprint of Semester–II End Examination (Course–3: : Differential Equations & Problem Solving Sessions

11.3.3 Model Question Paper for Course-3

Government College(A), Rajahmundry

II Semester End Examinations, March 2024

Course–3: Differential Equations & Problem Solving Sessions

Course Code: 224703

Duration: $2\frac{1}{2}$ Hours **Max Marks: 50**

PART – A (5 × 3 = 15 Marks)

Answer any FIVE questions. Each carries 3 Marks.

Q1. Solve: $\frac{dy}{dx} + y\tan x = \sin x$. (Unit–I, L3)

Q2. Solve: $(y^2 + xy)\,dx + (x^2 + xy)\,dy = 0$. (Unit–I, L3)

Q3. Find the orthogonal trajectories of the family $x^2 + y^2 = c^2$ in Cartesian form. (Unit–II, L4)

Q4. Solve Clairaut's equation: $y = x\frac{dy}{dx} + \left(\frac{dy}{dx}\right)^2$. (Unit–II, L4)

Q5. Solve: $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$. (Unit–III, L3)

Q6. Solve: $\frac{d^2y}{dx^2} + y = \cos x$. (Unit–III, L3)

Q7. Find the particular integral of $(D^2 - 2D + 1)y = e^{2x}$. (Unit–IV, L3)

Q8. Solve Cauchy–Euler equation: $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$. (Unit–V, L3)

PART – B (5 × 7 = 35 Marks)

Answer Five questions choosing one from each of the five units. Each carries 7 Marks.

Unit–I

Q9. Solve: $(2x + 3y)\,dx + (x + 4y)\,dy = 0$. (L3)

OR

Q10. Solve Bernoulli's equation: $\frac{dy}{dx} + y = y^2 e^x$. (L3)

Unit–II

Q11. Solve: $y^2\,dx + (x^2 - y^2)\,dy = 0$. (L3)

OR

Q12. Find the orthogonal trajectories of $y^2 = cx$ in polar coordinates. (L4)

Unit–III

Q13. Solve: $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = e^x$. (L3)

OR

Q14. Solve: $\frac{d^2y}{dx^2} + 4y = \sin 2x$. (L3)

Unit–IV

Q15. Find the particular integral of $(D^2 - 1)y = xe^x$. (L3)

OR

Q16. Solve: $(D^2 + 4)y = x\cos 2x$. (L3)

Unit–V

Q17. Solve: $x^2\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} + y = \ln x$. (L3)

OR

Q18. Solve Legendre's equation: $(1 - x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2y = 0$. (L3)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Marks (%)
L1 – Remembering	0%
L2 – Understanding	10%
L3 – Applying	70%
L4 – Analyzing	20%
L5 – Evaluating	0%
L6 – Creating	0%

11.4 Course 4 (Major): Analytical Solid Geometry & Problem Solving Sessions (w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.4.1 Syllabus of Course 4 (Major)

SEMESTER-II

COURSE 4: ANALYTICAL SOLID GEOMETRY

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. understand planes and system of planes
2. know the detailed idea of lines
3. understand spheres and their properties
4. know system of spheres and coaxial system of spheres
5. understand various types of cones

Course Content

Unit – 1
The Plane

Equation of plane in terms of its intercepts on the axis - Equations of the plane through the given points - Length of the perpendicular from a given point to a given plane - Bisectors of angles between two planes - Combined equation of two planes - Orthogonal projection on a plane.

Unit – 2
The Line

Equation of a line - Angle between a line and a plane - The condition that a given line may lie in a given plane - The condition that two given lines are coplanar - Number of arbitrary constants in the equations of straight line - Sets of conditions which determine a line - The shortest distance between two lines - The length and equations of the line of shortest distance between two straight lines - Length of the perpendicular from a given point to a given line.

Unit – 3
The Sphere

Definition and equation of the sphere - Equation of the sphere through four given points - Plane sections of a sphere - Intersection of two spheres - Equation of a circle - Sphere through a given circle - Intersection of a sphere and a line - Power of a point - Tangent plane - Plane of contact; Polar plane - Pole of a Plane - Conjugate points - Conjugate planes.

Unit – 4
Spheres (continued)

Angle of intersection of two spheres - Conditions for two spheres to be orthogonal - Radical plane; Coaxial system of spheres - Simplified from of the equation of two spheres.

Unit – 5
Cones

Definitions of a cone – vertex, guiding curve and generators - Equation of the cone with a given vertex and guiding curve - Equations of cones with vertex at origin are homogenous - Condition that the general equation of the second degree should represent a cone - Enveloping cone of a sphere - Right circular cone - Equation of the right circular cone with a given vertex, axis and semi vertical angle.

Activities

Seminar/ Quiz/ Assignments/Three dimensional analytical Solid geometry and its applications/ Problem Solving Sessions.

Text Book

Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, published by S. Chand & Company Ltd. 7th Edition.

Reference Books

1. A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, published by Wiley Eastern Ltd., 1999.
2. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by TataMcGraw -Hill Publishers.
3. Solid Geometry by B. Rama Bhupal Reddy, published by Spectrum University Press.

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11.4.2 Blue Print for Course 4 at end of Semester-II

Course 4: Analytical Solid Geometry & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A (5 × 3 = 15)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B (5 × 7 = 35)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.4.1: Blueprint of Semester–II End Examination (Course–4: : Analytical Solid Geometry & Problem Solving Sessions

11.4.3 Model Question Paper for Course-4

GOVERNMENT COLLEGE (A), RAJAHMUNDRY

II Semester End Examinations

Course 4: Analytical Solid Geometry

(For the batch admitted in 2023–24 under Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Maximum Marks: 50**

PART – A (5 × 3 = 15 Marks)

Answer any Five questions. Each carries 3 Marks.

Q1. Find the length of the perpendicular from the point $(2, -1, 3)$ to the plane $2x - y + 2z = 5$. (Unit–I, L3)

Q2. Obtain the equation of the plane passing through the points $(1, 0, 0)$, $(0, 1, 0)$ and $(0, 0, 1)$. (Unit–I, L3)

Q3. Find the condition that the line $\frac{x-1}{2} = \frac{y+3}{-1} = \frac{z}{1}$ lies in the plane $2x - y + 3z = 7$. (Unit–II, L3)

Q4. Find the shortest distance between the lines $\frac{x}{1} = \frac{y-1}{2} = \frac{z}{-1}$ and $\frac{x-1}{2} = \frac{y}{-1} = \frac{z-2}{1}$. (Unit–II, L4)

Q5. Find the equation of the sphere passing through the points $(1, 0, 0)$, $(0, 1, 0)$, $(0, 0, 1)$ and $(1, 1, 1)$. (Unit–III, L3)

Q6. Find the tangent plane to the sphere $x^2 + y^2 + z^2 - 4x - 2y + 2z - 20 = 0$ at the point $(2, 2, 4)$. (Unit–III, L3)

Q7. Find the radical plane of the spheres $x^2 + y^2 + z^2 - 4x - 2y - 3 = 0$ and $x^2 + y^2 + z^2 + 2x - 4y + 1 = 0$. (Unit–IV, L3)

Q8. Show that the equation $x^2 + y^2 - z^2 = 0$ represents a cone and find its vertex. (Unit–V, L4)

PART – B ($5 \times 7 = 35$ Marks)

Answer five questions, choosing one from each unit. Each carries 7 Marks.

Unit–I

Q9. Find the equation of the plane which passes through the point $(1, -2, 3)$ and makes equal intercepts on the coordinate axes. (L3)

OR

Q10. Show that the bisector planes of the angle between the planes $2x - y + 2z = 3$ and $x + y + 2z = 5$ are perpendicular. (L4)

Unit–II

Q11. Find the equation of the line of shortest distance between the lines $\frac{x-1}{2} = \frac{y+2}{-1} = \frac{z}{1}$ and $\frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{-1}$. (L4)

OR

Q12. Find the angle between the lines of intersection of the planes $x + y + z = 1$ and $x - y + z = 5$ with the plane $2x + y - z = 0$. (L4)

Unit–III

Q13. Find the equation of the sphere through the circle $x^2+y^2+z^2-2x-4y-6 = 0,\ z = 0$ and passing through the point $(1, 1, 1)$. (L3)

OR

Q14. A sphere passes through the points $(1, 2, 3)$ and $(2, 3, 4)$ and has its centre on the plane $x + y + z = 6$. Find the equation of the sphere. (L3)

Unit–IV

Q15. Show that the radical plane of two spheres is perpendicular to the line joining their centres. (L4)

OR

Q16. Find the condition that the spheres $x^2 + y^2 + z^2 + 2x - 4y - 3 = 0$ and $x^2 + y^2 + z^2 - 3x + 6y + 8 = 0$ may cut orthogonally. (L4)

Unit–V

Q17. Find the equation of the right circular cone with vertex at the origin, axis along the line $\frac{x}{1} = \frac{y}{1} = \frac{z}{1}$, and semi-vertical angle 45°. (L4)

OR

Q18. Find the enveloping cone of the sphere $x^2 + y^2 + z^2 - 2x - 4y - 6z + 10 = 0$ with vertex at $(1, 2, 3)$. (L4)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	0%
L2 – Understanding	0%
L3 – Applying	50%
L4 – Analyzing	50%
L5 – Evaluating	0%
L6 – Creating	0%

11.5 Course 5 (Major): Group Theory & Problem Solving Sessions (w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.5.1 Syllabus of Course 5 (Major)

SEMESTER-III

COURSE 5: GROUP THEORY

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. acquire the basic knowledge and structure of groups
2. get the significance of the notation of a subgroup and cosets.
3. understand the concept of normal subgroups and properties of normal subgroup
4. study the homomorphisms and isomorphisms with applications.
5. understand the properties of permutation and cyclic groups

Course Content

Unit – 1
Groups

Binary Operation – Algebraic structure – semi group-monoid – Group definition and elementary properties Finite and Infinite groups – examples – order of a group, Composition tables with examples.

Unit – 2
Sub Groups

Complex Definition – Multiplication of two complexes Inverse of a complex-Subgroup definition-examples-criterion for a complex to be a subgroups; Criterion for the product of two subgroups to be a subgroup-union and Intersection of subgroups. Coset Definition – properties of Cosets – Index of a subgroups of a finite groups – Lagrange's Theorem.

Unit – 3
Normal Subgroups

Normal Subgroups: Definition of normal subgroup – proper and improper normal subgroup–Hamilton group- Criterion for a subgroup to be a normal subgroup – intersection of two normal subgroups Sub group of index 2 is a normal sub group

Unit – 4
Homomorphisms

Quotient groups, Definition of homomorphism – Image of homomorphism elementary properties of homomorphism – Isomorphism – automorphism definitions and elementary properties–kernel of a homomorphism – fundamental theorem on Homomorphism and applications.

Unit – 5
Permutations and Cyclic Groups

Definition of permutation – permutation multiplication – Inverse of a permutation – cyclic permutations – transposition – even and odd permutations – Cayley's theorem.

Cyclic Groups - Definition of cyclic group – elementary properties – classification of cyclic groups.

Activities

Seminar/ Quiz/ Assignments/ Applications of Group Theory to Real life Problem /Problem Solving Sessions.

Text Book

Modern Algebra by A.R.Vasishtha and A.K.Vasishtha, KrishnaPrakashanMedia Pvt. Ltd., Meerut.

Reference Books

1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir&Pundir, published by PragathiPrakashan

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11.5.2 Blue Print for Course 5 at end of Semester-III

Course 5:Group Theory & Problem Solving Sessions (w.e.f. 2023-24)

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	III	Theorem / Problem	3
	5	IV	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	V	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.5.1: Blueprint of Semester–III End Examination (Course–5: : Group Theory & Problem Solving Sessions

11.5.3 Model Question Paper for Course-5

GOVERNMENT AUTONOMOUS COLLEGE,
RAJAMAHENDRAVARAM
III Semester End Examinations
Course 5: Group Theory & Problem Solving Sessions
(For the batch admitted in 2023–24 under Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Maximum Marks: 50**

PART – A ($5 \times 3 = 15$ Marks)

Answer any Five questions. Each carries 3 Marks.

Q1. Write the composition table of $\mathbb{Z}_3 = \{0, 1, 2\}$ under addition modulo 3. (Unit–I, L1)

Q2. Define a group. Give one example of a finite group and one of an infinite group. (Unit–I, L1)

Q3. Prove that the intersection of two subgroups of a group G is a subgroup of G. (Unit–II, L3)

Q4. State and prove Lagrange's Theorem for finite groups. (Unit–II, L4)

Q5. Define a normal subgroup. Give an example of a proper normal subgroup. (Unit–III, L2)

Q6. Show that a subgroup of index 2 in a group is always normal. (Unit–III, L4)

Q7. Define a homomorphism of groups. Give an example. (Unit–IV, L2)

Q8. Write down the cycle decomposition of the permutation $(123)(45)$ and state whether it is even or odd. (Unit–V, L3)

PART – B ($5 \times 7 = 35$ Marks)

Answer five questions, choosing one from each unit. Each carries 7 Marks.

Unit–I

Q9. Verify whether $(\mathbb{Z}, +)$ and $(\mathbb{Z}, \cdot)$ are groups. Justify your answer. (L3)

OR

Q10. Show that the set $\{1, -1, i, -i\}$ under multiplication forms a group. (L3)

Unit–II

Q11. Prove that the union of two subgroups of a group G is a subgroup of G if and only if one is contained in the other. (L4)

OR

Q12. If H is a subgroup of a finite group G, prove that the order of H divides the order of G. (L4)

Unit–III

Q13. Show that the intersection of two normal subgroups of a group G is a normal subgroup of G. (L4)

OR

Q14. Prove that every subgroup of index 2 is normal in G with an example. (L4)

Unit–IV

Q15. State and prove the Fundamental Theorem on Homomorphism. (L4)

OR

Q16. Define isomorphism and automorphism. Show that every automorphism of a group is an isomorphism. (L4)

Unit–V

Q17. State and prove Cayley's Theorem. (L4)

OR

Q18. Prove that every subgroup of a cyclic group is cyclic. (L4)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	12%
L2 – Understanding	12%
L3 – Applying	18%
L4 – Analyzing	58%
L5 – Evaluating	0%
L6 – Creating	0%

11.6 Course 6 (Major):Numerical Methods & Problem Solving Sessions (w.e.f. 2023-24)(Only for B.Sc. Mathematics)

11.6.1 Syllabus of Course 6 (Major)

SEMESTER-III

COURSE 6: NUMERICAL METHODS

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. difference between the operators Δ, ∇, E and the relation between them
2. know about the Newton – Gregory Forward and backward interpolation
3. know the Central Difference operators δ, μ, σ and relation between them
4. solve Algebraic and Transcendental equations
5. understand the concept of Curve fitting

Course Content

Unit – 1

The calculus of finite differences

The operators Δ, ∇, E - Fundamental theorem of difference calculus- properties of Δ, ∇, E and problems on them to express any value of the function in terms of the leading terms and the leading differences - relations between E and D - relation between D and Δ - problems on one or more missing terms- Factorial notation- problems on separation of symbols- problems on Factorial notation.

Unit – 2

Interpolation with equal and unequal intervals

Derivations of Newton – Gregory Forward and backward interpolation and problems on them. Divided differences - Newton divided difference formula - Lagrange's and problems on them.

Unit – 3

Central Difference Interpolation formulae

Central Difference operators δ, μ, σ and relation between them - Gauss forward formula for equal intervals - Gauss Backward formula - Stirlings formula - Bessel's formula and problems on the above formulae.

Unit – 4

Solution of Algebraic and Transcendental equation

Method for finding initial approximate value of the root - Bisection method - to find the solution of given equations by using (i) Regula Falsi method (ii) Iteration method (iii) Newton – Raphson's method and problems on them.

Unit – 5

Curve Fitting

Least-squares curve fitting procedures - fitting a straight line-nonlinear curve fitting-curve fitting by a sum of exponentials

Activities

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions.

Text Book

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books

1. Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson,(2003) 7th Edition

2.Introductory Methods of Numerical Analysis by S.S. Sastry, (6^{th} Edition) PHI New Delhi 2012

3. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K. Iyengar and R. K. Jain, New Age International Publishers (2012), 6th edition.

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11.6.2 Blue Print for Course 6 at end of Semester-III

Course 6:Numerical Methods & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A $(5 \times 3 = 15)$	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B $(5 \times 7 = 35)$	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.6.1: Blueprint of Semester–III End Examination (Course–6: Numerical Methods & Problem Solving Sessions

11.6.3 Model Question Paper for Course-6

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

III Semester End Examinations

B.Sc. Mathematics(Honours) Major

Course 6: Numerical Methods & Problem Solving Sessions

(For the batch admitted in 2023–24 under Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Maximum Marks: 50**

PART – A (5 × 3 = 15 Marks)

Answer any FIVE questions. Each carries 3 Marks.

Q1. Find the forward differences of the function $f(x) = x^2 + 2x + 1$. (Unit–I, L2)

Q2. Using factorial notation, express $f(x + 3)$ in terms of $f(x)$ and its differences. (Unit–I, L3)

Q3. Using Newton–Gregory forward formula, interpolate the value of $f(x)$ at $x = 2.5$ given the data: $(1, 1), (2, 8), (3, 27), (4, 64)$. (Unit–II, L3)

Q4. Apply Newton's divided difference formula to find $f(5)$, given $f(2) = 4, f(4) = 16, f(6) = 36$. (Unit–II, L3)

Q5. Find the relation between central difference operator δ and shift operator E. (Unit–III, L2)

Q6. Find a real root of the equation $x^3 - x - 1 = 0$ using the Bisection method (two iterations). (Unit–IV, L3)

Q7. Solve $x^3 - 2x - 5 = 0$ using Newton–Raphson method (one iteration). (Unit–IV, L3)

Q8. Fit a straight line of the form $y = ax+b$ for the following data: $(1, 2), (2, 3), (3, 5), (4, 7)$. (Unit–V, L3)

PART – B ($5 \times 7 = 35$ Marks)

Answer five questions, choosing one from each unit. Each carries 7 Marks.

UNIT-1

Q9. State and prove the Fundamental Theorem of Difference Calculus. (L4)

OR

Q10. Using the method of separation of symbols, show that $\Delta^2 x^3 = 6x + 6$. (L3)

UNIT-2

Q11. Derive Newton–Gregory forward interpolation formula and illustrate with an example. (L4)

OR

Q12. Using Lagrange's interpolation formula, find the polynomial passing through the points $(1, 1), (2, 8), (3, 27)$. (L3)

UNIT-3

Q13. Derive Gauss forward interpolation formula and solve a suitable problem. (L4)

OR

Q14. From the following data, find $f(3.5)$ using Bessel's interpolation formula: $(2, 4), (3, 9), (4, 16), (5, 25$
(L3)

UNIT-4

Q15. Solve the equation $x^3 - x - 2 = 0$ by Regula–Falsi method (perform two iterations).
(L3)

OR

Q16. Solve the equation $\cos x = x$ using the iteration method up to three decimal places.
(L3)

UNIT-5

Q17. Fit a curve of the form $y = ax^2 + b$ to the following data: $(1, 2), (2, 5), (3, 10), (4, 17)$. (L3)

OR

Q18. Fit an exponential curve of the form $y = ab^x$ for the data: $(1, 1.9), (2, 6.1), (3, 17.1), (4, 46.0)$. (L3)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	0%
L2 – Understanding	12%
L3 – Applying	76%
L4 – Analyzing	12%
L5 – Evaluating	0%
L6 – Creating	0%

11.7 Course 7(Major) :Laplace Transforms & Problem Solving Sessions (w.e.f. 2023-24)(Only for B.Sc. Mathematics)

11.7.1 Syllabus of Course 7 (Major)

SEMESTER-III

COURSE 7: LAPLACE TRANSFORMS

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. understand the definition and properties of Laplace transformations
2. get an idea about first and second shifting theorems and change of scale property
3. understand Laplace transforms of standard functions like Bessel, Error function etc
4. know the reverse transformation of Laplace and properties
5. get the knowledge of application of convolution theorem

Course Content

Unit – 1

LAPLACE TRANSFORMS – I

Definition of Laplace Transform - Linearity Property - Piecewise Continuous Function - Existence of Laplace Transform - Functions of Exponential order and of Class A.

Unit – 2

LAPLACE TRANSFORMS – II

First Shifting Theorem, Second Shifting Theorem, Change of Scale Property, Laplace transform of the derivative of f(t), Initial value theorem and Final value theorem.

Unit – 3

LAPLACE TRNASFORM – III

Laplace Transform of Integrals - Multiplication by t, Multiplication by t^n - division by t -Laplace transform of Bessel Function - Laplace Transform of Error Function - Laplacetransform of Sine and Cosine integrals.

Unit – 4

INVERSE LAPLACE TRANSFORMS – I

Definition of Inverse Laplace Transform - Linearity Property - First Shifting Theorem -Second Shifting Theorem - Change of Scale property - use of partial fractions - Examples.

Unit – 5

INVERSE LAPLACE TRANSFORMS – II

Inverse Laplace transforms of Derivatives - Inverse Laplace Transforms of Integrals -Multiplication by Powers of 'p' - Division by powers of 'p' - Convolution Definition -Convolution Theorem - proof and Applications - Heaviside's Expansion theorem and itsApplications.

Activities

Seminar/ Quiz/ Assignments/ Applications of Laplace Transforms to Real life Problem /Problem Solving Sessions.

Text Book

LaplaceTransforms by A.R.Vasishtha,Dr.R.K.Gupta,KrishnaPrakashanMedia Pvt.Ltd., Meerut.

Reference Books

1. Introduction to Applied Mathematics by Gilbert Strang, Cambridge Press
2. Laplace and Fouries transforms by Dr.J.K. Goyal and K.P. Guptha, PragathiPrakashan, Meerut.

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11.7.2 Blue Print for Course 7 at end of Semester-III

Course 7:Laplace Transforms & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.7.1: Blueprint of Semester–III End Examination (Course–7: Laplace Transforms & Problem Solving Sessions

11.7.3 Model Question Paper for Course-7

Government College(A), Rajahmundry

B.Sc. Mathematics (Honours) Major

SEMESTER–III

Course–7: Laplace Transforms & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Section–A (5 × 3 = 15 Marks)

Answer any FIVE questions. Each carries 3 Marks.

Q1. Define Laplace transform. Find $L\{e^{2t}\}$. (Unit–I, L1)

Q2. State and prove the linearity property of Laplace transform. (Unit–I, L2)

Q3. State and prove the First Shifting Theorem. (Unit–II, L2)

Q4. Find the Laplace transform of $f(t) = \sin(at)$. (Unit–II, L3)

Q5. Find $L\{t \sin t\}$. (Unit–II, L3)

Q6. Find the Laplace transform of the Bessel function $J_0(t)$. (Unit–III, L3)

Q7. Find the inverse Laplace transform of $\frac{1}{s^2+4}$. (Unit–IV, L3)

Q8. State and prove the Convolution theorem of Laplace transforms. (Unit–V, L4)

PART – B (5 × 7 = 35 Marks)

Answer five questions, choosing one from each unit. Each carries 7 Marks.

UNIT-1

Q9. Define Laplace transform and prove the existence theorem for piecewise continuous functions. (L4)

OR

Q10. Find the Laplace transform of $f(t) = e^{at} \sin bt$. (L3)

UNIT-2

Q11. Prove the Second Shifting Theorem and illustrate it with an example. (L4)

OR

Q12. State and prove the Initial and Final Value Theorems. (L4)

UNIT-3

Q13. Find the Laplace transform of $\frac{\sin t}{t}$. (L3)

OR

Q14. Find the Laplace transform of the Error function $\text{erf}(\sqrt{t})$. (L3)

UNIT-4

Q15. Find the inverse Laplace transform of $\frac{s+2}{s^2+4}$. (L3)

OR

Q16. Using partial fractions, find $L^{-1}\left\{\frac{2s+3}{s^2+3s+2}\right\}$. (L3)

UNIT-5

Q17. State and prove the Convolution Theorem. Apply it to find $L^{-1}\left\{\frac{1}{s(s+1)}\right\}$. (L4)

OR

Q18. State and prove Heaviside's Expansion Theorem. Use it to find the inverse Laplace transform of $\frac{1}{(s+1)(s+2)(s+3)}$. (L4)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	6%
L2 – Understanding	12%
L3 – Applying	46%
L4 – Analyzing	36%
L5 – Evaluating	0%
L6 – Creating	0%

11.8 Course 8 (Major):Special Functions & Problem Solving Sessions (w.e.f. 2023-24)(Only for B.Sc. Mathematics)

11.8.1 Syllabus of Course 8 (Major)

SEMESTER-III

COURSE 8: SPECIAL FUNCTIONS

Theory Credits: 4 5 hrs/week

Learning Outcomes

After successful completion of the course will be able to

1. Understand the Beta and Gamma functions, their properties and relation between these two functions, understand the orthogonal properties of Chebyshev polynomials and recurrence relations.
2. Find power series solutions of ordinary differential equations.
3. Solve Hermite equation and write the Hermite Polynomial of order (degree) n, also Find the generating function for Hermite Polynomials, study the orthogonal properties of Hermite Polynomials and recurrence relations.
4. Solve Legendre equation and write the Legendre equation of first kind, also find the generating function for Legendre Polynomials, understand the orthogonal properties of Legendre Polynomials.
5. Solve Bessel equation and write the Bessel equation of first kind of order n, also find the generating function for Bessel function understand the orthogonal properties of Bessel unction.

Course Content

Unit–1

Beta and Gamma functions, Chebyshev polynomials

Euler'sIntegrals-BetaandGammaFunctions,ElementarypropertiesofGammaFunctions, TransformationofGamma Functions.

AnotherformofBetaFunction,Relationbetween BetaandGamma Functions.

Chebyshevpolynomials,orthogonalpropertiesofChebyshevpolynomials,recurrence relations, generating functions for Chebyshev polynomials.

Unit–2

PowerseriesandPowerseriessolutionsofordinarydifferentialequations

Introduction,summaryofusefulresults,powerseries,radiusofconvergence,theorems on Power series

Introductionofpowerseriessolutionsofordinarydifferential equation

Ordinaryandsingularpoints,regularandirregularsingularpoints,power series solution.

Unit–3

Hermitepolynomials

HermiteDifferentialEquations,SolutionofHermiteEquation,Hermite polynomials, generating function for Hermite polynomials.OtherformsforHermitePolynomials,RodriguesformulaforHermite Polynomials, to find first few Hermite Polynomials.OrthogonalpropertiesofHermitePolynomials,Recurrenceformulaefor Hermite Polynomials.

Unit–4

Legendrepolynomials

Definition,SolutionofLegendre'sequation,Legendrepolynomialofdegree n, generating function of Legendre polynomials.Definitionof$P_n(x)$and$Q_n(x)$, GeneralsolutionofLegendre'sEquation(derivationsnot required)toshowthat$P_n(x)$isthecoefficientof h^n,intheexpansionof $(1-2xh+h^2)^{-1/2}$ OrthogonalpropertiesofLegendre'spolynomials,RecurrenceformulasforLegendre's Polynomials.

Unit–5

Bessel'sequation

Definition,SolutionofBessel'sequation,Bessel'sfunctionofthefirstkindof ordern,Bessel's functionofthesecondkindofordern.

IntegrationofBessel'sequationinseriesform=0, Definition of $J_n(x)$ recurrenceformulaefor$J_n(x)$ Generating function for$J_n(x)$,orthogonally of Bessel functions.

Activities

Seminar/ Quiz/ Assignments/ Applications of Special functions to Real life Problem /Problem Solving Sessions.

Text Book

SpecialFunctions by J.N.SharmaandDr.R.K.Gupta,KrishnaPrakashan,

ReferenceBooks

1. Dr.M.D.Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055.
2. Shanti Narayan and Dr.P.K.Mittal, Integral Calculus, S. Chand &CompanyPvt. Ltd., Ram Nagar, New Delhi-110055.
3. GeorgeF.Simmons,DifferentialEquationswithApplicationsandHistoricalNotes,Tata McGRAW-Hill Edition, 1994.

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11.8.2 Blue Print for Course 8 at end of Semester-III

Course 8:Special Functions & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.8.1: Blueprint of Semester–III End Examination (Course–8: Special Functions & Problem Solving Sessions

11.8.3 Model Question Paper for Course-8

Government College(A),Rajahmundry

BSc Mathematics (Honours) Major

SEMESTER–III
COURSE–8: Special Functions & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A (Answer any FIVE questions, each carries 3 Marks)

Q1. Define the Gamma function. State one of its properties. (L1)

Q2. Evaluate $\int_0^\infty e^{-x^2}\,dx$ using Gamma function. (L3)

Q3. Write the power series expansion of e^x. Find its radius of convergence. (L1)

Q4. Distinguish between an ordinary point and a singular point of a differential equation. (L2)

Q5. Write the first three Hermite polynomials. (L1)

Q6. State the generating function for Hermite polynomials. (L1)

Q7. Verify the recurrence relation for Legendre polynomials for $n = 1, 2$. (L5)

Q8. Apply the generating function of Bessel functions to find $J_0(x)$. (L3)

PART – B

(Answer five questions, choosing **one** from each unit. Each carries 7 Marks)

. $5 \times 7 = 35$ Marks

UNIT–1

Q9. Define Beta and Gamma functions. Show that

$$B(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}.$$

(L2)

OR

Q10. Prove the orthogonality relation of Chebyshev polynomials. (L3)

UNIT–2

Q11. Find the power series solution about $x = 0$ of the differential equation

$$(1 - x)y'' - xy' + y = 0.$$

(L4)

OR

Q12. Explain ordinary point, regular singular point, and irregular singular point with examples. (L2)

UNIT–3

Q13. Solve Hermite's differential equation and obtain Hermite polynomials. (L3)

OR

Q14. Prove the recurrence relation:

$$H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x).$$

(L3)

UNIT–4

Q15. Solve Legendre's differential equation and show that its solution is a Legendre polynomial. (L3)

OR

Q16. Verify that

$$\int_{-1}^{1} P_m(x)P_n(x)\,dx = \frac{2}{2n+1}\delta_{mn}.$$

(L5)

UNIT–5

Q17. Solve Bessel's differential equation and define the Bessel function of the first kind of order n. (L3)

OR

Q18. Using the generating function for Bessel functions, find explicit expressions for $J_0(x)$ and $J_1(x)$. (L3)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.9 Course 9 (Major):Ring Theory & Problem Solving Sessions (w.e.f. 2023-24) (Common for BSc Mathematics & BSc Computational Mathematics)

11.9.1 Syllabus of Course 9 (Major)

SEMESTER-IV

COURSE 9: RING THEORY

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. acquire the basic knowledge of rings, fields and integral domains
2. get the knowledge of subrings and ideals
3. construct composition tables for finite quotient rings
4. study the homomorphisms and isomorphisms with applications.
5. get the idea of division algorithm of polynomials over a field.

Course Content

Unit – 1

Ringsand Fields

Definition of a ring and Examples –Basic properties – Boolean rings - Fields – Divisors of 0 and Cancellation Laws– Integral Domains – Division ring - The Characteristic of a Ring, Integral domain and Field – NonCommutative Rings - Matrices over a field – The Quaternion ring.

Unit – 2

Subrings and Ideals

Definition and examples of Subrings – Necessary and sufficient conditions for a subset to be a subring – Algebra of Subrings – Centre of a ring – left, right and two sided ideals – Algebra of ideals – Equivalence of a field and a commutative ring without proper ideals

Unit III: Principal ideals and Quotient rings

Definition of a Principal ideal ring(Domain) – Every field is a PID – The ring of integers is a PID – Example of a ring which is not a PIR – Cosets – Algebra of cosets – Quotient rings – Construction of composition tables for finite quotient rings of the ring Z of integers and the ring $Z_n$of integers modulo n.

Unit – 4

Homomorphism of Rings

Homomorphism of Rings – Definition and Elementary properties – Kernel of a homomorphism – Isomorphism – Fundamental theorems of homomorphism of rings – Maximal and prime Ideals – Prime Fields

Unit – 5

Rings of Polynomials

Polynomials in an indeterminate – The Evaluation morphism -- The Division Algorithm in $F[x]$ – Irreducible Polynomials – Ideal Structure in $F[x]$ – Uniqueness of Factorization $F[x]$.

Activities

Seminar/ Quiz/ Assignments/ Applications of ring theory concepts to Real life Problem /Problem Solving Sessions.

Text book

Modern Algebra by A.R.Vasishta and A.K.Vasishta, Krishna Prakashan Media Pvt. Ltd.

Reference books

1**.** A First Course in Abstract Algebra by John. B. Farleigh, Narosa Publishing House.

2. Linear Algebra by Stephen. H. Friedberg and Others,Pearson Education India

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11.9.2 Blue Print for Course 9 at end of Semester-IV

Course 9:Ring Theory& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	**Q.No.**	**Unit**	**Nature of Question**	**Marks**
A $(5 \times 3 = 15)$	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B $(5 \times 7 = 35)$	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.9.1: Blueprint of Semester–IV End Examination (Course–9:Ring Theory & Problem Solving Sessions

11.9.3 Model Question Paper for Course-9

Government College(A),Rajahmundry

BSc Mathematics (Honours) Major

SEMESTER–IV
COURSE–9: Ring Theory & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A

(Answer any FIVE questions, each carries 3 Marks)

Q1. Define a ring. Give examples of a commutative and a non-commutative ring. (L1)

Q2. State and prove the cancellation law in an integral domain. (L2)

Q3. Define a Boolean ring and give one example. (L1)

Q4. Explain the concept of a subring with necessary and sufficient conditions. (L2)

Q5. Define left, right, and two-sided ideals with examples. (L1)

Q6. Construct a quotient ring using integers modulo 5. (L3)

Q7. State the fundamental theorem of homomorphism of rings. (L2)

Q8. Explain the division algorithm for polynomials over a field. (L2)

PART – B

(Answer five questions, choosing **one** from each unit. Each carries 7 Marks)

. $5 \times 7 = 35$ Marks

UNIT–1

Q9. Prove that the characteristic of a field is either 0 or a prime number. (L3)

OR

Q10. Show that every division ring is an integral domain but not necessarily a field. (L3)

UNIT–2

Q11. Determine whether the subset $2\mathbb{Z}$ is an ideal in the ring $\mathbb{Z}$. (L3)

OR

Q12. Prove that the center of a ring is a subring. (L2)

UNIT–3

Q13. Construct the quotient ring $\mathbb{Z}_6/2\mathbb{Z}_6$ and write its composition table. (L3)

OR

Q14. Give an example of a principal ideal ring which is not a field. (L3)

UNIT–4

Q15. Let $\phi : \mathbb{Z} \to \mathbb{Z}_5$ be defined by $\phi(n) = n \bmod 5$. Prove that ϕ is a homomorphism and find its kernel. (L4)

OR

Q16. Show that a maximal ideal in a commutative ring with unity leads to a field in the quotient ring. (L3)

UNIT–5

Q17. UNIT–5
Use the division algorithm to divide $x^4 + 2x^3 + x + 1$ by $x^2 + 1$ over $\mathbb{Q}[x]$. (L3)

OR

Q18. Prove that every non-zero polynomial in $\mathbb{F}[x]$ can be uniquely factored into irreducible polynomials. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.10 Course 10 (Major) :Introduction to Real Analysis & Problem Solving Sessions (w.e.f. 2023-24) (Common for B.Sc. Mathematics & B.Sc.Computat Mathematics)

11.10.1 Syllabus of Course 10 (Major)

SEMESTER-IV

COURSE 10: INTRODUCTION TO REAL ANALYSIS

Theory Credits: 4 5 hrs/week

CourseOutcomes

Aftersuccessfulcompletionofthiscourse,thestudentwillbeableto

1. get clearideaaboutthe realnumbersandrealvaluedfunctions.
2. obtaintheskillsofanalysingtheconceptsandapplyingappropriatemethodsfortesting convergence of a sequence/ series.
3. testthecontinuityand differentiabilityandRiemannintegrationofafunction.
4. knowthegeometricalinterpretationofmeanvalue theorems.
5. know about the fundamental theorem of integral calculus

Course Contents

Unit – 1

REALNUMBERS,REAL SEQUENCES

The algebraic and order properties of R - Absolute value and Real line - Completeness property of R - Applications of supremum property - intervals. (**No question is to be set from this portion)**

Sequences and their limits -Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence -The Cauchy's criterion - properly divergent sequences - Monotone sequences - Necessary and Sufficient condition for Convergence of Monotone Sequence - Limit Point of Sequence -Subsequencesand the Bolzano-weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence.

Unit – 2

INFINITIE SERIES

Introductiontoseries -convergenceofseries -Cauchy'sgeneralprincipleof convergencefor series tests for convergence of series - Series of non-negative terms - P-test - Cauchy'sn^{th} roottest -D'-Alembert'sTest-AlternatingSeries–Leibnitz Test.

Unit –3

LIMIT & CONTINUITY

Real valued Functions - Boundedness of a function - Limits of functions - Some extensions of the limit concept - Infinite Limits - Limits at infinity **(No question is to be set from this portion).**Continuous functions - Combinations of continuous functions - Continuous Functions on intervals - uniform continuity.

Unit – 4

DIFFERENTIATION ANDMEANVALUETHEORMS

The derivability of a function at a point and and on an interval - Derivability and continuity of a function -MeanvalueTheorems -Rolle'sTheorem,Lagrange's Theorem, Cauchy's Mean value Theorem

Unit – 5

RIEMANNINTEGRATION

Riemann Integral - Riemann integral functions - Darboux theorem -Necessary and sufficientcondition for R integrability - Properties of integrable functions - Fundamental theorem of integral calculus - integral as the limit of a sum - Mean value Theorems.

Activities

Seminar/ Quiz/ Assignments/ Applications of Real Analysis to Real life Problem /Problem Solving Sessions.

TextBook

An Introduction to Real Analysis by Robert G.Bartle and Donlad R. Sherbert, John Wiley and sonsPvt. Ltd

ReferenceBooks

1. ElementsofRealAnalysis by ShanthiNarayan andDr.M.D.Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.

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11.10.2 Blue Print for Course 10 at end of Semester-IV

Course 10:Introduction to Real Analysis& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.10.1: Blueprint of Semester–IV End Examination (Course–1O:Introduction to Real Analysis & Problem Solving Sessions

11.10.3 Model Question Paper for Course-10

Government College (A), Rajahmundry

B.Sc Mathematics (Honours) Major

SEMESTER–IV

COURSE–10: Introduction to Real Analysis & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A (Answer any FIVE questions, each carries 3 Marks) $5 \times 3 = 15$ Marks

Q1. Define a convergent sequence and state the Cauchy criterion. (L1)

Q2. Give an example of a monotone sequence and test its convergence. (L2)

Q3. Define a series and state the Cauchy root test. (L1)

Q4. State the Leibnitz test for alternating series with an example. (L2)

Q5. Define uniform continuity and give an example. (L1)

Q6. State Rolle's theorem and give a simple application. (L2)

Q7. State Lagrange's mean value theorem. (L1)

Q8. Define Riemann integrability of a function. (L1)

Part–B

(Answer five questions, choosing one from each unit. Each carries 7 Marks)

$5 \times 7 = 35$ Marks

UNIT–1

Q9. Prove that every bounded monotone sequence is convergent. (L3)

OR

Q10. Prove the Bolzano–Weierstrass theorem for sequences. (L4)

UNIT–2

Q11. Test the convergence of the series $\sum_{n=1}^{\infty} \frac{1}{n^2}$ using the p-test. (L3)

OR

Q12. Test the convergence of $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n}$ using the Leibnitz test. (L3)

UNIT–3

Q13. Prove that a continuous function on a closed interval is bounded. (L3)

OR

Q14. Prove that a uniformly continuous function preserves Cauchy sequences. (L3)

UNIT–4

Q15. Verify Lagrange's mean value theorem for $f(x) = x^3 - 3x$ in $[0, 2]$. (L4)

OR

Q16. Apply Cauchy's mean value theorem to $f(x) = x^2, g(x) = x$ in $[1, 3]$. (L3)

UNIT–5

Q17. Evaluate $\int_0^1 x^2\,dx$ using Riemann sums. (L3)

OR

Q18. Prove the fundamental theorem of calculus for $f(x) = 3x^2$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.11 Course 11 (Major) :Integral Transforms with Applications & Problem Solving Sessions(w.e.f. 2023-24)(Only for B.Sc. Mathematics)

11.11.1 Syllabus of Course 11 (Major)

SEMESTER-IV

COURSE 11: INTEGRAL TRANSFORMS WITH APPLICATIONS

Theory Credits: 4 5 hrs/week

LearningOutcomes

Studentsaftersuccessfulcompletionofthecoursewillbeableto

1. understand the application of Laplace transforms to solve ODEs
2. understand the application of Laplace transforms to solve Simultaneous DEs
3. understand the application of Laplace transforms to Integral equations
4. basic knowledge of Fourier-Transformations
5. Comprehend thepropertiesofFouriertransformsandsolveproblemsrelatedtofinite Fourier transforms.

Course Content

Unit – 1

Application of Laplace Transform to solutions of Differential Equations

Solutions of ordinary Differential Equations - Solutions of Differential Equations with constants coefficients - Solutions of Differential Equations with Variable coefficients.

Unit – 2

Application of Laplace Transform to solutions of Differential Equations

Solutions of Simultaneous Ordinary Differential equations - Solutions of Partial Differential Equations**.**

Unit – 3

Application of Laplace Transforms to Integral Equations

Definitions of Integral Equations - Abel's Integral Equation - Integral Equation of Convolution Type - Integral Differential Equations - Application of L.T. to Integral Equations**.**

Unit – 4

Fourier Transforms - I

Definition of Fourier Transform - Fourier sine Transform - Fourier cosine Transform - Linear Property of Fourier Transform - Change of Scale Property for Fourier Transform - sine Transform and cosine transform shifting property - Modulation theorem.

Unit – 5

Fourier Transforms – II

Definition of Convolution - Convolution theorem for Fourier transform - Parseval's Identity - Relationship between Fourier and Laplace transforms - problems related to Integral Equations -Finite Fourier Transforms - Finite Fourier Sine Transform - Finite Fourier Cosine Transform - Inversion formula for sine and cosine transforms only - statement and related problems**.**

Activities

Seminar/ Quiz/ Assignments/Applications of Integral Transforms in real life problems /Problem Solving Sessions.

Text Book

B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.

Reference Book

1. Fourier Series and Integral Transformations by Dr.S. Sreenadh and others, published by S.Chand and Co, New Delhi
2. E.M. Stein and R. Shakarchi, Fourier analysis: An introduction, (Princeton University Press, 2003).
3. R.S. Strichartz, A guide to Distribution theory and Fourier transforms, (World scientific, 2003).

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11.11.2 Blue Print for Course 11 at end of Semester-IV

Course 11:Integral Transforms with Applications& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.11.1: Blueprint of Semester–IV End Examination (Course–11:Integral Transforms with Applications & Problem Solving Sessions

11.11.3 Model Question Paper for Course-11

Government College (A), Rajahmundry

B.Sc Mathematics (Honours) Major

SEMESTER–IV

COURSE–11: Integral Transforms with Applications & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A (Answer any FIVE questions, each carries 3 Marks) $5 \times 3 = 15$Marks

Q1. Define the Laplace transform and give two examples. (L1)

Q2. State the linearity property of Laplace transform with example. (L1)

Q3. Solve $\dfrac{dy}{dt} + 2y = e^{-3t}$ using Laplace transform. (L3)

Q4. Solve the simultaneous differential equations $\dfrac{dx}{dt} = x + y, \dfrac{dy}{dt} = x - y$ using Laplace transform. (L3)

Q5. Define Abel's integral equation with an example. (L1)

Q6. State the convolution theorem for Laplace transforms. (L2)

Q7. Define Fourier sine and cosine transforms. (L1)

Q8. State the inversion formula for finite Fourier sine transform. (L2)

Part–B

(Answer five questions, choosing one from each unit. Each carries 7 Marks)
$5 \times 7 = 35$Marks

UNIT–1

Q9. Solve the differential equation $\dfrac{d^2y}{dt^2} - 3\dfrac{dy}{dt} + 2y = \sin t$ using Laplace transform. (L3)

OR

Q10. Solve $\frac{d^2y}{dt^2} + 4y = e^{-t}$ using Laplace transform method. (L3)

UNIT–2

Q11. Solve the system: $\frac{dx}{dt} = 2x+y, \frac{dy}{dt} = x+2y$ with initial conditions $x(0) = 1, y(0) = 0$ using Laplace transform. (L3)

OR

Q12. Solve the partial differential equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, $u(x, 0) = \sin(\pi x)$, using Laplace transform. (L4)

UNIT–3

Q13. Solve the integral equation $\phi(t) = t + \int_0^t (t-s)\phi(s)ds$ using Laplace transform. (L3)

OR

Q14. Solve Abel's integral equation $\int_0^t \frac{\phi(s)}{\sqrt{t-s}} ds = t$ for $\phi(t)$. (L4)

UNIT–4

Q15. Find the Fourier sine and cosine transforms of $f(x) = e^{-ax}$. (L3)

OR

Q16. Verify the linearity property of Fourier transform for $f(x) = x, g(x) = x^2$. (L3)

UNIT–5

Q17. Find the finite Fourier sine transform of $f(x) = x$ in $0 < x < \pi$. (L3)

OR

Q18. Verify Parseval's identity for $f(x) = \sin x$ in $0 < x < \pi$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.12 Course 12 (Major) :Linear Algebra & Problem Solving Sessions (w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.12.1 Syllabus of Course 12 (Major)

SEMESTER-V

COURSE 12: LINEAR ALGEBRA

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. understand the concepts of vector spaces, subspaces
2. understand the concepts of basis, dimension and their properties
3. understand the concept of linear transformation and its properties
4. apply Cayley- Hamilton theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods
5. learn the properties of inner product spaces and determine orthogonality in inner product spaces.

Course Content

UNIT – I

Vector Spaces-I

Vector Spaces - General properties of vector spaces - n-dimensional Vectors - addition and scalar multiplication of Vectors - internal and external composition - Null space - Vector subspaces -Algebra of subspaces - Linear Sum of two subspaces - linear combination of Vectors- Linear span Linear independence and Linear dependence of Vectors.

UNIT –II

Vector Spaces-II

Basis of Vector space - Finite dimensional Vector spaces - basis extension - co-ordinates- Dimension of a Vector space - Dimension of a subspace - Quotient space and Dimension of Quotient space.

UNIT –III

Linear Transformations

Linear transformations - linear operators- Properties of L.T- sum and product of L.Ts - Algebra of Linear Operators - Range and null space of linear transformation - Rank and Nullity of linear transformations - Rank- Nullity Theorem.

UNIT –IV

Matrices

Characteristic equation - Characteristic Values - Characteristic vectors of a square matrix - Cayley Hamilton Theorem – problems on Cayley Hamilton Theorem.

UNIT –V

Inner product space

Inner product spaces- Euclidean and unitary spaces- Norm or length of a Vector- Schwartz inequality- Triangle Inequality- Parallelogram law- Orthogonality- Orthonormal set- Problems on Gram– Schmidt orthogonalisation process - Bessel's inequality.

Activities :

Seminar/ Quiz/ Assignments/Applications of Linear Algebra in real life problems\ Problem Solving.

Text Books

1.Linear Algebra by J.N. Sharma and A.R. Vasishtha, published by Krishna Prakashan Media (P) Ltd.

2.Matrices by A.R.Vasishtha and A.K.Vasishtha published by Krishna Prakashan Media (P) Ltd.

Reference Books

1. Linear Algebra by Stephen H. Friedberg et. al. published by Prentice Hall of India Pvt. Ltd. 4th Edition, 2007
2. Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson education low priced edition), New Delhi.
3. Matrices by Shanti Narayana, published by S.Chand Publications

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11.12.2 Blue Print for Course 12 at end of Semester-V/VI

Course 12:Linear Algebra& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	V	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.12.1: Blueprint of Semester–V/VI End Examination (Course–12:Linear Algebra & Problem Solving Sessions

11.12.3 Model Question Paper for Course-12

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

B.Sc. Mathematics (Honours) Major

SEMESTER–V/VI

Course 12: Linear Algebra & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Maximum Marks: 50**

PART – A (Answer any **Five questions. Each carries 3 Marks**) $5 \times 3 = 15$ Marks

Q1. Define a vector space. Verify whether the set of all 2×2 matrices forms a vector space. (Unit–I, L1)

Q2. Show that the intersection of two subspaces is also a subspace. (Unit–I, L2)

Q3. Find a basis and the dimension of the subspace of $\mathbb{R}^3$ defined by $x + y + z = 0$. (Unit–II, L3)

Q4. Explain the concept of quotient space and find the dimension of $\mathbb{R}^3/W$, where $W = \{(x, y, 0)\}$. (Unit–II, L3)

Q5. Define linear transformation. Determine whether $T : \mathbb{R}^2 \to \mathbb{R}^2, T(x, y) = (x+y, x-y)$ is linear. (Unit–III, L2)

Q6. Verify the rank-nullity theorem for the linear transformation $T(x, y, z) = (x+y, y+z)$. (Unit–III, L3)

Q7. Find the characteristic values and characteristic vectors of the matrix $\begin{bmatrix} 2 & 0 \\ 1 & 3 \end{bmatrix}$. (Unit–IV, L3)

Q8. State and prove the Cauchy-Schwarz inequality in inner product spaces. (Unit–V, L4)

PART – B (Answer five questions, choosing **one from each unit. Each carries 7 Marks**) $5 \times 7 = 35$ Marks

UNIT–I

Q9. Prove that any linear combination of vectors in a subspace is also in the subspace. (L3)

OR

Q10. Show that the linear sum of two subspaces is a subspace and determine its dimension in a given example. (L4)

UNIT–II

Q11. Find a basis for the quotient space $\mathbb{R}^3/W$ where W is spanned by $\{(1,0,0),(0,1,0)\}$. (L3)

OR

Q12. Extend the basis $\{(1,0,0),(0,1,0)\}$ of a subspace of $\mathbb{R}^3$ to a basis of $\mathbb{R}^3$. (L4)

UNIT–III

Q13. Let $T:\mathbb{R}^2\to\mathbb{R}^2$ be defined by $T(x,y)=(2x+3y,x+y)$. Find the range and null space of T. (L3)

OR

Q14. If T_1 and T_2 are linear transformations, prove that T_1+T_2 and $T_1\circ T_2$ are also linear. (L4)

UNIT–IV

Q15. Using Cayley-Hamilton theorem, find A^{-1} for $A=\begin{bmatrix}1&2\\3&4\end{bmatrix}$. (L3)

OR

Q16. Find A^5 using Cayley-Hamilton theorem for $A=\begin{bmatrix}2&1\\1&2\end{bmatrix}$. (L4)

UNIT–V

Q17. Apply Gram-Schmidt process to orthonormalize the vectors $(1,1,0),(1,0,1),(0,1,1)$ in $\mathbb{R}^3$. (L5)

OR

Q18. Verify Bessel's inequality for the vectors $(1,1,0),(1,0,1)$ in $\mathbb{R}^3$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	6%
L2 – Understanding	12%
L3 – Applying	40%
L4 – Analyzing	22%
L5 – Evaluating	10%
L6 – Creating	10%

11.13 Course 13 (Major) :Vector Calculus & Problem Solving Sessions (w.e.f. 2023-24)(Common for B.Sc. Mathematics & B.Sc.Computational Mathematics)

11.13.1 Syllabus of Course 13 (Major)

SEMESTER-V

COURSE 13: VECTOR CALCULUS

Theory Credits: 4 5 hrs/week

Course Outcomes

Studentsaftersuccessfulcompletionofthecoursewillbeableto

1. Learnmultipleintegrals asanaturalextensionofdefiniteintegraltoafunctionoftwovariables inthecaseofdoubleintegral/threevariables inthecaseoftripleintegral.
2. Learnapplicationsintermsoffindingsurfaceareabydoubleintegralandvolumebytripleintegral.
3. Determinethegradient,divergenceandcurlofavectorandvectoridentities.
4. Evaluateline,surfaceandvolumeintegrals.
5. understand relation between surface and volume integrals (Gauss divergence theorem),relationbetweenlineintegralandvolumeintegral(Green'stheorem),relationbetween lineandsurfaceintegral(Stokestheorem)

Course Content

Unit–1
MultipleIntegrals-I

Introduction -Doubleintegrals -Evaluationofdoubleintegrals –Propertiesofdouble integrals -Regionofintegration -doubleintegrationinPolarCo-ordinates – Changeofvariablesindoubleintegrals -changeoforderofintegration.

Unit–2
Multipleintegrals-II

Tripleintegral -regionofintegration -changeofvariables -Plane areasbydoubleintegrals - surfaceareabydoubleintegral -Volumeasadoubleintegral,volumeasatripleintegral.

Unit–3
Vectordifferentiation

Vectordifferentiation –ordinary - derivativesofvectors – Differentiability –Gradient –Divergence - Curloperators - Formulaeinvolvingtheseparators.

Unit–4
Vectorintegration

Line Integralswithexamples - Surface Integralwithexamples - Volumeintegralwithexamples.

Unit–5
Vectorintegrationapplications

Gausstheoremandapplicationsof Gausstheorem - Green'stheoreminplane and applicationsofGreen'stheorem - Stokes'stheoremandapplications ofStokestheorem.

Activities

Seminar/ Quiz/ Assignments/ Applications of Vector calculus to Real life Problems /Problem Solving Sessions.

Text Book

A text Book of Higher Engineering Mathematics by B.S.Grawal, Khanna Publishers, 43rd Edition

ReferenceBooks

1. Vector Calculus by P.C.Matthews, Springer Verlag publications.
2. Vector Analysis by Murray Spiegel, Schaum Publishing Company, NewYork

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11.13.2 Blue Print for Course 13 at end of Semester-V/VI

Course 13:Vector Calculus & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	III	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.13.1: Blueprint of Semester–V/VI End Examination (Course–13:Vector Calculus & Problem Solving Sessions

11.13.3 Model Question Paper for Course-13

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

B.Sc. Mathematics (Honours) Major

SEMESTER–V/VI

Course 13: Vector Calculus & Problem Solving Sessions

Duration: $2\frac{1}{2}$ **Hours** **Maximum Marks: 50**

PART – A (5 × 3 = 15 Marks)

(Answer any **Five questions. Each carries 3 Marks**)

Q1. Evaluate the double integral $\iint_R (x+y)\,dxdy$, where R is the rectangle $0 \le x \le 1$, $0 \le y \le 2$. (Unit–I, L3)

Q2. Change the order of integration for $\int_0^1 \int_x^1 f(x,y)\,dydx$. (Unit–I, L2)

Q3. Evaluate the triple integral $\iiint_V z\,dV$, where V is the cube $0 \le x,y,z \le 1$. (Unit–II, L3)

Q4. Find the gradient of the scalar function $f(x,y,z) = x^2y + y^2z + z^2x$. (Unit–III, L2)

Q5. Compute the divergence and curl of $\mathbf{F} = (xy, yz, zx)$. (Unit–III, L3)

Q6. Evaluate the line integral $\int_C (y\,dx + x\,dy)$ along the straight line from $(0,0)$ to $(1,1)$. (Unit–IV, L3)

Q7. Evaluate the surface integral $\iint_S z\,dS$, where S is the plane $z = 2 - x - y$ over the region $x \ge 0, y \ge 0, x + y \le 2$. (Unit–IV, L4)

Q8. State Gauss's divergence theorem and apply it to verify $\iiint_V (\nabla \cdot \mathbf{F})dV = \iint_S \mathbf{F} \cdot \mathbf{n}dS$ for $\mathbf{F} = (x,y,z)$ and V is the unit cube. (Unit–V, L4)

PART – B (5 × 7 = 35 Marks)

(Answer five questions, choosing **one from each unit. Each carries 7 Marks**)

UNIT–I

Q9. Evaluate $\iint_R (x^2+y^2)\,dxdy$ over the circular region $x^2 + y^2 \le 1$ using polar coordinates. (L3)

OR

Q10. Change the order of integration and evaluate $\int_0^1 \int_x^{\sqrt{x}} e^{y^2} dydx$. (L4)

UNIT–II

Q11. Find the volume of the solid bounded by the paraboloid $z = 4 - x^2 - y^2$ and the plane $z = 0$. (L4)

OR

Q12. Find the surface area of the part of the plane $z = x + y$ lying above the square $0 \leq x, y \leq 1$. (L4)

UNIT–III

Q13. For $\mathbf{F} = (x^2, y^2, z^2)$, compute $\nabla \cdot \mathbf{F}$ and $\nabla \times \mathbf{F}$. (L3)

OR

Q14. Verify the vector identity $\nabla \times (\nabla f) = 0$ for $f(x, y, z) = xyz$. (L3)

UNIT–IV

Q15. Evaluate the line integral $\oint_C (y\,dx + z\,dy + x\,dz)$, where C is the boundary of the triangle with vertices $(1, 0, 0), (0, 1, 0), (0, 0, 1)$. (L4)

OR

Q16. Evaluate the surface integral $\iint_S \mathbf{F} \cdot \mathbf{n}\,dS$ for $\mathbf{F} = (x, y, z)$ over the surface of the cube $0 \leq x, y, z \leq 1$. (L4)

UNIT–V

Q17. Use Green's theorem to evaluate $\oint_C (x^2y\,dx + xy^2\,dy)$, where C is the square with vertices $(0, 0), (1, 0), (1, 1), (0, 1)$. (L4)

OR

Q18. Use Stokes' theorem to evaluate $\oint_C \mathbf{F} \cdot d\mathbf{r}$ for $\mathbf{F} = (-y, x, z)$ around the boundary of the triangle with vertices $(1, 0, 0), (0, 1, 0), (0, 0, 1)$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	0%
L2 – Understanding	12%
L3 – Applying	36%
L4 – Analyzing	30%
L5 – Evaluating	12%
L6 – Creating	10%

11.14 Course 14 (Major): Elective A OR B (w.e.f. 2023-24) (Only for B.Sc. Mathematics)

11.14.1 Course 14 (Major)(Elective A):Functions of a complex variables & Problem Solving Sessions (Only for B.Sc. Mathematics)

11.14.1.1 Syllabus of Course 14 Elective A (Major)

SEMESTER-V

COURSE 14: FUNCTIONS OF A COMPLEX VARIABLE

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. determine a Bilinear transformation under given condition
2. know about continuity, compactness and connectedness of sets in complex plane
3. know the necessary condition and sufficient condition for f(z)to be analytic
4. know about the inverse of an analytic function
5. know about the convergence of sequences and the necessary & sufficient condition for a sequence to be convergent
6. know the power series expansion of elementary functions

Course Content

Unit – 1

Bilinear Transformations

Extended Complex Plane – Resultant and Inverse of a bilinear transformation – The linear group – Geometrical significance of the transformation. Angle preserving property of Bilinear Transformation– Determination of Bilinear transformations under given condition, some special bilinear transformations.

Unit – 2

Topological Considerations

Neighbourhood of a point – Interior, exterior and frontier points of a set, open and closed sets. Connected sets, Domains and continua - a theorem on Nests of closed Rectangular domains- Bolzano Weierstrass theorem- Hein-Borel theorem. Limits - algebraic operations with limits – continuity and uniform continuity – compactness – connectedness - Jordan curve theorem - connectedness of line segments and polygonal lines. Branch line and Branch point - Characterisation of open connected sets by polygonal lines.

Unit – 3

Analytic functions

Differentiable functions of a complex variable - Geometrical representation of a variable - Analytic function- Elementary rules and chain rule - Derivatives of polynomials and rational functions - The necessary condition and sufficient condition for $f(z)$to be analytic - Analytic functions in a Domain – Derivative of w in polar form - Construction of $f(z)$.

Unit – 4

Inverse of an analytic function and infinite series

The inverse of an analytic function – neighbourhood preserving mappings - Domain preserving and angle preserving property of analytic mappings.

Convergent sequences, necessary and sufficient condition for a sequence to be convergent, Cauchy sequence, Convergence of infinite series. Cauchy general principle of convergence for a series. Absolute convergence of a series. Abel’s and Dirichilet’s tests. Rearrangement of series, product of series.

Unit – 5
Power Series

Power series - exponential, trigonometric and hyperbolic functions - zeros of $sin\,z, cos\,z$ - periods of $sin\,z, cos\,z, E(z)$ - A law of logarithms - Analytic character of $log\,z$ - generalized a^b - Analytic character of z^n - $\mathrm{Cos}^{-1}\,z$, $\mathrm{Sin}^{-1}\,z$ and derivatives of $\mathrm{Cos}^{-1}\,z$, $\mathrm{Sin}^{-1}\,z$.

Activities

Seminar/ Quiz/ Assignments/ Applications of Functions of complex variables to Real life Problem /Problem Solving Sessions.

Text Book

Theory of Functions of a Complex variable by Shanti Narayan &Dr. P. K. Mittal, S. Chand &Company Ltd.

Reference Books

1. Theory of Functions of a Complex Variable by A. I. Markushevich, Second Edition, AMS Chelsea Publishing
2. Theory And Applications by M. S. Kasara, Complex Variables, 2nd Edition, Prentice Hall India Learning Private Limited

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11.14.1.2 Blue Print for Course 14(Elective A) at end of Semester-V/VI

Course 14 (Elective A):Functions of a complex variables & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	II	Theorem / Problem	3
	3	III	Theorem / Problem	3
	4	III	Theorem / Problem	3
	5	IV	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	V	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.14.1: Blueprint of Semester–V/VI End Examination (Course–14(Elective-A:Functions of a complex variables & Problem Solving Sessions

11.14.1.3 Model Question Paper for Course-14(Elective-A)

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

B.Sc. Mathematics (Honours) Major

SEMESTER–V/VI

COURSE 14 (Elective A): Functions of a Complex Variable & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max Marks: 50**

PART – A **(5 × 3 = 15 Marks)**

(Answer any five questions. Each carries 3 Marks)

Q1. Find the bilinear transformation that maps $z = 0, 1, \infty$ into $w = 1, i, -1$. (L3 – Apply)

Q2. Define: (i) Interior point, (ii) Frontier point, (iii) Domain in the complex plane. Give one example for each. (L1 – Remember)

Q3. Verify whether $f(z) = z^2 + 2\bar{z}$ is analytic. (L2 – Understand)

Q4. Find the derivative of $w = e^{iz}$ in polar form. (L3 – Apply)

Q5. Test the convergence of $\sum \frac{1}{n^2+1}$. (L4 – Analyze)

Q6. State and prove Abel's test for convergence of a series. (L2 – Understand)

Q7. Find the zeros of $\sin z$. (L3 – Apply)

Q8. Show that $\cos^{-1} z$ is analytic in its domain. (L4 – Analyze)

PART – B **(5 × 7 = 35 Marks)**

(Answer five questions, choosing **one from each unit. Each carries 7 Marks**)

UNIT–1

Q9. Determine the bilinear transformation that maps $z = i, -i, 1$ to $w = 0, \infty, 1$. (L3 – Apply)

OR

Q10. Prove that bilinear transformations preserve cross ratios. (L4 – Analyze)

UNIT–2

Q11. State and prove Bolzano–Weierstrass theorem. (L2 – Understand)

OR

Q12. Explain Jordan curve theorem with an example. (L2 – Understand)

UNIT–3

Q13. Show that the function $f(z) = u(x, y)+iv(x, y)$ is analytic if and only if Cauchy–Riemann equations are satisfied. (L4 – Analyze)

OR

Q14. Construct an analytic function whose real part is $u(x, y) = e^x \cos y$. (L3 – Apply)

UNIT–4

Q15. Test the convergence of the series $\sum \frac{(-1)^n}{n}$. (L4 – Analyze)

OR

Q16. Prove Cauchy's general principle of convergence for a series. (L2 – Understand)

UNIT–5

Q17. Find the power series expansion of $\sin z$ and hence deduce its zeros. (L3 – Apply)

OR

Q18. Derive the logarithmic property $\log(ab) = \log a + \log b$ in the complex plane. (L4 – Analyze)

Summary of Bloom's Taxonomy Distribution

Bloom's Level	**Marks**	**Percentage**
L1 – Remember	3	6%
L2 – Understand	17	34%
L3 – Apply	17	34%
L4 – Analyze	13	26%
Total	50	100%

11.14.2 Course 14 (Major) (Elective B):Advanced Numerical Methods & Problem Solving Sessions(Only for B.Sc. Mathematics)

11.14.2.1 Syllabus of Course 14 Elective B (Major)

SEMESTER-V

COURSE 14: ADVANCED NUMERICAL METHODS

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. find derivatives using various difference formulae
2. understand the process of Numerical Integration
3. solveSimultaneous Linear systems of Equations
4. understand Iterative methods
5. find Numerical Solution of Ordinary Differential Equations

Course Content

UNIT – I
Numerical Differentiation

Derivatives using Newton's forward difference formula - Newton's backward difference formula-Derivatives using central difference formula - Stirling's interpolation formula - Newton's divided difference formula.

UNIT – II
Numerical Integration

General quadrature formula on errors - Trapezoidal rule – Simpson's 1/3 rule - Simpson's 3/8 rule-Weddle's rule - Euler-Maclaurin formula of summation and quadrature - The Euler transformation.

UNIT – III
Solution of Simultaneous Linear systems of Equations – I

Solution of linear systems - Direct Methods - Matrix inversion method – Gaussian elimination method-Gauss Jordan Method.

UNIT – IV
Solution of Simultaneous Linear systems of Equations – II

Method of factorization - solution of Tridiagonal systems - Iterative methods - Jacobi's method - Gauss - Siedal method.

UNIT – V
Numerical Solution of Ordinary Differential Equations

Introduction – solution of Taylor's series – Picard's method of successive approximations – Euler's method – Modified Euler's method – Runge-Kutta methods.

Activities

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions.

Text Book

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books

1.Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson Publications.

2. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K. Iyengar and R. K. Jain, New Age International Publishers.

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11.14.2.2 Blue Print for Course 14(Elective B) at end of Semester-V/VI

Course 14 (Elective B):Advanced Numerical Methods & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A (5 × 3 = 15)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B (5 × 7 = 35)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.14.2: Blueprint of Semester–V/VI End Examination (Course–14(Elective-B:)Advanced Numerical Methods & Problem Solving Sessions

11.14.2.3 Model Question Paper for Course-14(Elective-B)

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

B.Sc. Mathematics (Honours) Major

SEMESTER – V/VI

COURSE 14 (Elective B): Advanced Numerical Methods & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max Marks: 50**

Part – A (5 × 3 = 15 Marks).

Answer any five questions Each question carries 3 marks

Q1. Find $\frac{dy}{dx}$ at $x = 1.4$ from the following data using Newton's forward difference formula:

x	1.0	1.2	1.4	1.6	1.8
y	1.000	1.262	1.579	1.956	2.400

(L3 – Apply)

Q2. Use Newton's divided difference formula to find the derivative at $x = 2$ for the data: $(1, 1), (2, 4), (3, 9), (4, 16)$. (L3 – Apply)

Q3. Evaluate $\int_0^1 (1 + x^2)\, dx$ using Trapezoidal rule with 4 subintervals. (L3 – Apply)

Q4. State and derive Simpson's $\frac{1}{3}$ rule for numerical integration. (L2 – Understand)

Q5. Solve the system of equations by Gauss elimination:

$$x + y + z = 6, \quad 2y + 5z = -4, \quad 2x + 5y - z = 27$$

(L3 – Apply)

Q6. Using Gauss–Jordan method, solve the system:

$$2x + y - z = 1, \quad x + 3y + 2z = 1, \quad x + y + 2z = 0$$

(L3 – Apply)

Q7. Apply one iteration of Jacobi's method to solve:

$$10x + y + z = 12, \quad 2x + 10y + z = 13, \quad 2x + 2y + 10z = 14$$

(L4 – Analyze)

Q8. Apply Euler's method to approximate $y(0.1)$ given $\frac{dy}{dx} = x + y,\ y(0) = 1$, with step size $h = 0.1$. (L3 – Apply)

Part – B (5 × 7 = 35 Marks)

Answer five questions choosing one from each of five units. Each question carries 7 marks

UNIT–1

Q9. Derive Newton's backward difference formula for derivative. (L2 – Understand)

OR

Q10. Use Stirling's interpolation formula to find $f(1.5)$ from:

$$x : 1, 2, 3, 4, 5, 6, 7; \quad f(x) : 2.718, 7.389, 20.086, 54.598, 148.413, 403.429, 1096.633$$

(L3 – Apply)

UNIT–2

Q11. Derive Euler–Maclaurin formula for summation. (L2 – Understand)

OR

Q12. Evaluate $\int_0^1 \frac{1}{1+x^2} dx$ using Simpson's $\frac{1}{3}$ rule and compare with exact value. (L4 – Analyze)

UNIT–3

Q13. Solve the system of equations using matrix inversion:

$$2x + y + z = 10, \quad x + 2y + z = 10, \quad x + y + 2z = 10$$

(L3 – Apply)

OR

Q14. Use Gauss elimination method to solve:

$$3x + 2y - z = 1, \quad 2x - 2y + 4z = -2, \quad -x + 0.5y - z = 0$$

(L3 – Apply)

UNIT–4

Q15. Solve the tridiagonal system by Thomas algorithm:

$$2x_1 + x_2 = 5, \quad x_1 + 2x_2 + x_3 = 6, \quad x_2 + 2x_3 = 5$$

(L3 – Apply)

OR

Q16. Solve the system using Gauss–Seidel method up to two iterations:

$$4x - y + z = 7, \quad -x + 4y - 2z = 6, \quad x - y + 4z = 5$$

(L4 – Analyze)

UNIT–5

Q17. Apply Runge–Kutta method of order 4 to solve $\frac{dy}{dx} = x + y$ with $y(0) = 1$, find $y(0.1)$. (L3 – Apply)

OR

Q18. Using Picard's method, obtain two approximations to the solution of $\frac{dy}{dx} = x + y,\ y(0) = 1$. (L2 – Understand)

Summary of Bloom's Taxonomy Distribution

Bloom's Level	Marks	Percentage
L1 – Remember	0	0%
L2 – Understand	14	28%
L3 – Apply	26	52%
L4 – Analyze	10	20%
Total	50	100%

11.15 Course 15 (Major) : Elective A OR B (w.e.f. 2023-24)(Only for B.Sc. Mathematics)

11.15.1 Course 15 (Major) (Elective A):Number Theory & Problem Solving Sessions (Only for B.Sc. Mathematics)

11.15.1.1 Syllabus of Course 15 Elective A (Major)

SEMESTER-V

COURSE 15: NUMBER THEORY

Theory Credits: 4 5 hrs/week

Learning Outcomes

After successful completion of the course, students will be able to

1. understand the fundamental theorem of arithmetic
2. understand Mobius function, Euler quotient function, The Mangoldt function , Liouville's function, The divisor functions and the generalized convolutions.
3. understand Euler's summation formula, application to the distribution of lattice points and the applications to μ (n) and Λ (n)
4. understand the concepts of congruencies, residue classes and complete residues systems.
5. Comprehend the concept of quadratic residues mod p and quadratic non residues mod p.

UNIT-I

The Fundament Theorem of Arithmetic

Introduction, Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The greatest common divisor of more than two numbers

UNIT-II

Arithmetical Functions And Dirichlet Multiplication

Introduction- The Mobius function $\mu\ (n)$ – The Euler quotient function $\varphi\ (n)$ - A relation connecting φ and μ - A product formula for $\varphi\ (n)$ - The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function $\Lambda\ (n)$- multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function $\lambda\ (n)$ - The divisor functions $\sigma_\alpha\ (n)$

UNIT-III

Averages Of Arithmetical Functions

Introduction- The big oh notation. Asymptotic equality of functions- Euler's summation formula- Some elementary asymptotic formulas-The average order of $d(n)$- The average order of the divisor functions $\sigma_\alpha\ (n)$- The average order of $\varphi\ (n)$- An application to the distribution of lattice points visible from the origin- The average order of $\mu\ (n)$ and $\Lambda(n)$-The partial sums of a Dirichlet product- Applications to $\mu\ (n)$ and $\Lambda\ (n)$

UNIT-IV

Congruences

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p. Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem

UNIT-V

Quadratic Residues and the Quadratic Reciprocity Law

Quadratic Residues, Legendre's symbol and its properties, Evaluation of $(-1/p)$ and $(2/p)$, Gauss lemma, The Quadratic reciprocity law, Applications of the reciprocity law, The Jacobi Symbol, Gauss sums and the quadratic reciprocity law, the reciprocity law for quadratic Gauss sums, Another proof of the quadratic reciprocity law.

Activities

Seminar/ Quiz/ Assignments/ Applications of Number theory to Real life Problem /Problem Solving Sessions

Text Book

Introduction to Analytic Number Theory by T.M.Apostol, Springer Verlag-New York, Heidalberg-Berlin-1976.

Reference Books

1. Elementary Number Theory by G.A.Jones and J.M.Jones, , Springer
2. Elementary Number Theory by David, M. Burton, 2nd Edition UBS Publishers.
3. Number Theory by Hardy & Wright, Oxford Univ., Press.
4. Elements of the Theory of Numbers by Dence, J. B &Dence T.P, Academic Press

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11.15.1.2 Blue Print for Course 14(Elective A) at end of Semester-V/VI

Course 15 (Elective A):Number Theory & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	**Q.No.**	**Unit**	**Nature of Question**	**Marks**
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	II	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.15.1: Blueprint of Semester–V/VI End Examination (Course–15(Elective-A:Number Theory & Problem Solving Sessions

11.15.1.3 Model Question Paper for Course-15(Elective-A)

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

B.Sc. Mathematics (Honours) Major

SEMESTER – V/VI

Course–15 (Elective A): Number Theory & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: $2\frac{1}{2}$ Hours **Max. Marks: 50**

Part – A (5 × 3 = 15 Marks).

Answer any five questions Each question carries 3 marks

1. State and prove the Fundamental Theorem of Arithmetic. (L1)
2. Define the Möbius function $\mu(n)$ with an example. (L2)
3. Write the product formula for Euler's totient function $\varphi(n)$. (L2)
4. Find $\mu(n)$ for $n = 30$ and $n = 36$. (L3)
5. State Euler's Summation Formula. (L2)
6. Find the average order of $d(n)$ up to $n = 20$. (L3)
7. Define residue classes modulo m with an example. (L2)
8. Define the Legendre symbol and write its basic properties. (L1)

Part – B (5 × 7 = 35 Marks)

Answer five questions choosing one from each of five units. Each question carries 7 marks

UNIT–1

9. Prove that there are infinitely many prime numbers. (L2)

OR

10. Use the Euclidean algorithm to find $\gcd(414, 662)$. (L3)

UNIT–2

11. Find the Dirichlet inverse of the constant function $f(n) = 1$. (L3)

OR

12. Prove that $\sum_{d|n} \varphi(d) = n$. (L4)

UNIT–3

13. Using Euler's summation formula, estimate $\sum_{n\leq 10} n$. (L3)

OR

14. Show that the average order of $\varphi(n)$ is $\frac{6n}{\pi^2}$. (L4)

UNIT–4

15. Solve the congruence $7x \equiv 1 \pmod{26}$. (L3)

OR

16. Solve the system of congruences:

$$x \equiv 2 \pmod 3, \quad x \equiv 3 \pmod 4, \quad x \equiv 2 \pmod 5.$$

(L4)

UNIT–5

17. Evaluate the Legendre symbol $\left(\frac{2}{13}\right)$ using properties. (L3)

OR

18. State and prove the Law of Quadratic Reciprocity. (L4)

Bloom's Taxonomy Distribution

Bloom's Level	**Weightage (%)**
L1 (Remember)	15%
L2 (Understand)	20%
L3 (Apply)	30%
L4 (Analyze)	25%
L5 (Evaluate)	0%
L6 (Create)	0%

11.15.2 Course 15 (Major) (Elective B):) Mathematical Statistics & Problem Solving Sessions(Only for B.Sc. Mathematics)

11.15.2.1 Syllabus of Course 15 Elective B (Major)

SEMESTER-V

COURSE 15: MATHEMATICAL STATISTICS

Theory Credits: 4 5 hrs/week

Course Outcomes

After completion of the course, student will be able to

1. understandthe probability set function and conditional probability
2. understand about random variables, discrete and continuous type distributions
3. understand the distribution of two random variables and expectation of a random variables
4. know binomial and related distributions
5. normal distributions and the applications of normal distributions

Unit – 1
Probability and Distributions

Sets – set functions – The probability set function – counting rules – additional properties of probability- conditional probability and independence - simulations

Unit – 2
Probability and Distributions continued..

Random Variables - Discrete Random Variables - Continuous Random Variables -Quantiles- Transformations - Mixtures of Discrete and Continuous Type Distributions

Expectation of a Random Variable - Computation for an Estimation of the Expected Gain - Some Special Expectations - Important Inequalities

Unit – 3
Multivariate Distributions

Distributions of Two Random Variables - Marginal Distributions - Expectation –Transformations Bivariate Random Variables - Conditional Distributions and Expectations - Independent Random Variables - The Correlation Coefficient - Extension to Several Random Variables

Multivariate Variance-Covariance Matrix- Transformations for Several Random Variables - Linear combinationsof Random Variables

Unit – 4
Some Special Distributions

The Binomial and Related Distributions - Negative Binomial and Geometric Distributions - multinomial Distribution- Hypergeometric Distribution - The Poisson Distribution - The Γ, $\chi 2$and β Distributions - The $\chi 2$-Distribution - The β-Distribution

Unit – 5
Normal Distribution

The Normal Distribution. - Contaminated Normals - The Multivariate Normal Distribution - Bivariate Normal Distribution - Multivariate - Normal Distribution. General Case- Applications -t- and F-Distribution

Activities

Seminar/ Quiz/ Assignments/ Applications of Mathematical statistics to Real life Problem /Problem Solving Sessions.

Text Book

Introduction to Mathematical Statistics by Robert V Hogg, Joseph W MacKeen, Eighth Edition, Allen T Craig, Pearson

Reference Books

1. Fundamentals of Statistics by Goon A.M., Gupta M.K. and Dasgupta B., (2002) Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Fundamentals Of Mathematical Statistics by Gupta, S. C. and Kapoor, V.K. (2008): 4 thEdition (Reprint), Sultan Chand &Sons
3. Mathematical Statistics with Applications by Miller, Irwin and Miller, Marylees(2006) John E.Freund's, (7th Edn.), Pearson Education, Asia.
4. Introduction to the Theory of Statistics by Mood, A.M. Graybill, F.A. and Boes, D.C., (2007), 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co.Ltd.

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11.15.2.2 Blue Print for Course 15(Elective A) at end of Semester-V/VI

Course 15 (Elective B):) Mathematical Statistics& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A $(5 \times 3 = 15)$	1	I	Theorem / Problem	3
	2	II	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B $(5 \times 7 = 35)$	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.15.2: Blueprint of Semester–V/VI End Examination (Course–15(Elective-B:) Mathematical Statistics & Problem Solving Sessions

11.15.2.3 Model Question Paper for Course-15(Elective-B)

Government College (A), Rajahmundry

B.Sc. Mathematics (Honours) Major

Semester–V/VI

Course–15 (Elective–B): Mathematical Statistics & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A (Answer any **five** questions. Each carries 3 marks.)

Q1. Define probability set function and give an example. (Unit–I, L1)

Q2. Define a random variable and give an example. (Unit–II, L1)

Q3. Find the expectation of a discrete random variable with pmf $P(X = x) = \frac{1}{6}, x = 1, 2, \ldots, 6$. (Unit–II, L2)

Q4. State and explain the inequality $P(A \cup B) \leq P(A) + P(B)$. (Unit–II, L2)

Q5. If the joint probability distribution of (X, Y) is given, explain how to find the marginal distributions. (Unit–III, L2)

Q6. Define covariance between two random variables. (Unit–III, L1)

Q7. State the probability mass function of the Poisson distribution. (Unit–IV, L1)

Q8. Write any two applications of the Normal distribution. (Unit–V, L2)

Part–B (Answer **five** questions, choosing one from each unit. Each carries 7 marks.)

UNIT–I

Q9. Define conditional probability. Prove that $P(A \cap B) = P(A|B) \cdot P(B)$. (Unit–I, L3)

OR

Q10. State and prove the addition theorem of probability for two events. (Unit–I, L3)

UNIT–II

Q11. Define continuous random variable. Derive the mean and variance of uniform distribution on $[0, 1]$. (Unit–II, L3)

OR

Q12. State and prove Markov's inequality. (Unit–II, L3)

UNIT–III

Q13. Define correlation coefficient. Show that $-1 \leq \rho(X, Y) \leq 1$. (Unit–III, L4)

OR

Q14. If X, Y are independent random variables with variances σ_X^2, σ_Y^2, prove that $\mathrm{Var}(X + Y) = \sigma_X^2 + \sigma_Y^2$. (Unit–III, L3)

UNIT–IV

Q15. Derive the mean and variance of the Binomial distribution. (Unit–IV, L3)

OR

Q16. Define Poisson distribution. Derive its mean and variance. (Unit–IV, L3)

UNIT–V

Q17. Derive the moment generating function (m.g.f.) of the Normal distribution. Hence find mean and variance. (Unit–V, L4)

OR

Q18. Define Standard Normal distribution. Show how any Normal variable can be standardized. (Unit–V, L3)

Bloom's Levels Distribution:

Bloom's Level	Marks (%)
L1 – Remembering	9 (18%)
L2 – Understanding	12 (24%)
L3 – Applying	17 (34%)
L4 – Analyzing	12 (24%)

.

With Effect from 2023-24 admitted Batch Specilized Courses only for B.Sc.Computational Mathematics

11.16 Course 6 (Major) :Numerical Methods with MATLAB/Octave (3T + 2P) (w.e.f. 2023-24)(Only for B.Sc.Computational Mathematics)

11.16.1 Syllabus of Course 6 (Major)

Course Outcomes

After successful completion of this course, the student will be able to

1. difference between the operators Δ, ∇, E and the relation between them and know MATLAB fundamentals
2. know elementary programming with MATLAB and know about the Newton - Gregory Forward and backward interpolation, interpolation with unequal interval and know computing with MATLAB programming
3. know the Central Difference operators δ, μ, σ and relation between them and know computing with MATLAB programming
4. solve Algebraic and Transcendental equations and and know computing with MATLAB programming
5. understand the concept of Curve fitting and know computing with MATLAB programming

Course Content

Unit 1

The calculus of finite differences and Basic Matlab

The operators Δ, ∇, E ,Fundamental theorem of difference calculus- properties of Δ, ∇, E and problems on them to express any value of the function in terms of the leading terms and the leading differences - relations between E and D - relation between D and -

problems on one or more missing terms- Factorial notation- problems on separation of symbols- problems on Factorial notation.

MATLAB Fundamentals - The MATLAB Environment , Assignment , Mathematical Operations , Use of Built-In Functions, Graphics

Unit 2

Interpolation with equal and unequal intervals and their computations with MATLAB programming.

Programming with MATLAB - M-Files , Input-Output , Structured Programming , Nesting and Indentation Passing Functions to M-Files

Derivations of Newton Gregory Forward and backward interpolation and problems on them. Divided differences - Newton divided difference formula -Lagrange's and problems on them-

Construction of appropriate M-files for interpolations in the Programming with MATLAB and their execution.

Unit 3

Central Difference Interpolation formulae and their computations with MATLAB programming.

Central Difference operators δ, μ, σ and relation between them - Gauss forward formula for equal intervals - Gauss Backward formula - Stirlings formula - Bessel's formula and problems on the above formulae.

Construction of appropriate M-files for interpolations using central differences in the Programming with MATLAB and their execution.

Unit 4

Solutions of Algebraic and Transcendental equations and and their computations with MATLAB programming.

Method for finding initial approximate value of the root - Bisection method - to find the solution of given equations by using (i) Regula Falsi method (ii) Iteration method

(iii) Newton method and problems on them.

Construction of appropriate M-files for finding roots in (i) Regula Falsi method (ii) Iteration method (iii) Newton method -Raphson's in the Programming with MATLAB and their execution.

Unit 5

Curve Fitting and Applications of MATLAB programming in Curve Fitting

Least-squares curve fitting procedures - fitting a straight line-nonlinear curve fitting-curve fitting by a sum of exponentials - MATLAB programming to compute the equations of these curve fittings.

Activities

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions/practicals using Matlab in Numerical Methods.

Prescribed Text Books

1. Introductory Methods of Numerical Analysis by S.S. Sastry, (6th Edition) PHI New Delhi 2012.
2. Applied Numerical Methods with MATLAB® for Engineers and Scientists Third Edition by Steven C. Chapra, Berger Chair in Computing and Engineering, Tufts University,Mc Graw Hill Company.

Reference Books

1. Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson,(2003) 7th Edition

2. Numerical Analysis by G. Shanker Rao, New Age International Publications

3. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K. Iyengar and R. K. Jain, New Age International Publishers (2012), 6th edition.

4. Applied Numerical Analysis Using MATLAB,SECOND EDITION , PEARSON PUBLICATIONS by Laurene V. Fausett, Texas A & M University-Commerce *****

5. NUMERICAL METHODS IN ENGINEERING WITH MATLAB by Jaan Kiusalaas, The Pennsylvania State University, Cambridge University Press

11.16.2 Model paper of Course 6 (Major)

GOVERNMENT COLLEGE (A),RAJAHMUNDRY

B.Sc HONOURS COMPUTATIONAL MATHEMATICS

SEMESTER-III REGULAR EXAMINATIONS

-NOVEMBER/DECEMBER 2025

COURSE :NUMERICAL METHODS USING MATLAB/OCTAVE & PROBLEM SOLVING SESSIONS

MAJOR COURSE NO.6

(THEORY—-CREDITS=3)

Time: $2\frac{1}{2}$ **Hours** **Max Marks: 50 Marks**

PART-A

Answer ANY FIVE questions Each questions carry 3 marks

$5 \times 3 = 15$ **Marks**

Q.No.	Question	Marks	Bloom's Taxonomy level	Course Level Outcome
1	(a) Define forward difference operator	1 marks	BL_1	CLO1
	(b)Evaluate $\Delta^2(3e^x)$	2 marks	BL_5	CLO1
2	(a) What does the MATLAB command $x = 1 : 10$ represent?	1 mark	BL_2	CLO1
	(b)Write a MATLAB command for a vector of numbers from 2 to 20 with spacing 5	1mark	BL_2	CLO1
	(c)Write a Built- In function in MATLAB	1mark	BL_1	CLO1
3	Write the relational operators in MATLAB for the relations i)Equal ,ii) Not equal, iii),Less than iv) Greater than v) Less than or equal to vi) Greater than or equal to	3 marks	BL_1	CLO2
4	(a) Write Newton's forward difference interpolation formula.	2 marks	BL_1	CO4
	(b)Which of the following is Newton's forward difference interpolation function . i)a trigonometric function ii)a polynomial function iii) an exponential function iv) an hyperbolic function	1 mark	BL_1	CLO2
5	Write Gauss backward Interpolation formula	3 marks	BL_1	CLO3
6	Prove that $\mu^2 = 1 + \frac{1}{4}\delta^2$.	3 marks	BL_3	CLO3

Q.No.	Question	Marks	Bloom's Taxonomy level	Course Level Outcome
7	Let $x = \xi$ be a root of $f(x) = 0$ and I be an interval containing the point $x = \xi$. Let $x = \phi(x)$ is equivalent to $f(x) = 0$ on I. Then what are necessary conditions for the iterative formula $x_{n+1} = \phi(x_n)$ to converge to ξ.	3 marks	BL_1	CLO4
8	Derive the normal equations to fit a straight line in the following data x y 0 −1 2 5 5 12 7 20	3 marks	BL_3	CLO5

PART-B

Answer FIVE questions choosing ONE question from each unit.

Each questions carry 7 marks $5 \times 7 = 35$ **Marks**

UNIT-1				
9	(a) Prove that $\Delta = E - 1$	2 marks	BL_3	CLO1
	(b)Prove that $\nabla = 1 - E^{-1}$	2 marks	BL_3	CLO1
	(c) Find the missing term in the following data . x : 0 1 2 3 4 . y : 1 3 9 ? 81	3 marks	BL_3	CLO1
OR				
10	What are the primary windows in MATLAB	3 marks	BL_1	CLO1
	What is the output of the MATLAB assignment $>> a = [1 \quad 2 \quad 3 \quad 4 \quad 5]$	1 marks	BL_3	CLO1
	What is the output of the MATLAB assignment $>> a = [1; \quad 2; \quad 3; \quad 4; \quad 5]$	1 marks	BL_3	CLO1
	What is the output of the MATLAB assignment $>> A = [1 \quad 2 \quad 3; \quad 4 \quad 5 \quad 6; \quad 7 \quad 8 \quad 9]$	2 marks	BL_3	CLO1

. **P.T.O**

11.17 Course 7 (Major) :Probability and Statistics with R (3T + 2P) (w.e.f. 2023-24)(Only for B.Sc.Computational Mathematics)

11.17.1 Syllabus of Course 7 (Major)

Course Outcomes

After successful completion of this course, the student will be able to

1. know basic R computing software and know probability and its computation with R
2. know Probability Distributions and Probability Densities and their computing with R.
3. know Mathematical Expectation and its computing with R.
4. know Special Probability Densities and their computing with R.
5. know Special Probability Distributions and their computing with R.

Course Content

UNIT- 1
AN INTRODUCTION TO R & PROBABILITY

An Introduction to R: Downloading and Installing R—Communicating with R— Basic R Operations and Concepts—Getting Help for R—External Resources for R

Probability:Introduction Sample Spaces — Events — The Probability of an Event — Some Rules of Probability — Conditional Probability — Independent Events— Bayes' Theorem - Computing them with R

UNIT-2

PROBABILITY DISTRIBUTIONS AND PROBABILITY DENSITIES AND THEIR COMPUTING WITH R

Probability Distributions and Probability Densities: Introduction — Probability Distributions — Bionomial distribution— Continuous Random Variables — Poisson distribution— Probability Density Functions — Computations of them with R.

UNIT-3

MATHEMATICAL EXPECTATION AND IT'S COMPUTING WITH R

Mathematical Expectation : Introduction — The Expected Value of a Random Variable — Moments — Chebyshev's Theorem — Their computatations with R

UNIT- 4

SPECIAL PROBABILITY DISTRIBUTIONS AND THEIR COMPUTING WITH R

Special Probability Distributions : Introduction — The Discrete Uniform Distribution — The Bernoulli Distribution — The Binomial Distribution — The Negative Binomial and Geometric Distributions — The Hypergeometric Distribution -Their computations with R

UNIT- 5

SPECIAL PROBABILITY DENSITIES AND THEIR COMPUTING WITH R

Special Probability Densities : Introduction — The Uniform Distribution — The Gamma, Exponential, and Chi-Square Distributions — Beta Distribution and their computing with R

Activities

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions/practicals using R in Probability and Statistics.

Prescribed Text Books

1. John E. Freund's Mathematical Statistics IRWIN MILLER, MARYLEES MILLER, Prentice Hall International, Inc,SIXTH EDITION

2. Introduction to Probability and Statistics Using R by G. Jay Kerns First Edition

Reference Books

1. PROBABILITY AND STATISTICAL INFERENCE Ninth Edition by Robert V. Hogg, Elliot A. Tanis, Dale L. Zimmerman, Person publications

2. Probability and Statistics with Examples using R Siva Athreya, Deepayan Sarkar, and Steve Tanner Version: January 20th, 2021

3. The Book of R, A First Course in Programming and Statistics by Tilman M. Davies, no starch press San Francisco

4. Simple R – Using R for Introductory Statistics by John Verzani

5. Applied Statistics with R David Dalpiaz

6. PROBABILITY & STATISTICS WITH R FOR ENGINEERS AND SCIENTISTS Michael Akritas The Pennsylvania State University,Pearson

11.17.2 Model Paper of Course 7 (Major)

Government College (Autonomous), Rajahmundry

B.Sc. Computational Mathematics

Course 7 (Major): Probability and Statistics with R

Question Paper

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

Instructions:

1. Answer any five questions from Section–A.

2. Answer all questions from Section–B.

3. Each question in Section–B carries internal choice.

4. Simple R commands may be written wherever necessary.

SECTION–A

Answer any FIVE questions. Each question carries 3 marks.

(5 × 3 = 15 Marks)

1. Write any three basic arithmetic operations in R with examples.
2. Define sample space and event with one example.
3. State Bayes' theorem.
4. What is a binomial distribution? Write its probability mass function.
5. Define probability density function.
6. Define expectation of a random variable.
7. State Chebyshev's theorem.
8. Write the probability mass function of Bernoulli distribution.
9. Define exponential distribution.
10. Write the R command to find probabilities for a binomial distribution.

SECTION–B

Answer ALL questions. Each question carries 7 marks.

(5 × 7 = 35 Marks)

11. **(Unit–I)** Explain the basic features of R software. Write short notes on downloading, installing, and communicating with R. Also give examples of basic R operations. **[7 Marks]**

OR

12. Define conditional probability and independent events. State and prove the multiplication rule of probability. Also write a simple R command to compute a conditional probability from given numerical values. **[7 Marks]**

13. **(Unit–II)** Define binomial distribution. Find the probability of getting exactly 3 heads in 5 tosses of a fair coin. Also write the R command for the same computation. **[7 Marks]**

OR

14. Define Poisson distribution. If a random variable X follows Poisson distribution with mean 3, find $P(X = 2)$. Write the corresponding R command. [**7 Marks**]

15. **(Unit–III)** Define mathematical expectation. If a random variable X has the following probability distribution,

x	0	1	2	3
$P(X = x)$	0.1	0.3	0.4	0.2

find $E(X)$. [**7 Marks**]

OR

16. Define moments of a random variable. State Chebyshev's theorem and explain its importance in probability theory. [**7 Marks**]

17. **(Unit–IV)** Define Bernoulli distribution and binomial distribution. Explain how binomial distribution is obtained as the sum of independent Bernoulli trials. [**7 Marks**]

OR

18. Define geometric distribution and negative binomial distribution. Write their probability mass functions and mention one application of each. [**7 Marks**]

19. **(Unit–V)** Define uniform distribution and exponential distribution. Write their probability density functions and mention their uses. [**7 Marks**]

OR

20. Write short notes on Gamma, Chi-square, and Beta distributions. Also mention suitable R commands used for computing probabilities from these distributions. [**7 Marks**]

11.18 Course 8 (Major) :Discrete Mathematics (w.e.f. 2023-24)(Only for B.Sc.Computational Mathematics)

11.18.1 Syllabus of Course 8 (Major)

Course Outcomes

After successful completion of this course, the student will be able to

1. know Mathematical Logic and Proofs
2. know Sets, Relations and Functions and elementary properties.
3. know advanced Counting Techniques
4. know Recurrence relations and generating functions
5. know basic properties in Boolean Algebra

Course Content

Unit 1
Mathematical Logic and Proofs

Mathematical Logic and Proofs: Propositional logic and equivalences, Predicate and Quantifiers, Introduction to Proofs, Proof methods

Unit 2
Sets, Relations and Functions

Sets, Relations and Functions: Relations and their properties, Closure of Relations, Order Relations, Equivalence relations, Posets and Lattices

Unit 3

Counting Techniques

Counting Techniques: Permutations and Combinations, Binomial coefficients, Pigeonhole principle, Double counting, Principle of Inclusion-Exclusion

Unit 4

Recurrence relations

Recurrence relations and its solution, Divide and Conquer, Generating functions

Unit 5

Boolean Algebra

Boolean Algebra: Boolean functions, Logic gates, Simplification of Boolean Functions, Boolean Circuits

Activities:

Seminar/ Quiz/ Assignments/ /Problem Solving Sessions.

Prescribed Text Book:

Discrete Mathematics and Its Applications by K. H. Rosen, Tata McGraw-Hill

Reference Books

1. Basic Techniques of Combinatorial Theory by D. I. A. Cohen, John Wiley & Sons

2. . Introduction to Graph Theory by D. B. West, Pearson Prentice Hall

3. . Elements of Discrete Mathematics by C. L. Liu, Tata McGraw-Hill

4. . Invitation to Discrete Mathematics by J. Matousek and J. Nesetril, Oxford University Press

UNIT-2				
11	Using the following table ,find $f(x)$ as polynomial in x x : −1, 0, 3, 6, 7 $f(x)$: 3, −6, 39, 822, 1611	7 marks	BL_3	CLO2
OR				
12	Write an M-file to implement Lagrange interpolation.	7 marks	BL_2	CLO2
UNIT-3				
13	Use Stirling formula to find u_{32} from the following data $u_{20} = 14.035$, $u_{25} = 13.674$, $u_{30} = 13.257$, $u_{35} = 12.734$, $u_{40} = 12.089$, $u_{45} = 11.309$	7 marks	BL_3	CLO3
OR				
14	From the following table ,find the value of $e^{1.17}$ using Gauss' farward formula x — e^x 1.00 — 2.7183 1.05 — 2.8577 1.10 — 3.0042 1.15 — 3.1582 1.20 — 3.3201 1.25 — 3.4903 1.30 — 3.6693	7 marks	BL_3	CLO3
UNIT-4				
15	Find a real root of the equation $f(x) = x^3 - 2x - 5 = 0$ using the Newton-Raphson method	7 marks	BL_3	CLO4
OR				
16	Write an M-file to implement the Regula Falsi method.	7 marks	BL_2	CLO4
UNIT-5				
17	Determine the constants a and b by the method of least square method such that $y = ae^{bx}$ fits the following data x — y 2 — 04.077 4 — 11.084 6 — 30.128 8 — 81.897 10 — 222.62	7 marks	BL_3	CLO5
OR				
18	Fit a second degree polynomial to the given data of points in the following table x : 0.0, 1.0, 2.0 y : 1.0, 6.0, 17.0	7 marks	BL_3	CLO5

11.18.2 Model Paper

GOVERNMENT COLLEGE (A),RAJAHMUNDRY

B.Sc HONOURS COMPUTATIONAL MATHEMATICS

SEMESTER-III ACADEMIC YEAR 2025-26

COURSE :DISCRETE MATHEMATICAL STRUCTURES & PROBLEM SOLVING SESSIONS

MAJOR COURSE NO.7

(THEORY—-CREDITS=4)

Time: $2\frac{1}{2}$ **Hours** **Max Marks: 50 Marks**

PART-A

Answer ANY FIVE questions Each questions carry 3 marks

$5 \times 3 = 15$ **Marks**

Q.No.	Question	Marks	Bloom's Taxonomy level	Course Level Outcome
1	(a) Define a proposition	2 marks	BL_1	CLO1
	(b)Give an example for proposition	1 mark	BL_2	CLO1
2	What is the negation of each of these propositions.. (a) $4 + 2 = 6$ (b) All the days in the month of August are rainy in Rajahmundry (c) Summer in Rajahmundry is hot and sunny	3 marks	BL_4 &BL_5	CLO1
3	(a) Define Cartesian product of two sets	2 marks	BL_1	CLO2
	(b) What do you mean by two sets are equal?	1 mark	BL_2	CLO2
4	If a set S contains n elements, using product rule find the number of different subsets of S.	3 marks	BL_3	CLO2
5	If a set S contains n elements, using product rule find the number of different subsets of S.	3 marks	BL_3	CLO3
6	How many strings of length r can be be formed from English alphabet (repetitions are allowed).	3 marks	BL_3	CLO3

Q.No.	Question	Marks	Bloom's Taxonomy level	Course Level Outcome
7	Define recurrence relation.	3 marks	BL_1	CLO4
8	Evaluate the value of $1 \cdot 0 + \overline{(0+1)}$ using Boolean sum and Boolean product	3 marks	BL_3	CLO5

PART-B

Answer FIVE questions choosing ONE question from each unit.

Each questions carry 7 marks $5 \times 7 = 35$ **Marks**

UNIT-1				
9	(a) Construct the truth table of the compound proposition $(p \vee \neg q) \longrightarrow (p \wedge q)$	3 mark	BL_6	CLO1
	(b) Show that $p \vee (q \wedge r)$ and $(p \vee q) \wedge (p \vee r)$ are logically equivalent	4 marks	BL_3	CLO1
OR				
10	Translate the following statement into logical notation using the given predicates: "There exists a student who has a laptop and is a roommate of someone who also has a laptop."	4 marks	BL_3 $\&BL_4$	CLO1
	Translate the statement $\forall x \quad (C(x) \vee \exists y(C(y) \wedge F(x,y)))$ into English ,where $C(x)$ is " x has a computer ", $F(x,y)$ is " x and y are friends," and the domain for both x and y consists of all students in your college.	3 marks	BL_2	CLO1

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11.19 Course 11 (Major) :Elementary Number Theory (w.e.f. 2023-24)(Only for B.Sc.Computational Mathematics)

11.19.1 Syllabus of Course 11 (Major)

SEMESTER III

COURSE: ELEMENTARY NUMBER THEORY

Theory   Credits:4   5 Hours/Week

Learning Outcomes

After successful completion of the course, the student will be able to:

- Apply the division algorithm, greatest common divisor, Euclidean algorithm, and solve Diophantine equations.
- Understand the fundamental theorem of arithmetic, compute the sum and number of divisors, and use Möbius inversion and Euler's phi function.
- Work with congruences, solve linear congruences using the Chinese Remainder Theorem, and apply Fermat's, Wilson's, and Euler's theorems.
- Study orders of integers modulo n, primitive roots for primes, and recognize composite numbers having primitive roots.
- Apply Euler's criterion, Legendre symbol, and related results in number theory problems.

Course Content

Unit–I: Division and Diophantine Equations
The division algorithm, the greatest common divisor, the Euclidean algorithm, Diophantine equations of the form $ax + by = c$, the fundamental theorem of arithmetic.

Unit–II: Divisors and Functions
The sum and number of divisors, Möbius inversion formula, Euler's phi function.

Unit–III: Congruences and Theorems
Basic properties of congruences, linear congruence and the Chinese Remainder Theorem, Fermat's Little Theorem, Wilson's Theorem, Euler's Theorem.

Unit–IV: Primitive Roots
The order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots.

Unit–V: Quadratic Residues
Euler's criterion, the Legendre symbol and its properties.

Activities

Seminar, Quiz, Assignments, Applications of Number Theory to Real Life Problems, Problem Solving Sessions.

Text Book

- David M. Burton, *Elementary Number Theory*, 6th Edition, McGraw–Hill Higher Education, 2007.

Reference Books

1. W. W. Adams and L. J. Goldstein, *Introduction to the Theory of Numbers*, 3rd Edition, Wiley Eastern, 1972.

2. A. Baker, *A Concise Introduction to the Theory of Numbers*, Cambridge University Press, 1984.

3. I. Niven and H. S. Zuckerman, *An Introduction to the Theory of Numbers*, 5th Edition, Wiley, 2008.

4. Thomas Koshy, *Elementary Number Theory with Applications*, 2nd Edition, Academic Press.

11.19.2 Blue Print for Course 11 at end of Semester-IV

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

UNIT-2				
11	State and prove PRINCIPLE OF WELL-ORDERED INDUCTION	7 marks	BL_3	CLO2
OR				
12	(a)Define Poset .	2 marks	BL_1	CLO2
	(b)Define Hasse diagram.	2 marks	BL_1	CLO2
	(c)Draw the Hasse diagram for the partial ordering $\{(A, B)/A \subseteq B\}$ on the power set $P(S)$ where $S = \{a, b, c\}$	3 marks	BL_3	CLO2
UNIT-3				
13	(a) Write the Pigeonhole Principle and prove it	4 marks	BL_1& BL_3	CLO3
	(b)Let be n and r nonnegative integers with $r \leq n$. Then prove that $C(n, r) = C(n, n - r)$	3 marks	BL_3	CLO3
OR				
14	(a)How many ways are there to distribute hands of 5 cards to each of four players from the standard deck of 52 card?	3 marks	BL_3	CLO3
	(b)How many positive integers not exceeding 1000 are divisible by 7 or 11?	4 marks	BL_3	CLO3
UNIT-4				
15	(a)What is the charecteristic equation of of a recurrence relation	2 marks	BL_1	CLO4
	(b)What is the solution of the recurrence relation $$a_n + a_{n-1} + 2a_{n-2} \quad \text{with} \quad a_0 = 2 \quad \& \quad a_1 = 7$$	5 marks	BL_3	CLO4
OR				
16	Find the solution of the recurrence relation $$a_n = 6a_{n-1} - 11a_{n-2} + 6a_{n-3}$$	7 marks	BL_3	CLO4
UNIT-5				
17	Write any seven Boolean identities	7 marks	BL_1	CLO5
OR				
18	Find the $K-$maps for (a) $xy + \overline{x}y$, (b)$x\overline{y} + \overline{x}y$, (c) $x\overline{y} + \overline{x}y + \overline{x}y\overline{y}$ and simplify the sum -of - products expansions.	7 marks	BL_3	CLO5

Part	**Q.No.**	**Unit**	**Nature of Question**	**Marks**
A $(5 \times 3 = 15)$	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B $(5 \times 7 = 35)$	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.19.1: Blueprint of Semester–IV End Examination (Course–11 ELEMENTARY NUMBER THEORY & Problem Solving Sessions

11.19.3 Model Question Paper for Course-11

Government College (A), Rajahmundry

B.Sc Computational Mathematics (Honours) Major

SEMESTER–IV
COURSE–11: ELEMENTARY NUMBER THEORY

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Note:

1. Answer **any five** questions from **Part–A**.
2. Answer **one question from each unit** in **Part–B**, choosing either of the two alternatives.
3. Figures to the right indicate full marks.

PART – A

Answer any five questions. Each question carries 3 marks.

1. State and prove the Division Algorithm for integers. **[L1]**

2. Use the Euclidean algorithm to find $\gcd(252, 198)$. **[L3]**

3. Define the Euler phi-function $\varphi(n)$. Find $\varphi(20)$. **[L2/L3]**

4. State the Möbius inversion formula. **[L1]**

5. Solve the linear congruence $14x \equiv 8 \pmod{30}$. **[L3]**

6. Define the order of an integer a modulo n. Find the order of 2 modulo 7. **[L2/L3]**

7. Show that 3 is a primitive root modulo 7. **[L4]**

8. State Euler's criterion. Using it, determine whether 2 is a quadratic residue modulo 7. **[L3/L5]**

PART – B

Answer one question from each unit. Each question carries 7 marks.

(9) **(Unit–I)**

(a) State the Fundamental Theorem of Arithmetic.

(b) Solve the Diophantine equation $84x + 36y = 12$. **[L1+L3]**

(10) **(Unit–I)**

(a) Find $\gcd(414, 662)$ using the Euclidean algorithm.

(b) Hence express the gcd as a linear combination of 414 and 662. **[L3]**

(11) **(Unit–II)**

Define the divisor-sum function $\sigma(n)$ and the divisor-counting function $\tau(n)$. If

$$n = 2^3 \cdot 3^2 \cdot 5,$$

find $\tau(n)$ and $\sigma(n)$. **[L2+L3]**

(12) **(Unit–II)**

State and prove the formula

$$\sum_{d|n} \varphi(d) = n.$$

Hence compute $\varphi(18)$. **[L2+L4]**

(13) **(Unit–III)**

State the Chinese Remainder Theorem and solve the system

$$x \equiv 2 \pmod 3, \qquad x \equiv 3 \pmod 5, \qquad x \equiv 2 \pmod 7.$$

[L2+L3]

(14) **(Unit–III)**

(a) State Fermat's Little Theorem and Euler's Theorem.

(b) Use them to find the remainder when 7^{100} is divided by 15. **[L1+L3]**

(15) **(Unit–IV)**

Define a primitive root modulo a prime p. Prove that if g is a primitive root modulo a prime p, then the order of g modulo p is $p - 1$. **[L2+L4]**

(16) **(Unit–IV)**

(a) Find the order of each of the integers $2, 3, 4$ modulo 11.

(b) Hence determine a primitive root modulo 11. **[L3+L4]**

(17) **(Unit–V)**

Define the Legendre symbol $\left(\frac{a}{p}\right)$. State its basic properties and evaluate

$$\left(\frac{2}{7}\right), \quad \left(\frac{3}{7}\right), \quad \left(\frac{5}{11}\right).$$

[L2+L3]

(18) **(Unit–V)**

State and prove Euler's criterion. Use it to determine whether 10 is a quadratic residue modulo 13. **[L2+L5]**

Bloom's Taxonomy Distribution (Approximate)

Bloom's Level	Approximate Weightage in Paper
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.20 Course 14 (Major): Elective A OR B (w.e.f. 2023-24) (Only for B.Sc. Computational Mathematics)

11.20.1 Course 14 (Major)(Elective A):Scientific Computing using MATLAB/Octave (Only for B.Sc.Coputational Mathematics)

11.20.2 Course 14 (Major)(Elective B) :Advanced Numerical Methods with MATLAB/Octave (3T + 2P) (w.e.f. 2023-24)(Only for B.Sc.Computational Mathematics)

11.20.2.1 Syllabus of Course 14 (Major)(Elective B)

SEMESTER VI

COURSE: ADVANCED NUMERICAL ANALYSIS USING MATLAB

Theory Credits:4 5 Hours/Week

Course Outcomes

After successful completion of this course, the student will be able to:

1. Compute derivatives using forward, backward, and central difference formulas with MATLAB.
2. Apply numerical integration techniques such as Trapezoidal rule, Simpson's rules, and Weddle's rule.
3. Solve systems of linear equations using direct methods such as matrix inversion and Gaussian elimination in MATLAB.
4. Implement iterative methods (Jacobi, Gauss–Seidel) and factorization methods for solving linear systems.
5. Obtain numerical solutions of ordinary differential equations using Euler, Modified Euler, Taylor series, Picard, and Runge–Kutta methods in MATLAB.

Syllabus

Unit I: Numerical Differentiation

Topics: Derivatives using Newton's forward difference formula – Newton's backward difference formula – Central difference formula – Stirling's interpolation formula – Newton's divided difference formula.

MATLAB Component: Implement forward, backward, and central difference approximations in MATLAB. Write scripts to calculate derivatives of tabulated data and compare with exact values.

Unit II: Numerical Integration

Topics: General quadrature formula and error analysis – Trapezoidal rule – Simpson's 1/3 rule – Simpson's 3/8 rule – Weddle's rule – Euler–Maclaurin summation and quadrature – Euler transformation.

MATLAB Component: Use MATLAB to perform numerical integration with built-in functions (`trapz`, `integral`) and user-defined functions for Simpson's and Weddle's rules. Compare numerical results with exact integrals.

Unit III: Solution of Simultaneous Linear Systems – I

Topics: Direct methods for solving linear systems – Matrix inversion method – Gaussian elimination method – Gauss–Jordan method.

MATLAB Component: Solve systems of linear equations in MATLAB using matrix division (`A\b`), Gaussian elimination, and inverse methods. Compare efficiency of approaches.

Unit IV: Solution of Simultaneous Linear Systems – II

Topics: Factorization methods – Solution of tridiagonal systems – Iterative methods – Jacobi method – Gauss–Seidel method.

MATLAB Component: Implement Jacobi and Gauss–Seidel methods in MATLAB using loops. Solve tridiagonal systems using MATLAB's sparse matrix techniques. Study convergence criteria numerically.

Unit V: Numerical Solution of Ordinary Differential Equations

Topics: Taylor series method – Picard's method of successive approximations – Euler's method – Modified Euler's method – Runge–Kutta methods.

MATLAB Component: Use MATLAB to implement Euler, Modified Euler, and Runge–Kutta methods. Solve initial value problems with `ode45` and compare results with analytical solutions.

Activities

Seminar / Quiz / Assignments / Applications of Numerical Methods to real-life problems / Problem-solving sessions using MATLAB.

Textbook

1. G. Shanker Rao, *Numerical Analysis*, New Age International Publications.

Reference Books

1. Curtis F. Gerald and Patrick O. Wheatley, *Applied Numerical Analysis*, Pearson Publications.
2. M.K. Jain, S.R.K. Iyengar, R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New Age International Publishers.

11.20.2.2 Blue Print for Course 14 (Major)(Elective B) at end of Semester-V/VI

Batch: 2023–24 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A (5 × 3 = 15)	1	I	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	2	I	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	3	II	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	4	III	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	5	III	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	6	IV	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	7	IV	Theory / Algorithm / Numerical Computation / MATLAB Application	3
	8	V	Theory / Algorithm / Numerical Computation / MATLAB Application	3
B (5 × 7 = 35)	9 **or** 10	I	Theory / Algorithm / Numerical Computation / MATLAB Application	7
	11 **or** 12	II	Theory / Algorithm / Numerical Computation / MATLAB Application	7
	13 **or** 14	III	Theory / Algorithm / Numerical Computation / MATLAB Application	7
	15 **or** 16	IV	Theory / Algorithm / Numerical Computation / MATLAB Application	7
	17 **or** 18	V	Theory / Algorithm / Numerical Computation / MATLAB Application	7

11.20.2.3 Model Question Paper for Course-14(Elective-B)

GOVERNMENT COLLEGE (A), RAJAHMUNDRY

B.Sc. Honours – Computational Mathematics

Semester VI

Course 14 (Major)(Elective B): ADVANCED NUMERICAL ANALYSIS USING MATLAB

Time: $2\frac{1}{2}$ Hours **Max. Marks: 50**

Instructions:

1. Answer **any five** questions from **Part-A**.
2. Answer **one question from each pair** in **Part-B**.
3. Non-programmable calculator may be used.

PART-A

Answer any five questions $5 \times 3 = 15$

1. Using Newton's forward difference formula, find $f'(1)$ from the following data:

x	1	2	3	4
$f(x)$	1	8	27	64

2. Using the backward difference formula, find the derivative at $x = 3$ from:

x	0	1	2	3
y	1	3	9	19

3. Evaluate

$$\int_0^2 \frac{1}{1+x}\,dx$$

approximately by the trapezoidal rule using $h = 0.5$.

4. Solve the system of equations by Gaussian elimination:

$$2x + y - z = 8,$$
$$-3x - y + 2z = -11,$$
$$-2x + y + 2z = -3.$$

5. Solve the following system by Gauss–Jordan method:

$$x + y + z = 6,$$
$$2x + 3y + z = 11,$$
$$x - y + 2z = 5.$$

6. Perform two iterations of the Jacobi method for the system

$$10x - y + 2z = 6,$$
$$-x + 11y - z = 25,$$
$$2x - y + 10z = -11$$

starting with $(x, y, z) = (0, 0, 0)$.

7. Perform two iterations of the Gauss–Seidel method for the system

$$4x + y + z = 7,$$
$$x + 5y + 2z = -8,$$
$$2x + y + 6z = 9$$

starting with $(x, y, z) = (0, 0, 0)$.

8. Use Euler's method to compute $y(0.2)$ for

$$\frac{dy}{dx} = x + y, \qquad y(0) = 1$$

with step size $h = 0.1$.

PART-B

Answer one question from each UNIT $5 \times 7 = 35$

UNIT-I

9. Using Newton's divided difference formula, find $f'(2)$ from the data

x	1	2	4	7
$f(x)$	3	6	12	24

and hence estimate the slope of the interpolating polynomial at $x = 2$.

10. Write a MATLAB program to compute the derivative of the tabulated function by the central difference formula and use it to find $f'(2)$ from

x	1.0	1.5	2.0	2.5	3.0
$f(x)$	1.000	1.225	1.491	1.822	2.225

Also compare the numerical result with the exact derivative of $f(x) = e^{0.4x}$ at $x = 2$.

UNIT-II

11. Evaluate

$$\int_0^3 \frac{dx}{1+x^2}$$

by Simpson's $\frac{3}{8}$ rule taking $h = 0.5$.

12. Write a MATLAB program to evaluate

$$\int_0^1 e^{-x^2}\,dx$$

numerically using the trapezoidal rule with $n = 10$ subintervals. Display the value obtained and compare it with MATLAB's built-in numerical integration command.

UNIT-III

13. Solve the system by the matrix inversion method:

$$\begin{aligned} 2x - y + z &= 5, \\ x + 2y - z &= 1, \\ 3x + y + 2z &= 10. \end{aligned}$$

14. Solve the system by Gaussian elimination and back substitution:

$$\begin{aligned} x + y + z &= 6, \\ 2x + 5y + 2z &= -4, \\ 2x + 3y + 8z &= 5. \end{aligned}$$

UNIT-IV

15. Using the Jacobi iterative method, solve the system

$$\begin{aligned} 10x - y + 2z &= 6, \\ -x + 11y - z &= 25, \\ 2x - y + 10z &= -11 \end{aligned}$$

correct to three decimal places.

16. Solve the tridiagonal system

$$\begin{aligned} 4x_1 - x_2 &= 7, \\ -x_1 + 4x_2 - x_3 &= 4, \\ -x_2 + 4x_3 - x_4 &= 5, \\ -x_3 + 4x_4 &= 6 \end{aligned}$$

by a suitable factorization method.

UNIT-V

17. Apply the Modified Euler method to find $y(0.2)$ and $y(0.4)$ for

$$\frac{dy}{dx} = x + y, \qquad y(0) = 1,$$

taking step size $h = 0.2$.

18. Use the fourth-order Runge–Kutta method to approximate $y(0.2)$ for

$$\frac{dy}{dx} = x + y, \qquad y(0) = 1$$

with step size $h = 0.2$.

11.21 Course 15 (Major): Elective A OR B (w.e.f. 2023-24) (Only for B.Sc. Computational Mathematics)

11.21.1 Course 15 (Major)(Elective A) :Cryptography using Python/MATLAB/ Octave/SageMath/C/Java (3T+2P) (w.e.f. 2023-24)(Only for B.Sc.Computational Mathematics)

11.21.2 Course 15 (Major)(Elective B):Machine Learning using Python (3T+2P)(Only for B.Sc.Computational Mathematics)

11.21.2.1 Syllabus of Course 15 (Major)(Elective B)(Only for B.Sc.Computational Mathematics)

SEMESTER VI

COURSE: MACHINE LEARNING USING PYTHON

Theory Credits:4 5 Hours/Week

Learning Outcomes

After successful completion of the course, the student will be able to:

- Understand the fundamentals of Python programming and apply them for machine learning tasks.
- Implement regression techniques including simple, multiple, and advanced regression models.
- Apply classification algorithms such as logistic regression, decision trees, KNN, and ensemble methods.
- Utilize gradient descent, cross-validation, and regularization techniques to improve models.
- Perform clustering using K-means and hierarchical clustering to analyze and segment data.

Course Content

Unit–I: Introduction to Python
Declaring variables, conditional statements, control flow statements, functions, working with collections (lists, tuples, sets, dictionaries), strings, functional programming, data frames, exploration of data using visualization.
(Textbook Chapters 1 and 2)

Unit–II: Regression Analysis
Simple linear regression: building regression models, creating feature set and outcome variable, splitting dataset into training and validation sets, fitting the model. Model diagnostics: R^2, hypothesis testing of coefficients, ANOVA in regression, residual analysis, outlier analysis. Making predictions and measuring accuracy. Multiple linear regression.
(Textbook Chapter 4)

Unit–III: Classification
Binary logistic regression, gain chart, lift chart, decision tree.
(Textbook Chapter 5)

Unit–IV: Advanced Machine Learning Methods
Gradient descent algorithm, scikit-learn library for machine learning, bias–variance tradeoff, k-fold cross-validation. Advanced regression models: Ridge regression, LASSO regression, Elastic Net regression. Logistic regression model, k-nearest neighbors (KNN) algorithm,

11.21.2.2 Blue Print for Course 15 (Major)(Elective B) at end of Semester-V/VI

Course 15:MACHINE LEARNING USING PYTHON

Batch: 2023–24 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	**Q.No.**	**Unit**	**Nature of Question**	**Mark**
A ($5 \times 3 = 15$)	1	I	Python Basics / Short Program / Concept	3
	2	I	Data Handling / Visualization / Short Problem	3
	3	II	Regression Concept / Short Computation	3
	4	III	Classification Concept / Short Problem	3
	5	III	Classification Metric / Model Idea	3
	6	IV	ML Method / Short Note / Easy Application	3
	7	IV	Validation / Regularization / Easy Concept	3
	8	V	Clustering Concept / Short Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Python Program / Data Frame / Visualization	7
	11 **or** 12	II	Regression Method / Interpretation / Prediction	7
	13 **or** 14	III	Classification Model / Tree / Logistic Regression	7
	15 **or** 16	IV	Advanced ML Method / Cross Validation / KNN / Ensemble	7
	17 **or** 18	V	Clustering Method / Distance / Segmentation	7

11.21.2.3 Model Question Paper for Course-15 (Major)(Elective B)

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

B.Sc. Computational Mathematics (Honours) Major

SEMESTER–V/VI

Course 15: MACHINE LEARNING USING PYTHON

Duration: 2 $\frac{1}{2}$ Hours **Maximum Marks: 50**

Instructions:

1. Answer **any five** questions from **Part–A**.
2. Answer **one question from each pair** in **Part–B**.
3. Figures to the right indicate full marks.
4. The paper is designed at an easy level.

PART – A (5 × 3 = 15 Marks)

Answer any five questions. Each question carries 3 marks.

1. Define a DataFrame in Python. Explain any two operations that can be performed on a DataFrame.

2. What is Simple Linear Regression? Explain the steps involved in building a regression model.

3. Define R^2 (coefficient of determination) and explain its importance in regression analysis.

4. Explain Binary Logistic Regression with an example.

5. What is Decision Tree learning? Mention its advantages.

6. Define Bias–Variance tradeoff in machine learning.

7. Explain the steps involved in K-means clustering.

8. What is Hierarchical clustering? How does it differ from K-means clustering?

PART – B (5 × 7 = 35 Marks)

(Answer five questions, choosing **one from each unit. Each carries 7 Marks**)

UNIT–I

9. Explain the framework for developing machine learning models with suitable examples. (7)

10. Explain the following Python collections with examples:

- Lists
- Tuples
- Dictionaries

(7)

UNIT–II

11. Explain the procedure for building a simple linear regression model using Python? (7)

12. Discuss multiple linear regression and explain how multicollinearity is detected and handled. (7)

UNIT–III

13. Explain the steps involved in building a Logistic Regression model and evaluating it using a confusion matrix. (7)

14. Explain Decision Tree classification and discuss the Gini impurity measure. (7)

UNIT–IV

15. Explain the Gradient Descent Algorithm and its role in machine learning model optimization. (7)

16. Describe the K-Nearest Neighbors (KNN) algorithm and explain how the optimal value of K is selected (7)

UNIT–V

17. Explain the Random Forest algorithm and its advantages over decision trees. (7)

18. Explain the K-means clustering algorithm and discuss the Elbow method for determining the number of clusters. (7)

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With Effect From 2023-24

Admitted Batch

Minor Courses

11.22 Course 1 (Minor): Differential Equations & Problem Solving Sessions (w.e.f. 2023-24)

11.22.1 Syllabus of Course 1 (Minor)

SEMESTER-II

COURSE 1: DIFFERENTIAL EQUATIONS

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. solve first order first degree linear differential equations.
2. convert a non-exact homogeneous equation to exact differential equation by using an integrating factor.
3. know the methods of finding solution of a differential equation of first order but not of first degree.
4. solve higher-order linear differential equations for both homogeneous and non-homogeneous, with constant coefficients.
5. understand and apply the appropriate methods for solving higher order differential equations.

Course Content

Unit – 1

Differential Equations of first order and first degree

Linear Differential Equations – Bernoulli's Equations - Exact Differential Equations –Integrating factors - Equations reducible to Exact Equations by Integrating Factors -

i) Inspection Method ii) $\frac{1}{Mx+Ny}$ iii) $\frac{1}{Mx-Ny}$

Unit – 2

Differential Equations of first order but not of first degree

Equations solvable for p, Equations solvable for y, Equations solvable for x – Clairaut's equation - Orthogonal Trajectories: Cartesian and Polar forms.

Unit – 3

Higher order linear differential equations

Solutions of homogeneous linear differential equations of order n with constant coefficients - Solutions of non-homogeneous linear differential equations with constant coefficients by means of polynomial operators

(i) $Q(x) = e^{ax}$ (ii) $Q(x) = Sin\ ax$ (or) $Cos\ ax$

Unit – 4

Higher order linear differential equations (continued.)

Solution to a non-homogeneous linear differential equation with constant coefficients

P.I. of $f(D)y = Q$ when $Q = bx^k$

P.I. of $f(D)y = Q$ when $Q = e^{ax}V$, where V is a function of x

P.I. of $f(D)y = Q$ when $Q = xV$, where V is a function of x

Unit – 5

Higher order linear differential equations with non-constant coefficients

Linear differential Equations with non-constant coefficients; Cauchy-Euler Equation; Legendre Equation; Method of variation of parameters

Activities

Seminar/ Quiz/ Assignments/ Applications of Differential Equations to Real life Problem /Problem Solving Sessions.

Text Book

Differential Equations and Their Applications by Zafar Ahsan, published by Prentice-Hall of India Pvt. Ltd, New Delhi-Second edition.

Reference Books

1. Ordinary and Partial Differential Equations by Dr. M.D. Raisinghania, published by S. Chand &Company, New Delhi.
2. Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha-Universities Press.
3. Differential Equations -Srinivas Vangala&Madhu Rajesh, published by Spectrum University Press.

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11.22.2 Blue Print for Course 1 (Minor) at end of Semester-II

Course 1 (Minor): Differential Equations & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.22.1: Blueprint of Semester–II End Examination (Course–3: : Differential Equations & Problem Solving Sessions

11.22.3 Model Question Paper for Course-1 (Minor)

Government College(A), Rajahmundry

II Semester End Examinations, March 2024

Course–1 (Minor): Differential Equations & Problem Solving Sessions

Course Code: 224703

Duration: $2\frac{1}{2}$ Hours **Max Marks: 50**

PART – A (5 × 3 = 15 Marks)

Answer any FIVE questions. Each carries 3 Marks.

Q1. Solve: $\frac{dy}{dx} + y \tan x = \sin x$. (Unit–I, L3)

Q2. Solve: $(y^2 + xy)\, dx + (x^2 + xy)\, dy = 0$. (Unit–I, L3)

Q3. Find the orthogonal trajectories of the family $x^2 + y^2 = c^2$ in Cartesian form. (Unit–II, L4)

Q4. Solve Clairaut's equation: $y = x\frac{dy}{dx} + \left(\frac{dy}{dx}\right)^2$. (Unit–II, L4)

Q5. Solve: $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$. (Unit–III, L3)

Q6. Solve: $\frac{d^2y}{dx^2} + y = \cos x$. (Unit–III, L3)

Q7. Find the particular integral of $(D^2 - 2D + 1)y = e^{2x}$. (Unit–IV, L3)

Q8. Solve Cauchy–Euler equation: $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$. (Unit–V, L3)

PART – B (5 × 7 = 35 Marks)

Answer Five questions choosing one from each of the five units. Each carries 7 Marks.

Unit–I

Q9. Solve: $(2x + 3y)\, dx + (x + 4y)\, dy = 0$. (L3)

OR

Q10. Solve Bernoulli's equation: $\frac{dy}{dx} + y = y^2 e^x$. (L3)

Unit–II

Q11. Solve: $y^2\, dx + (x^2 - y^2)\, dy = 0$. (L3)

OR

Q12. Find the orthogonal trajectories of $y^2 = cx$ in polar coordinates. (L4)

Unit–III

Q13. Solve: $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = e^x$. (L3)

OR

Q14. Solve: $\frac{d^2y}{dx^2} + 4y = \sin 2x$. (L3)

Unit–IV

Q15. Find the particular integral of $(D^2 - 1)y = xe^x$. (L3)

OR

Q16. Solve: $(D^2 + 4)y = x \cos 2x$. (L3)

Unit–V

Q17. Solve: $x^2\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} + y = \ln x$. (L3)

OR

Q18. Solve Legendre's equation: $(1 - x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2y = 0$. (L3)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	0%
L2 – Understanding	10%
L3 – Applying	70%
L4 – Analyzing	20%
L5 – Evaluating	0%
L6 – Creating	0%

11.23 Course 2 (Minor): Group Theory & Problem Solving Sessions (w.e.f. 2023-24)

11.23.1 Syllabus of Course 2 (Minor)

SEMESTER-III

COURSE 2: GROUP THEORY

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. acquire the basic knowledge and structure of groups
2. get the significance of the notation of a subgroup and cosets.
3. understand the concept of normal subgroups and properties of normal subgroup
4. study the homomorphisms and isomorphisms with applications.
5. understand the properties of permutation and cyclic groups

Course Content

Unit – 1
Groups

Binary Operation – Algebraic structure – semi group-monoid – Group definition and elementary properties Finite and Infinite groups – examples – order of a group, Composition tables with examples.

Unit – 2
Sub Groups

Complex Definition – Multiplication of two complexes Inverse of a complex-Subgroup definition-examples-criterion for a complex to be a subgroups; Criterion for the product of two subgroups to be a subgroup-union and Intersection of subgroups. Coset Definition – properties of Cosets – Index of a subgroups of a finite groups – Lagrange's Theorem.

Unit – 3
Normal Subgroups

Normal Subgroups: Definition of normal subgroup – proper and improper normal subgroup–Hamilton group- Criterion for a subgroup to be a normal subgroup – intersection of two normal subgroups Sub group of index 2 is a normal sub group

Unit – 4
Homomorphisms

Quotient groups, Definition of homomorphism – Image of homomorphism elementary properties of homomorphism – Isomorphism – automorphism definitions and elementary properties–kernel of a homomorphism – fundamental theorem on Homomorphism and applications.

Unit – 5
Permutations and Cyclic Groups

Definition of permutation – permutation multiplication – Inverse of a permutation – cyclic permutations – transposition – even and odd permutations – Cayley's theorem.

Cyclic Groups - Definition of cyclic group – elementary properties – classification of cyclic groups.

Activities

Seminar/ Quiz/ Assignments/ Applications of Group Theory to Real life Problem /Problem Solving Sessions.

Text Book

Modern Algebra by A.R.Vasishtha and A.K.Vasishtha, KrishnaPrakashanMedia Pvt. Ltd., Meerut.

Reference Books

1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir&Pundir, published by PragathiPrakashan

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11.23.2 Blue Print for Course 2 (Minor) at end of Semester-III

Course 2 (Minor):Group Theory & Problem Solving Sessions (w.e.f. 2023-24)

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	**Q.No.**	**Unit**	**Nature of Question**	**Marks**
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	III	Theorem / Problem	3
	5	IV	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	V	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.23.1: Blueprint of Semester–III End Examination (Course 2 (Minor): : Group Theory & Problem Solving Sessions

11.23.3 Model Question Paper for Course 2 (Minor)

GOVERNMENT AUTONOMOUS COLLEGE, RAJAMAHENDRAVARAM

III Semester End Examinations

Course 2 (Minor): Group Theory & Problem Solving Sessions

(For the batch admitted in 2023–24 under Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Maximum Marks: 50**

PART – A (5 × 3 = 15 Marks)

Answer any Five questions. Each carries 3 Marks.

Q1. Write the composition table of $\mathbb{Z}_3 = \{0, 1, 2\}$ under addition modulo 3. (Unit–I, L1)

Q2. Define a group. Give one example of a finite group and one of an infinite group. (Unit–I, L1)

Q3. Prove that the intersection of two subgroups of a group G is a subgroup of G. (Unit–II, L3)

Q4. State and prove Lagrange's Theorem for finite groups. (Unit–II, L4)

Q5. Define a normal subgroup. Give an example of a proper normal subgroup. (Unit–III, L2)

Q6. Show that a subgroup of index 2 in a group is always normal. (Unit–III, L4)

Q7. Define a homomorphism of groups. Give an example. (Unit–IV, L2)

Q8. Write down the cycle decomposition of the permutation $(123)(45)$ and state whether it is even or odd. (Unit–V, L3)

PART – B (5 × 7 = 35 Marks)

Answer five questions, choosing one from each unit. Each carries 7 Marks.

Unit–I

Q9. Verify whether $(\mathbb{Z}, +)$ and $(\mathbb{Z}, \cdot)$ are groups. Justify your answer. (L3)

OR

Q10. Show that the set $\{1, -1, i, -i\}$ under multiplication forms a group. (L3)

Unit–II

Q11. Prove that the union of two subgroups of a group G is a subgroup of G if and only if one is contained in the other. (L4)

OR

Q12. If H is a subgroup of a finite group G, prove that the order of H divides the order of G. (L4)

Unit–III

Q13. Show that the intersection of two normal subgroups of a group G is a normal subgroup of G. (L4)

OR

Q14. Prove that every subgroup of index 2 is normal in G with an example. (L4)

Unit–IV

Q15. State and prove the Fundamental Theorem on Homomorphism. (L4)

OR

Q16. Define isomorphism and automorphism. Show that every automorphism of a group is an isomorphism. (L4)

Unit–V

Q17. State and prove Cayley's Theorem. (L4)

OR

Q18. Prove that every subgroup of a cyclic group is cyclic. (L4)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Marks (%)
L1 – Remembering	12%
L2 – Understanding	12%
L3 – Applying	18%
L4 – Analyzing	58%
L5 – Evaluating	0%
L6 – Creating	0%

11.24 Course 3 (Minor):Ring Theory & Problem Solving Sessions (w.e.f. 2023-24)

11.24.1 Syllabus of Course 3 (Minor)

SEMESTER-IV

COURSE 3: RING THEORY

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. acquire the basic knowledge of rings, fields and integral domains
2. get the knowledge of subrings and ideals
3. construct composition tables for finite quotient rings
4. study the homomorphisms and isomorphisms with applications.
5. get the idea of division algorithm of polynomials over a field.

Course Content

Unit – 1

Ringsand Fields

Definition of a ring and Examples –Basic properties – Boolean rings - Fields – Divisors of 0 and Cancellation Laws– Integral Domains – Division ring - The Characteristic of a Ring, Integral domain and Field – NonCommutative Rings - Matrices over a field – The Quaternion ring.

Unit – 2

Subrings and Ideals

Definition and examples of Subrings – Necessary and sufficient conditions for a subset to be a subring – Algebra of Subrings – Centre of a ring – left, right and two sided ideals – Algebra of ideals – Equivalence of a field and a commutative ring without proper ideals

Unit III: Principal ideals and Quotient rings

Definition of a Principal ideal ring(Domain) – Every field is a PID – The ring of integers is a PID – Example of a ring which is not a PIR – Cosets – Algebra of cosets – Quotient rings – Construction of composition tables for finite quotient rings of the ring Z of integers and the ring $Z_n$of integers modulo n.

Unit – 4

Homomorphism of Rings

Homomorphism of Rings – Definition and Elementary properties – Kernel of a homomorphism – Isomorphism – Fundamental theorems of homomorphism of rings – Maximal and prime Ideals – Prime Fields

Unit – 5

Rings of Polynomials

Polynomials in an indeterminate – The Evaluation morphism -- The Division Algorithm in $F[x]$ – Irreducible Polynomials – Ideal Structure in $F[x]$ – Uniqueness of Factorization $F[x]$.

Activities

Seminar/ Quiz/ Assignments/ Applications of ring theory concepts to Real life Problem /Problem Solving Sessions.

Text book

Modern Algebra by A.R.Vasishta and A.K.Vasishta, Krishna Prakashan Media Pvt. Ltd.

Reference books

1. A First Course in Abstract Algebra by John. B. Farleigh, Narosa Publishing House.
2. Linear Algebra by Stephen. H. Friedberg and Others,Pearson Education India

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11.24.2 Blue Print for Course 3 (Minor)at end of Semester-IV

Course 3 (Minor):Ring Theory& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.24.1: Blueprint of Semester–IV End Examination (Course–9:Ring Theory & Problem Solving Sessions

11.24.3 Model Question Paper for Course 3 (Minor)

Government College(A),Rajahmundry

SEMESTER–IV
Course 3 (Minor): Ring Theory & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A

(Answer any FIVE questions, each carries 3 Marks)

Q1. Define a ring. Give examples of a commutative and a non-commutative ring. (L1)

Q2. State and prove the cancellation law in an integral domain. (L2)

Q3. Define a Boolean ring and give one example. (L1)

Q4. Explain the concept of a subring with necessary and sufficient conditions. (L2)

Q5. Define left, right, and two-sided ideals with examples. (L1)

Q6. Construct a quotient ring using integers modulo 5. (L3)

Q7. State the fundamental theorem of homomorphism of rings. (L2)

Q8. Explain the division algorithm for polynomials over a field. (L2)

PART – B

(Answer five questions, choosing **one** from each unit. Each carries 7 Marks)

. $5 \times 7 = 35$ Marks

UNIT–1

Q9. Prove that the characteristic of a field is either 0 or a prime number. (L3)

OR

Q10. Show that every division ring is an integral domain but not necessarily a field. (L3)

UNIT–2

Q11. Determine whether the subset $2\mathbb{Z}$ is an ideal in the ring $\mathbb{Z}$. (L3)

OR

Q12. Prove that the center of a ring is a subring. (L2)

UNIT–3

Q13. Construct the quotient ring $\mathbb{Z}_6/2\mathbb{Z}_6$ and write its composition table. (L3)

OR

Q14. Give an example of a principal ideal ring which is not a field. (L3)

UNIT–4

Q15. Let $\phi : \mathbb{Z} \to \mathbb{Z}_5$ be defined by $\phi(n) = n \bmod 5$. Prove that ϕ is a homomorphism and find its kernel. (L4)

OR

Q16. Show that a maximal ideal in a commutative ring with unity leads to a field in the quotient ring. (L3)

UNIT–5

Q17. UNIT–5
Use the division algorithm to divide $x^4 + 2x^3 + x + 1$ by $x^2 + 1$ over $\mathbb{Q}[x]$. (L3)

OR

Q18. Prove that every non-zero polynomial in $\mathbb{F}[x]$ can be uniquely factored into irreducible polynomials. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.25 Course 4 (Minor) :Introduction to Real Analysis & Problem Solving Sessions (w.e.f. 2023-24)

11.25.1 Syllabus of Course 4 (Minor)

SEMESTER-IV

COURSE 4: INTRODUCTION TO REAL ANALYSIS

Theory Credits: 4 5 hrs/week

CourseOutcomes

Aftersuccessfulcompletionofthiscourse,thestudentwillbeableto

1. get clearideaabouttherealnumbersandrealvaluedfunctions.
2. obtaintheskillsofanalysingtheconceptsandapplyingappropriatemethodsfortesting convergence of a sequence/ series.
3. testthecontinuityand differentiabilityandRiemannintegrationofafunction.
4. knowthegeometricalinterpretationofmeanvalue theorems.
5. know about the fundamental theorem of integral calculus

Course Contents

Unit – 1

REALNUMBERS,REAL SEQUENCES

The algebraic and order properties of R - Absolute value and Real line - Completeness property of R - Applications of supremum property - intervals. (**No question is to be set from this portion)**
Sequences and their limits -Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence -The Cauchy's criterion - properly divergent sequences - Monotone sequences - Necessary and Sufficient condition for Convergence of Monotone Sequence - Limit Point of Sequence -Subsequencesand the Bolzano-weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence.

Unit – 2

INFINITIE SERIES

Introductiontoseries -convergenceofseries -Cauchy'sgeneralprincipleof convergencefor series tests for convergence of series - Series of non-negative terms - P-test - Cauchy'sn^{th} roottest -D'-Alembert'sTest-AlternatingSeries–Leibnitz Test.

Unit –3

LIMIT & CONTINUITY

Real valued Functions - Boundedness of a function - Limits of functions - Some extensions of the limit concept - Infinite Limits - Limits at infinity **(No question is to be set from this portion).**Continuous functions - Combinations of continuous functions - Continuous Functions on intervals - uniform continuity.

Unit – 4

DIFFERENTIATION ANDMEANVALUETHEORMS

The derivability of a function at a point and and on an interval - Derivability and continuity of a function -MeanvalueTheorems -Rolle'sTheorem,Lagrange's Theorem, Cauchy's Mean value Theorem

Unit – 5

RIEMANNINTEGRATION

Riemann Integral - Riemann integral functions - Darboux theorem -Necessary and sufficientcondition for R integrability - Properties of integrable functions - Fundamental theorem of integral calculus - integral as the limit of a sum - Mean value Theorems.

Activities

Seminar/ Quiz/ Assignments/ Applications of Real Analysis to Real life Problem /Problem Solving Sessions.

TextBook

An Introduction to Real Analysis by Robert G.Bartle and Donlad R. Sherbert, John Wiley and sonsPvt. Ltd

ReferenceBooks

1. ElementsofRealAnalysis by ShanthiNarayan andDr.M.D.Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.

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11.25.2 Blue Print for Course 4 (Minor) at end of Semester-IV

Course 4 (Minor):Introduction to Real Analysis& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A $(5 \times 3 = 15)$	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	III	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B $(5 \times 7 = 35)$	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.25.1: Blueprint of Semester–IV End Examination (Course 4 (Minor):Introduction to Real Analysis & Problem Solving Sessions

11.25.3 Model Question Paper for Course 4 (Minor)

Government College (A), Rajahmundry

SEMESTER–IV
Course 4 (Minor): Introduction to Real Analysis & Problem Solving Sessions

Duration: 2 $\frac{1}{2}$ Hours **Max. Marks: 50**

Part–A (Answer any FIVE questions, each carries 3 Marks) $5 \times 3 = 15$ Marks

Q1. Define a convergent sequence and state the Cauchy criterion. (L1)

Q2. Give an example of a monotone sequence and test its convergence. (L2)

Q3. Define a series and state the Cauchy root test. (L1)

Q4. State the Leibnitz test for alternating series with an example. (L2)

Q5. Define uniform continuity and give an example. (L1)

Q6. State Rolle's theorem and give a simple application. (L2)

Q7. State Lagrange's mean value theorem. (L1)

Q8. Define Riemann integrability of a function. (L1)

Part–B

(Answer five questions, choosing one from each unit. Each carries 7 Marks)

$5 \times 7 = 35$ Marks

UNIT–1

Q9. Prove that every bounded monotone sequence is convergent. (L3)

OR

Q10. Prove the Bolzano–Weierstrass theorem for sequences. (L4)

UNIT–2

Q11. Test the convergence of the series $\sum_{n=1}^{\infty} \frac{1}{n^2}$ using the p-test. (L3)

OR

Q12. Test the convergence of $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n}$ using the Leibnitz test. (L3)

UNIT–3

Q13. Prove that a continuous function on a closed interval is bounded. (L3)

OR

Q14. Prove that a uniformly continuous function preserves Cauchy sequences. (L3)

UNIT–4

Q15. Verify Lagrange's mean value theorem for $f(x) = x^3 - 3x$ in $[0, 2]$. (L4)

OR

Q16. Apply Cauchy's mean value theorem to $f(x) = x^2, g(x) = x$ in $[1, 3]$. (L3)

UNIT–5

Q17. Evaluate $\int_0^1 x^2 \, dx$ using Riemann sums. (L3)

OR

Q18. Prove the fundamental theorem of calculus for $f(x) = 3x^2$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Marks (%)
L1 – Remembering	20%
L2 – Understanding	20%
L3 – Applying	40%
L4 – Analyzing	10%
L5 – Evaluating	10%
L6 – Creating	0%

11.26 Course 5 (Minor) :Linear Algebra & Problem Solving Sessions (w.e.f. 2023-24)

11.26.1 Syllabus of Course 5 (Minor)

SEMESTER-V

COURSE 5: LINEAR ALGEBRA

Theory Credits: 4 5 hrs/week

Course Outcomes

After successful completion of this course, the student will be able to

1. understand the concepts of vector spaces, subspaces
2. understand the concepts of basis, dimension and their properties
3. understand the concept of linear transformation and its properties
4. apply Cayley- Hamilton theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods
5. learn the properties of inner product spaces and determine orthogonality in inner product spaces.

Course Content

UNIT – I

Vector Spaces-I

Vector Spaces - General properties of vector spaces - n-dimensional Vectors - addition and scalar multiplication of Vectors - internal and external composition - Null space - Vector subspaces -Algebra of subspaces - Linear Sum of two subspaces - linear combination of Vectors- Linear span Linear independence and Linear dependence of Vectors.

UNIT –II

Vector Spaces-II

Basis of Vector space - Finite dimensional Vector spaces - basis extension - co-ordinates- Dimension of a Vector space - Dimension of a subspace - Quotient space and Dimension of Quotient space.

UNIT –III

Linear Transformations

Linear transformations - linear operators- Properties of L.T- sum and product of L.Ts - Algebra of Linear Operators - Range and null space of linear transformation - Rank and Nullity of linear transformations - Rank- Nullity Theorem.

UNIT –IV

Matrices

Characteristic equation - Characteristic Values - Characteristic vectors of a square matrix - Cayley Hamilton Theorem – problems on Cayley Hamilton Theorem.

UNIT –V

Inner product space

Inner product spaces- Euclidean and unitary spaces- Norm or length of a Vector- Schwartz inequality- Triangle Inequality- Parallelogram law- Orthogonality- Orthonormal set- Problems on Gram– Schmidt orthogonalisation process - Bessel’s inequality.

Activities :

Seminar/ Quiz/ Assignments/Applications of Linear Algebra in real life problems\ Problem Solving.

Text Books

1.Linear Algebra by J.N. Sharma and A.R. Vasishtha, published by Krishna Prakashan Media (P) Ltd.

2.Matrices by A.R.Vasishtha and A.K.Vasishtha published by Krishna Prakashan Media (P) Ltd.

Reference Books

1. Linear Algebra by Stephen H. Friedberg et. al. published by Prentice Hall of India Pvt. Ltd. 4th Edition, 2007
2. Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson education low priced edition), New Delhi.
3. Matrices by Shanti Narayana, published by S.Chand Publications

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11.26.2 Blue Print for Course 5 (Minor) at end of Semester-V/VI

Course 5 (Minor):Linear Algebra& Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A (5 × 3 = 15)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	II	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	V	Theorem / Problem	3
	8	V	Theorem / Problem	3
B (5 × 7 = 35)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.26.1: Blueprint of Semester–V/VI End Examination (Course 5 (Minor):Linear Algebra & Problem Solving Sessions

11.26.3 Model Question Paper for Course 5 (Minor)

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

SEMESTER–V/VI

Course 5 (Minor): Linear Algebra & Problem Solving Sessions

Duration: $2\frac{1}{2}$ **Hours** **Maximum Marks: 50**

PART – A (Answer any **Five questions. Each carries 3 Marks**) $5 \times 3 = 15$ Marks

Q1. Define a vector space. Verify whether the set of all 2×2 matrices forms a vector space. (Unit–I, L1)

Q2. Show that the intersection of two subspaces is also a subspace. (Unit–I, L2)

Q3. Find a basis and the dimension of the subspace of $\mathbb{R}^3$ defined by $x + y + z = 0$. (Unit–II, L3)

Q4. Explain the concept of quotient space and find the dimension of $\mathbb{R}^3/W$, where $W = \{(x, y, 0)\}$. (Unit–II, L3)

Q5. Define linear transformation. Determine whether $T : \mathbb{R}^2 \to \mathbb{R}^2, T(x, y) = (x+y, x-y)$ is linear. (Unit–III, L2)

Q6. Verify the rank-nullity theorem for the linear transformation $T(x, y, z) = (x+y, y+z)$. (Unit–III, L3)

Q7. Find the characteristic values and characteristic vectors of the matrix $\begin{bmatrix} 2 & 0 \\ 1 & 3 \end{bmatrix}$. (Unit–IV, L3)

Q8. State and prove the Cauchy-Schwarz inequality in inner product spaces. (Unit–V, L4)

PART – B (Answer five questions, choosing **one from each unit. Each carries 7 Marks**) $5 \times 7 = 35$ Marks

UNIT–I

Q9. Prove that any linear combination of vectors in a subspace is also in the subspace. (L3)

OR

Q10. Show that the linear sum of two subspaces is a subspace and determine its dimension in a given example. (L4)

UNIT–II

Q11. Find a basis for the quotient space $\mathbb{R}^3/W$ where W is spanned by $\{(1,0,0),(0,1,0)\}$. (L3)

OR

Q12. Extend the basis $\{(1,0,0),(0,1,0)\}$ of a subspace of $\mathbb{R}^3$ to a basis of $\mathbb{R}^3$. (L4)

UNIT–III

Q13. Let $T:\mathbb{R}^2 \to \mathbb{R}^2$ be defined by $T(x,y) = (2x+3y, x+y)$. Find the range and null space of T. (L3)

OR

Q14. If T_1 and T_2 are linear transformations, prove that $T_1 + T_2$ and $T_1 \circ T_2$ are also linear. (L4)

UNIT–IV

Q15. Using Cayley-Hamilton theorem, find A^{-1} for $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$. (L3)

OR

Q16. Find A^5 using Cayley-Hamilton theorem for $A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$. (L4)

UNIT–V

Q17. Apply Gram-Schmidt process to orthonormalize the vectors $(1, 1, 0), (1, 0, 1), (0, 1, 1)$ in $\mathbb{R}^3$. (L5)

OR

Q18. Verify Bessel's inequality for the vectors $(1, 1, 0), (1, 0, 1)$ in $\mathbb{R}^3$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	6%
L2 – Understanding	12%
L3 – Applying	40%
L4 – Analyzing	22%
L5 – Evaluating	10%
L6 – Creating	10%

11.27 Course 6 (Minor) :Vector Calculus & Problem Solving Sessions (w.e.f. 2023-24)

11.27.1 Syllabus of Course 6 (Minor)

SEMESTER-V

COURSE 6: VECTOR CALCULUS

Theory Credits: 4 5 hrs/week

Course Outcomes

Studentsaftersuccessfulcompletionofthecoursewillbeableto

1. Learnmultipleintegrals asanaturalextensionofdefiniteintegraltoafunctionoftwovariables inthecaseofdoubleintegral/threevariables inthecaseoftripleintegral.
2. Learnapplicationsintermsoffindingsurfaceareabydoubleintegralandvolumebytripleintegral .
3. Determinethegradient,divergenceandcurlofavectorandvectoridentities.
4. Evaluateline,surfaceandvolumeintegrals.
5. understand relation between surface and volume integrals (Gauss divergence theorem),relationbetweenlineintegralandvolumeintegral(Green'stheorem),relationbetween lineandsurfaceintegral(Stokestheorem)

Course Content

Unit–1
MultipleIntegrals-I

Introduction -Doubleintegrals -Evaluationofdoubleintegrals –Propertiesofdouble integrals -Regionofintegration -doubleintegrationinPolarCo-ordinates –Changeofvariablesindoubleintegrals -changeoforderofintegration.

Unit–2
Multipleintegrals-II

Tripleintegral -regionofintegration -changeofvariables -Plane areasbydoubleintegrals -surfaceareabydoubleintegral -Volumeasadoubleintegral,volumeasatripleintegral.

Unit–3
Vectordifferentiation

Vectordifferentiation –ordinary - derivativesofvectors – Differentiability –Gradient –Divergence -Curloperators - Formulaeinvolvingtheseparators.

Unit–4
Vectorintegration

Line Integralswithexamples - Surface Integralwithexamples - Volumeintegralwithexamples.

Unit–5
Vectorintegrationapplications

Gausstheoremandapplicationsof Gausstheorem - Green'stheoreminplane and applicationsofGreen'stheorem - Stokes'stheoremandapplications ofStokestheorem.

Activities

Seminar/ Quiz/ Assignments/ Applications of Vector calculus to Real life Problems /Problem Solving Sessions.

Text Book

A text Book of Higher Engineering Mathematics by B.S.Grawal, Khanna Publishers, 43rd Edition

ReferenceBooks

1. Vector Calculus by P.C.Matthews, Springer Verlag publications.
2. Vector Analysis by Murray Spiegel, Schaum Publishing Company, NewYork

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11.27.2 Blue Print for Course 6 (Minor) at end of Semester-V/VI

Course 6 (Minor):Vector Calculus & Problem Solving Sessions

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A ($5 \times 3 = 15$)	1	I	Theorem / Problem	3
	2	I	Theorem / Problem	3
	3	II	Theorem / Problem	3
	4	III	Theorem / Problem	3
	5	III	Theorem / Problem	3
	6	IV	Theorem / Problem	3
	7	IV	Theorem / Problem	3
	8	V	Theorem / Problem	3
B ($5 \times 7 = 35$)	9 **or** 10	I	Theorem / Problem	7
	11 **or** 12	II	Theorem / Problem	7
	13 **or** 14	III	Theorem / Problem	7
	15 **or** 16	IV	Theorem / Problem	7
	17 **or** 18	V	Theorem / Problem	7

Table 11.27.1: Blueprint of Semester–V/VI End Examination (Course 6 (Minor):Vector Calculus & Problem Solving Sessions

11.27.3 Model Question Paper for Course 6 (Minor)

GOVERNMENT COLLEGE(A), RAJAHMUNDRY

SEMESTER–V/VI

Course 6 (Minor): Vector Calculus & Problem Solving Sessions

Duration: $2\frac{1}{2}$ Hours **Maximum Marks: 50**

PART – A (5 × 3 = 15 Marks)

(Answer any **Five questions. Each carries 3 Marks**)

Q1. Evaluate the double integral $\iint_R (x+y)\,dxdy$, where R is the rectangle $0 \le x \le 1$, $0 \le y \le 2$. (Unit–I, L3)

Q2. Change the order of integration for $\int_0^1 \int_x^1 f(x,y)\,dydx$. (Unit–I, L2)

Q3. Evaluate the triple integral $\iiint_V z\,dV$, where V is the cube $0 \le x,y,z \le 1$. (Unit–II, L3)

Q4. Find the gradient of the scalar function $f(x,y,z) = x^2y + y^2z + z^2x$. (Unit–III, L2)

Q5. Compute the divergence and curl of $\mathbf{F} = (xy, yz, zx)$. (Unit–III, L3)

Q6. Evaluate the line integral $\int_C (y\,dx + x\,dy)$ along the straight line from $(0,0)$ to $(1,1)$. (Unit–IV, L3)

Q7. Evaluate the surface integral $\iint_S z\,dS$, where S is the plane $z = 2 - x - y$ over the region $x \ge 0, y \ge 0, x + y \le 2$. (Unit–IV, L4)

Q8. State Gauss's divergence theorem and apply it to verify $\iiint_V (\nabla \cdot \mathbf{F})dV = \iint_S \mathbf{F} \cdot \mathbf{n}dS$ for $\mathbf{F} = (x,y,z)$ and V is the unit cube. (Unit–V, L4)

PART – B (5 × 7 = 35 Marks)

(Answer five questions, choosing **one from each unit. Each carries 7 Marks**)

UNIT–I

Q9. Evaluate $\iint_R (x^2 + y^2)\,dxdy$ over the circular region $x^2 + y^2 \le 1$ using polar coordinates. (L3)

OR

Q10. Change the order of integration and evaluate $\int_0^1 \int_x^{\sqrt{x}} e^{y^2} dydx$. (L4)

UNIT–II

Q11. Find the volume of the solid bounded by the paraboloid $z = 4 - x^2 - y^2$ and the plane $z = 0$. (L4)

OR

Q12. Find the surface area of the part of the plane $z = x + y$ lying above the square $0 \leq x, y \leq 1$. (L4)

UNIT–III

Q13. For $\mathbf{F} = (x^2, y^2, z^2)$, compute $\nabla \cdot \mathbf{F}$ and $\nabla \times \mathbf{F}$. (L3)

OR

Q14. Verify the vector identity $\nabla \times (\nabla f) = 0$ for $f(x, y, z) = xyz$. (L3)

UNIT–IV

Q15. Evaluate the line integral $\oint_C (y\,dx + z\,dy + x\,dz)$, where C is the boundary of the triangle with vertices $(1, 0, 0), (0, 1, 0), (0, 0, 1)$. (L4)

OR

Q16. Evaluate the surface integral $\iint_S \mathbf{F} \cdot \mathbf{n}\,dS$ for $\mathbf{F} = (x, y, z)$ over the surface of the cube $0 \leq x, y, z \leq 1$. (L4)

UNIT–V

Q17. Use Green's theorem to evaluate $\oint_C (x^2y\,dx + xy^2\,dy)$, where C is the square with vertices $(0, 0), (1, 0), (1, 1), (0, 1)$. (L4)

OR

Q18. Use Stokes' theorem to evaluate $\oint_C \mathbf{F} \cdot d\mathbf{r}$ for $\mathbf{F} = (-y, x, z)$ around the boundary of the triangle with vertices $(1, 0, 0), (0, 1, 0), (0, 0, 1)$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Marks (%)**
L1 – Remembering	0%
L2 – Understanding	12%
L3 – Applying	36%
L4 – Analyzing	30%
L5 – Evaluating	12%
L6 – Creating	10%

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With Effect From 2023-24

Admitted Batch

Multidisciplinary Courses

11.28 Course 4 (Statistics Minor) :Numerical Analysis (w.e.f. 2023-24)

11.28.1 Syllabus of Course 4 (Statics Minor)

SEMESTER-IV

COURSE 4: NUMERICAL ANALYSIS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course the student will be able

1. Learn the different difference operators and applications.
2. Accustom with the interpolation techniques with equal and unequal intervals.
3. Able to use numerical differentiation tools.
4. Familiar to use numerical integration methods.

II. Syllabus

Unit 1

Definitions of Forward difference operator (Δ), Backward difference operator, Shift or Extension (displacement) operator (E), Central Differences operator(μ), Differentiation operator(D), Mean value operator Symbolic relations between operators, properties of difference and shift operators, fundamental theorem on finite differences and simple problems.

Unit 2

Interpolation with equal intervals: Concept of interpolation and extrapolation, assumptions and uses of interpolation, difference tables, methods of interpolation with equal intervals - Newton's formula for forward and backward interpolation, Central differences, Gauss forward and backward, Sterling, Bessel's and Laplace - Everett's Formulae.

Unit 3

Interpolation with unequal intervals: Divided differences and their properties. Methods of interpolation with unequal intervals – Newton's Divided difference formula and Lagrange's formula. Inverse interpolation - Lagrange's formula.

Unit 4

Numerical Differentiation: Introduction to Numerical differentiation. Determination of First and Second order derivatives for the given data using Newton's forward and backward, Gauss forward and backward, Sterling, Bessel's and Newton's Divided difference formula.

Unit 5

Numerical Integration: Introduction to numerical integration, General Quadrature formula for equidistant ordinates, Trapezoidal rule, Simpson's $1/3^{rd}$, Simpson's $3/8^{th}$ rule and Weddle's rule.

SEMESTER-IV
COURSE 4: NUMERICAL ANALYSIS

Practical | Credits: 1 | 2 hrs/week

Practical Syllabus

1. Interpolation by using Newton-Gregory forward and backward difference formulae.
2. Interpolation by using Gauss forward and backward difference formulae.
3. Interpolation by using Sterling and Bessel's formulae.
4. Interpolation by using Laplace-Everett's Formula.
5. Interpolation by using Newton's divided difference and Lagrange's formulae.
6. Inverse interpolation by using Lagrange's formula.
7. Determination of first and second order derivatives by using Newton-Gregory forward and backward difference formulae.
8. Determination of first and second order derivatives by using Gauss forward and backward difference formulae.
9. Determination of first and second order derivatives by using Newton's divided difference formula.
10. Numerical Integration by using Trapezoidal rule, Simpson's $1/3^{rd}$, Simpson's $3/8^{th}$ rule and Weddle's rule.

III. References

1. H. C. Saxena: Finite Differences and Numerical Analysis, S. Chand and Company, New Delhi.
2. P. P. Gupta, G. S. Malik & Sanjay Gupta: Calculus of Finite Differences and Numerical Analysis, Krishna Prakashan Media(P) Ltd., Meerut(UP), India.
3. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India.
4. C. F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison- Wesley, 1998.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

11.28.2 Blue Print for Course 4 (Statistics Minor) :Numerical Analysis at end of Semester-IV

Course 4 (Statistics Minor) :Numerical Analysis (w.e.f. 2023-24)

Batch: 2023–24 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question	Marks
A (Answer any 5) ($5 \times 3 = 15$)	1	I	Short definition / small computation (finite differences / operators)	3
	2	I	Short computation (difference table / simple polynomial)	3
	3	II	Short statement / application (Newton forward / equally spaced)	3
	4	II	Short computation (interpolation estimate one step)	3
	5	III	Short definition / divided difference computation	3
	6	III	Short Lagrange basis / small interpolant computation	3
	7	IV	Short formula (numeric differentiation — central/forward)	3
	8	V	Short rule (Simpson/Trapezoid statement or small application)	3
B (Attempt ONE question from each Unit) ($5 \times 7 = 35$)	9 **or** 10	I	Derivation / problem (finite differences / operator property)	7
	11 **or** 12	II	Derivation / problem (Newton/Gauss interpolation & application)	7
	13 **or** 14	III	Derivation / problem (divided differences / Lagrange polynomial)	7
	15 **or** 16	IV	Derivation / problem (numerical differentiation formula / application)	7
	17 **or** 18	V	Derivation / problem (composite Simpson / trapezoidal / error comment)	7

Table 11.28.1: Blueprint of End Examination: Course 4 — Numerical Analysis (Statistics Minor) (w.e.f. 2023-24)

11.28.3 Model Question Paper for Course 4 (Statistics Minor)(w.e.f. 2023-24)

MODEL QUESTION PAPER

Course 4 (Statistics Minor): NUMERICAL ANALYSIS

Total: 50 marks Time: 3 hours

Semester-IV

(Part–A: Answer any 5 short questions. Part–B: Answer one question from each Unit)

PART – A (Short questions) 15 marks

Answer any FIVE questions. Each question carries 3 marks.

1. (Unit 1) Define the forward difference operator Δ and the backward difference operator ∇. Give their action on $f(x)$ at node x_0.
2. (Unit 1) If $f(0) = 2,\ f(1) = 5,\ f(2) = 10$, compute $\Delta f(0)$ and $\Delta^2 f(0)$.
3. (Unit 2) State Newton's forward interpolation formula for equally spaced nodes (write first three terms).
4. (Unit 2) Given equally spaced data $x = 0, 1, 2$ with $f = 1, 4, 9$, use Newton's forward idea to estimate $f(0.5)$ (write the formula and compute).
5. (Unit 3) What is a divided difference $[x_0, x_1]f$? Compute $[1, 2]f$ for $f(1) = 3$, $f(2) = 7$.
6. (Unit 3) State Lagrange interpolation formula for three points; write the three basis polynomials.
7. (Unit 4) Write the central difference formula for $f'(x_0)$ using $f(x_0+h)$ and $f(x_0-h)$ and state its truncation order.
8. (Unit 5) State Simpson's 1/3 rule for integrating f on $[a, b]$ using two equal subintervals.

PART – B (Long questions) 35 marks

Attempt ONE question from each Unit. Each question carries 7 marks.

Unit 1

9. Derive (briefly) the relation $\Delta^2 f(x) = \Delta(\Delta f(x))$ and show with the polynomial $p(x) = x^2$ that $\Delta^2 p$ is constant for equally spaced nodes of step $h = 1$. (7)

10. Given the values $f(0) = 1,\ f(1) = 2,\ f(2) = 4,\ f(3) = 7$, construct the forward difference table up to second differences and write Newton's forward interpolation polynomial up to the quadratic term. (7)

Unit 2

11. Using Newton's forward formula for equally spaced nodes, find an approximation to $f(1.5)$ from the table:

x	1	2	3
$f(x)$	0	1	4

Show arithmetic and give the interpolated value up to 3 decimal places. (7)

12. Explain, in simple terms, when Gauss central interpolation is preferred over Newton forward interpolation. Give one short example (no long computations). (7)

Unit 3

13. For points $(0, 1), (1, 3), (2, 9)$ construct the divided difference table and write the Newton divided-difference interpolating polynomial. (7)

14. Use the Lagrange formula to find the quadratic polynomial passing through $(0, 1), (1, 2), (2, 5)$. (7)

Unit 4

15. Derive a forward-difference based formula (up to $O(h)$ or $O(h^2)$ as you prefer) to approximate $f'(x_0)$ using $f(x_0), f(x_0 + h), f(x_0 + 2h)$. State its order. (7)

16. Given data $x = 0, 0.1, 0.2$ and $f = 1.0000, 0.9950, 0.9802$, compute an approximation to $f'(0.1)$ using central difference formula and state approximate truncation error order. (7)

Unit 5

17. Derive composite Simpson's 1/3 rule for two subintervals ($n = 2$) and apply it to approximate $\int_0^1 (1 + x^2)\, dx$. Show intermediate sums. (7)

18. State Trapezoidal and Simpson's 1/3 rules; for $f(x) = \cos x$ on $[0, \pi/2]$ which rule (with same number of function evaluations) is expected to be more accurate and why? Give a brief explanation. (7)

11.29 Course 1 (Major) :Differential Equations (w.e.f. 2025-26)

11.29.1 Syllabus of Course 1 (Major)

SEMESTER-I

COURSE 1: DIFFERENTIAL EQUATIONS

Theory **Credits: 4** **5 hrs/week**

Course Objectives

1. To introduce the concepts and methods for solving first-order differential equations, including exact, linear, and Bernoulli equations.
2. To understand special types of first-order differential equations such as Clairaut's equations and those solvable for p, x or y.
3. To develop techniques for solving higher-order linear differential equations with constant coefficients.
4. To apply the operator method for finding particular integrals of non-homogeneous differential equations with various types of right-hand side functions.
5. To learn the method of variation of parameters for solving non-homogeneous differential equations.

Course Outcomes

After successful completion of the course, the student will be able to

1. Solve exact differential equations, linear equations, Bernoulli's equations, and equations reducible to exact form using integrating factors.
2. Analyze and solve first-order differential equations that are solvable for p, , and y, including Clairaut's equations.
3. Solve homogeneous and non-homogeneous linear differential equations of higher order with constant coefficients using operator methods.
4. Compute particular integrals for non-homogeneous equations when the right-hand side is a polynomial, exponential, or trigonometric function.
5. Solve non-homogeneous differential equations using the method of variation of parameters and other applicable techniques.

Unit – 1

Exact Differential Equations - Integrating factors - Equations reducible to Exact Equations by Integrating Factors **(i)** $\frac{1}{Mx+Ny}$ **(ii)** $\frac{1}{Mx-Ny}$ - Linear Differential Equations – Bernoulli's Equations

Unit – 2

Equations solvable for p, Equations solvable for y, Equations solvable for x – Clairaut's equation

Unit – 3

Solutions of homogeneous linear differential equations of second and higher order with constant coefficients *f(D)y = 0* - Solutions of non-homogeneous linear differential equations *f(D)y = Q(x)* of second order with constant coefficients by means of polynomial operators (i) $Q(x) = b\,e^{ax}$ where b is a real constant - (ii) $Q(x) = Sin\ ax$ (or) $Cos\ ax$ where a is a real constant.

Unit – 4

Solution to a non-homogeneous linear differential equations of second order with constant coefficients by means of polynomial operators $Q(x) = b\,x^k$, $Q(x) = e^{ax}\,V$, where V is a function of x.

Unit – 5

Solution of the non-homogeneous linear differential equations of second order with constant coefficients by means of polynomial operators $Q(x) = x\,V$, where V is a function of x – Problems on Method of Variation of parameters to find solutions of linear differential equations with variable coefficients.

Activities

The activities planned throughout the Differential Equations course include a variety of interactive and evaluative methods such as quizzes, assignments, seminars, and student presentations. Students will also engage in a mini project, prepare concept flowcharts, and participate in operator method chart activities. Peer teaching sessions, LMS-based online quizzes, and board work challenges will foster collaborative and digital learning. Additionally, poster presentations on applications and visual aids like chalk talks will be incorporated to support diverse learning styles and deepen conceptual clarity.

Text Book

Differential Equations and Their Applications by Zafar Ahsan, published by Prentice-Hall of India Pvt. Ltd, New Delhi-Second edition.

Reference Books

1. Ordinary and Partial Differential Equations by Dr. M.D. Raisinghania, published by S. Chand & Company, New Delhi.
2. Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha- Universities Press.
3. Differential Equations -Srinivas Vangala & Madhu Rajesh, published by Spectrum University

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11.29.2 Blue Print for Course 1 (Major) :Differential Equations (w.e.f. 2025-26)at end of Semester-I

Course 1 (Major) :Differential Equations (w.e.f. 2025-26)

Admitted Batch: 2025–26 onwards (Single Major System)

Duration: 2 ½ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question (Bloom's Level)	Marks
A (Answer any 5) ($5 \times 3 = 15$)	1	I	Solve a simple exact differential equation. (L1)	3
	2	I	Solve a Bernoulli's equation. (L2)	3
	3	II	Write Clairaut's equation and solve a basic case. (L1)	3
	4	II	Show that a given equation is solvable for y. (L3)	3
	5	III	Find the complementary function of $f(D)y = 0$. (L1)	3
	6	III	Solve a 2nd order LDE with $Q(x) = e^{ax}$. (L3)	3
	7	IV	Obtain P.I. for $f(D)y = x^2$. (L3)	3
	8	V	State the method of variation of parameters. (L2)	3
B (Attempt ONE question from each Unit) ($5 \times 7 = 35$)	9 **or** 10	I	(a) Solve by integrating factor: $(2xy + y^2)dx + (x^2 + xy)dy = 0$. (b) Solve: $(x + y)\,dy/dx + y = x$. (L3, L4)	7
	11 **or** 12	II	(a) Solve Clairaut's equation $y = x\frac{dy}{dx} + (\frac{dy}{dx})^2$. (b) Solve equation solvable for x: $y^2dx-(x^2+1)dy = 0$. (L3)	7
	13 **or** 14	III	Solve $D^2y+9y = \sin 3x$ OR $D^2y-4D+4)y = e^{2x}$. (L3)	7
	15 **or** 16	IV	Solve $(D^2+4)y = x^2+3e^{2x}$. OR Solve $(D^2+1)y = x\sin x$. (L3, L5)	7
	17 **or** 18	V	Solve $y'' + y = \tan x$ using variation of parameters. OR Solve $y'' - y = \frac{1}{x}$. (L3, L5)	7

Table 11.29.1: Blueprint of End Examination: Course 1 — Differential Equations (Major) (w.e.f. 2025–26)

11.29.3 Model Question Paper for Course 1 — Differential Equations (Major) (w.e.f. 2025–26)

MODEL QUESTION PAPER

Course 1 — Differential Equations (Major) (w.e.f. 2025–26)

Total: 50 marks Time: $2\frac{1}{2}$ hours

Semester-I

(Part–A: Answer any 5 short questions. Part–B: Answer one question from each Unit)

PART – A (Short questions) 15 marks

Answer any FIVE questions. Each question carries 3 marks.

1. Solve: $(y^2 + 2x)dx + (2y + x)dy = 0$. (L1)
2. Solve the Bernoulli's equation: $\frac{dy}{dx} + y = x^2y^2$. (L2)
3. Write Clairaut's form of equation and solve $y = xp + p^2$. (L1)
4. Show that $y^2dx - (x^2 + 1)dy = 0$ is solvable for y. (L3)
5. Find the complementary function of $(D^2 + 9)y = 0$. (L1)
6. Solve: $(D^2 - 4D + 4)y = e^{2x}$. (L3)
7. Obtain P.I. of $(D^2 + 1)y = x^2$. (L3)
8. State the method of variation of parameters. (L2)

PART – B (Long questions) 35 marks

Attempt ONE question from each Unit. Each question carries 7 marks.

Unit 1

9. Solve by integrating factor: $(2xy + y^2)dx + (x^2 + xy)dy = 0$. (L3)
10. Solve: $(x + y)\frac{dy}{dx} + y = x$. (L4)

Unit 2

11. Solve Clairaut's equation: $y = x\frac{dy}{dx} + (\frac{dy}{dx})^2$. (L3)

12. Solve: $y^2dx - (x^2+1)dy = 0$. (L3)

Unit 3

13. Solve: $D^2y + 9y = \sin 3x$. (L3)

14. Solve: $(D^2 - 4D + 4)y = e^{2x}$. (L3)

Unit 4

15. Solve: $(D^2 + 4)y = x^2 + 3e^{2x}$. (L3)

16. Solve: $(D^2 + 1)y = x \sin x$. (L5)

Unit 5

17. Solve: $y'' + y = \tan x$ using variation of parameters. (L5)

18. Solve: $y'' - y = \frac{1}{x}$. (L3)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Description	Weightage (%)	Marks (out of 50)
L1	Remembering	10%	5
L2	Understanding	10%	5
L3	Applying	60%	30
L4	Evaluating	10%	5
L5	Analyzing	10%	5

11.30 Course 2 (Major) :Solid Geometry (w.e.f. 2025-26)

11.30.1 Syllabus of Course 2 (Major)

SEMESTER-I

COURSE 2: SOLID GEOMETRY

Theory **Credits: 4** **5 hrs/week**

Course Objectives

1. To introduce fundamental concepts of planes, lines, and spheres in 3D geometry.
2. To develop analytical skills for deriving equations of planes, lines, and spheres in different forms.
3. To analyze geometric relationships, including angles, distances, and intersections between lines, planes, and spheres.
4. To study advanced properties of spheres, such as tangents, polar planes, and orthogonality conditions.
5. To apply geometric principles to solve problems involving coplanarity, shortest distances, and sphere-line/plane interactions.

Course Outcomes

After completing this course, students will be able to

1. Derive and interpret equations of planes and lines in various forms.
2. Compute angles, distances, and intersection conditions between geometric elements (lines, planes, spheres).
3. Determine coplanarity of lines and solve problems involving shortest distances in 3D space.
4. Analyse sphere-related problems, including tangents, intersections, and circle equations in 3D.
5. Apply advanced concepts like polar planes, conjugate points, and orthogonality conditions of spheres.

Course Content

Unit – 1
Equation of plane in terms of its intercepts on the axis - Equations of the plane through the given points - Length of the perpendicular from a given point to a given plane - Bisectors of angles between two planes - Combined equation of two planes

Unit – 2
Equation of a line in various forms - Angle between a line and a plane - The condition that a given line may lie in a given plane - The condition that two given lines are coplanar - Number of arbitrary constants in the equations of straight line - Sets of conditions which determine a line

Unit – 3
The shortest distance between two skew lines - The length and equations of the line of shortest distance between two skew lines - Length of the perpendicular from a given point to a given line.

Unit – 4

Definition and equation of the sphere - Equation of the sphere through four given points - Plane sections of a sphere - Intersection of two spheres - Equation of a circle - Sphere through a given circle - Intersection of a sphere and a line

Unit – 5

Power of a point - Tangent plane - Plane of contact; Polar plane - Pole of a Plane - Conjugate points - Conjugate planes - Angle of intersection of two spheres - Conditions for two spheres to be orthogonal - Radical Plane – Coaxial system of spheres-Limiting Points.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, published by S. Chand & Company Ltd. 7th Edition.

Reference Books

1. A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, published by Wiley Eastern Ltd., 1999.
2. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by Tata McGraw - Hill Publishers.
3. Solid Geometry by B. Rama Bhupal Reddy, published by Spectrum University Press.

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11.30.2 Blue Print for Course 2 (Major) :Solid Geometry (w.e.f. 2025-26)at end of Semester-I

Course 2 (Major) :Solid Geometry (w.e.f. 2025-26)

Admitted Batch: 2025–26 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question (Bloom's Level)	Marks
A (Answer any 5) ($5 \times 3 = 15$)	1	I	Find the equation of the plane passing through three given points. (L1)	3
	2	I	Find the bisector plane of the angle between two planes. (L2)	3
	3	II	Write the condition for a line to lie in a plane. (L1)	3
	4	II	Find the angle between a line and a plane. (L3)	3
	5	III	Find the length of the perpendicular from a point to a line. (L3)	3
	6	IV	Find the equation of the sphere through four given points. (L1)	3
	7	IV	Write the equation of a circle as the intersection of a sphere and a plane. (L2)	3
	8	V	Define and write the equation of the radical plane of two spheres. (L3)	3
B (Attempt ONE question from each Unit) ($5 \times 7 = 35$)	9 **or** 10	I	(a) Derive the equation of a plane in intercept form. (b) Find the length of the perpendicular from a point to a plane. (L1, L3)	7
	11 **or** 12	II	(a) Derive the condition for two lines to be coplanar. (b) Find the angle between a line and a plane. (L2, L3)	7
	13 **or** 14	III	(a) Derive the formula for the shortest distance between two skew lines. (b) Find the equation of the line of shortest distance. (L3, L4)	7
	15 **or** 16	IV	(a) Derive the equation of a sphere through four given points. (b) Find the equation of the circle cut by a sphere and a plane. (L3, L5)	7
	17 **or** 18	V	(a) Derive the condition for two spheres to be orthogonal. (b) Find the equation of the polar plane of a point w.r.t. a sphere. (L3, L5)	7

Table 11.30.1: Blueprint of End Examination: Course 2 — Solid Geometry (Major) (w.e.f. 2025–26)

11.30.3 Model Question Paper for Course 2 — Solid Geometry (Major) (w.e.f. 2025–26)

MODEL QUESTION PAPER

Course 2 — Solid Geometry (Major) (w.e.f. 2025–26)

Total: 50 marks Time: $2\frac{1}{2}$ hours

Semester-I

(Part–A: Answer any 5 short questions. Part–B: Answer one question from each Unit)

PART – A (Short questions) **15 marks**

Answer any FIVE questions. Each question carries 3 marks.

1. Find the equation of the plane passing through the points $(1,0,0)$, $(0,1,0)$, $(0,0,1)$. (L1)
2. Find the bisector plane between $x+y+z=0$ and $x-y+z=0$. (L2)
3. State the condition that a line may lie in a plane. (L1)
4. Find the angle between the line $\frac{x-1}{2}=\frac{y}{3}=\frac{z+1}{-1}$ and the plane $2x-y+2z=5$. (L3)
5. Find the length of the perpendicular from the point $(1,2,3)$ to the line $\frac{x-1}{1}=\frac{y-2}{-1}=\frac{z}{2}$. (L3)
6. Find the equation of the sphere passing through $(1,0,0)$, $(0,1,0)$, $(0,0,1)$, $(1,1,1)$. (L1)
7. Write the equation of a circle as the intersection of a sphere and a plane. (L2)
8. Define and write the equation of the radical plane of two spheres. (L3)

PART – B (Long questions) **35 marks**

Attempt ONE question from each Unit. Each question carries 7 marks.

Unit 1

9. Derive the equation of a plane in intercept form. (L1)

10. Find the length of the perpendicular from the point $(1, 2, 3)$ to the plane $2x + 3y + 6z = 12$. (L3)

Unit 2

11. Derive the condition for two lines to be coplanar. (L2)

12. Find the angle between the line $\frac{x}{1} = \frac{y-1}{2} = \frac{z}{-1}$ and the plane $x + 2y + 2z = 5$. (L3)

Unit 3

13. Derive the formula for the shortest distance between two skew lines. (L3)

14. Find the equation of the line of shortest distance between $\frac{x}{1} = \frac{y-1}{2} = \frac{z}{3}$ and $\frac{x-2}{2} = \frac{y}{-1} = \frac{z+1}{1}$. (L4)

Unit 4

15. Derive the equation of a sphere through four given points. (L3)

16. Find the equation of the circle cut from the sphere $x^2 + y^2 + z^2 = 25$ by the plane $x + 2y + 2z = 5$. (L5)

Unit 5

17. Derive the condition for two spheres to be orthogonal. (L3)

18. Find the polar plane of the point $(1, 2, 3)$ with respect to the sphere $x^2 + y^2 + z^2 = 9$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Description	Weightage (%)	Marks (out of 50)
L1	Remembering	10%	5
L2	Understanding	10%	5
L3	Applying	60%	30
L4	Evaluating	10%	5
L5	Analyzing	10%	5

11.31 Course 3 (Major) : Group Theory (w.e.f. 2025-26)

11.31.1 Syllabus of Course 3 (Major)

SEMESTER-II

COURSE 3: GROUP THEORY

Theory **Credits: 4** **5 hrs/week**

Course Objectives

1. To introduce students to the foundational concepts of algebraic structures with a focus on groups.
2. To develop an understanding of subgroups, cosets, and their relevance in group theory.
3. To explore the properties and significance of normal subgroups and their role in constructing quotient groups.
4. To study and apply the concepts of group homomorphisms, isomorphisms, and the fundamental theorem of homomorphism.
5. To examine the structure and properties of permutation and cyclic groups, including their role in group classification.

Course Outcomes

After successful completion of this course, the student will be able to

1. Understand the definition and basic properties of groups, including finite and infinite groups, and construct composition tables.
2. Analyze subgroups and cosets, apply Lagrange's Theorem, and understand the structure of a group through its subgroups.
3. Identify and verify normal subgroups, and understand their role in forming quotient groups.
4. Understand and apply homomorphisms and isomorphisms, including the fundamental homomorphism theorem and its applications.
5. Work with permutations, transpositions, and cyclic groups, and understand their properties and significance in group theory, including Cayley's Theorem.

Course Content

Unit – 1

Binary Operation – Algebraic structure – **S**emi group - **M**onoid – Group definition and **its** elementary properties **-** **F**inite and Infinite groups – examples – order of a group **-** Composition tables with examples.

Unit – 2

Definition of Complex – Multiplication of two complexes- Inverse of a complex- Definition of Subgroup - examples-Criterion for a complex to be a subgroup- Criterion for the product of two subgroups to be a subgroup-Union and Intersection of subgroups – Definition of Cosets – Properties of Cosets – Index of a subgroup of a finite group – Lagrange's Theorem.

Unit – 3

Normal Subgroups - Definition of normal subgroup – Proper and improper normal subgroups – Hamilton group- Criterion for a subgroup to be a normal subgroup – Intersection of two normal subgroups - Sub group of index 2 is a normal sub group

Unit – 4
Quotient groups - Definition of homomorphism – Image of a homomorphism- Elementary properties of homomorphisms – Isomorphism – Automorphism- Definitions and elementary properties–Kernel of a homomorphism – Fundamental theorem of Homomorphism and applications.

Unit – 5
Definition of permutation –Multiplication of Permutations– Inverse of a permutation – Cyclic permutations – Transposition – Even and odd permutations – Cayley's theorem - Cyclic Groups - Definition of cyclic group – Elementary properties

Activities
The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book
Modern Algebra by A.R.Vasishtha and A.K. Vasishtha, Krishna Prakashan Media Pvt. Ltd., Meerut.

Reference Books
1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir & Pundir, published by Pragathi Prakashan

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11.31.2 Blue Print for Course 3 (Major) : Group Theory (w.e.f. 2025-26)at end of Semester-II

Course 3 (Major) : Group Theory (w.e.f. 2025-26)

Admitted Batch: 2025–26 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	**Q.No.**	**Unit**	**Nature of Question (Bloom's Level)**	**Marks**
A (Answer any 5) $(5 \times 3 = 15)$	1	I	Define a group and give two examples. (L1)	3
	2	I	Using a composition table, find the order of each element in the set $\{e, a, b\}$ with given table. (L2)	3
	3	II	State and explain the criterion for a nonempty subset to be a subgroup. (L1)	3
	4	II	If H is a subgroup of finite index in G, state Lagrange's theorem consequence for orders. (L3)	3
	5	III	Define a normal subgroup and give one example. (L2)	3
	6	IV	State the definition of a group homomorphism and give the definitions of kernel and image. (L1)	3
	7	V	Define a permutation and write the disjoint cycle form of the permutation (1 4 3 2). (L2)	3
	8	V	State Cayley's theorem and explain its significance. (L3)	3
B (Attempt ONE question from each Unit) $(5 \times 7 = 35)$	9 **or** 10	I	(a) Prove that the intersection of two subgroups is a subgroup. (b) Give an example of a finite group of order 6 and find orders of its elements. (L2, L3)	7
	11 **or** 12	II	(a) Prove Lagrange's theorem for finite groups. (b) If $\|G\| = 21$, discuss the possible orders of subgroups. (L3, L4)	7
	13 **or** 14	III	(a) Define normal subgroup and prove that subgroup of index 2 is normal. (b) Give an example of a non-normal subgroup and justify. (L3, L4)	7
	15 **or** 16	IV	(a) Let $\phi : G \to H$ be a homomorphism. Prove First Isomorphism Theorem. (b) Apply it to map $\mathbb{Z} \to \mathbb{Z}_n$. (L3, L5)	7
	17 **or** 18	V	(a) Show how any permutation can be written as a product of transpositions; define parity. (b) Prove that alternating group A_n is a subgroup of index 2 in S_n. (L3, L5)	7

Table 11.31.1: Blueprint of End Examination: Course 3 — Group Theory (Major) (w.e.f. 2025–26)

Model Question Paper for Course 3 — Group Theory (Major) (w.e.f. 2025–26)

MODEL QUESTION PAPER

Course 3 — Group Theory (Major) (w.e.f. 2025–26)

Total: 50 marks Time: $2\frac{1}{2}$ hours

Semester-II

(Part–A: Answer any 5 short questions. Part–B: Answer one question from each Unit)

PART – A (Short questions) **15 marks**

Answer any FIVE questions. Each question carries 3 marks.

1. Define a group and give two examples. (L1)
2. Using the composition table below, find the order of each element. (table given). (L2)
3. State the necessary and sufficient condition for a nonempty subset to be a subgroup. (L1)
4. State the consequence of Lagrange's theorem for orders of subgroups in a finite group. (L3)
5. Define a normal subgroup and give one example. (L2)
6. Define a group homomorphism; define kernel and image. (L1)
7. Write the permutation (1 4 3 2) in disjoint cycle form and state its order. (L2)
8. State Cayley's theorem and mention its significance. (L3)

PART – B (Long questions) **35 marks**

Attempt ONE question from each Unit. Each question carries 7 marks.

Unit 1

9. (a) Prove that the intersection of two subgroups is a subgroup.
   (b) Give an example of a group of order 6 and compute orders of its elements. (L2, L3)
10. Prove that if $|G| = p$ (prime) then G is cyclic. (L3)

Unit 2

11. (a) Prove Lagrange's theorem for finite groups.
(b) If $|G| = 21$, discuss possible orders of elements and subgroups. (L3, L4)

12. Let H be a subgroup of G. Prove that left cosets partition G and deduce index properties. (L3)

Unit 3

13. (a) Define normal subgroup and prove a subgroup of index 2 is normal.
(b) Provide an example of a subgroup that is not normal and justify. (L3, L4)

14. Prove: If $N \triangleleft G$ and G/N is cyclic then G is abelian? (Discuss / counterexample). (L4)

Unit 4

15. (a) Let $\phi : G \to H$ be a group homomorphism. State and prove the First Isomorphism Theorem.
(b) Apply it to the map $\mathbb{Z} \xrightarrow{mod\ n} \mathbb{Z}_n$. (L3, L5)

16. Define automorphism; show inner automorphisms form a normal subgroup of $\mathrm{Aut}(G)$. (L5)

Unit 5

17. (a) Show every permutation can be expressed as product of transpositions; define parity.
(b) Prove A_n is a subgroup of index 2 in S_n. (L3, L5)

18. State and prove Cayley's theorem: every finite group is isomorphic to a subgroup of a symmetric group. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	Description	Weightage (%)	Marks (out of 50)
L1	Remembering	10%	5
L2	Understanding	10%	5
L3	Applying	60%	30
L4	Evaluating	10%	5
L5	Analyzing	10%	5

11.32 Course 4 (Major) : Elementary Real Analysis (w.e.f. 2025-26)

11.32.1 Syllabus of Course 4 (Major)

SEMESTER-II

COURSE 4: ELEMENTRAY REAL ANALYSIS

Theory	**Credits: 4**	**5 hrs/week**

Course Objectives

1. To develop a strong foundation in the real number system and its axiomatic structure.
2. To introduce the concepts of order, bounds, completeness, and related foundational properties of real numbers.
3. To explore the properties of sets in real analysis, including neighborhoods, limit points, open and closed sets.
4. To build analytical skills in handling sequences, convergence criteria, and monotonicity.
5. To understand the behavior of infinite series and apply standard convergence tests effectively.

Course Outcomes

After successful completion of this course, the student will be able to

1. Understand the real number system, its axioms, and properties, including completeness, supremum, and infimum.
2. Apply the Archimedean property, denseness, and concepts of neighborhoods, limit points, and derived sets in problem-solving.
3. Analyze sequences for boundedness and convergence using definitions and the Cauchy criterion.
4. Understand the concept of subsequences, apply the Bolzano-Weierstrass theorem, and test convergence using Cauchy's general principle.
5. Determine the convergence of infinite series using various tests and solve related analytical problems.

Course Content

Unit – 1

Real number system - Field axioms – Properties of real numbers - Order axioms – Properties of Order relation - Principal of induction - Extended real number system – Modulus of a real number – Properties of modulus – Triangle property - Aggregates – Finite and infinite aggregates – Boundedness of an aggregate – Least upper bound (supremum) and greatest lower bound (infimum) of an aggregate – Properties of boundedness – Completeness axiom – Dedekind's theorem - Theorem on Dedekind's axiom and completeness axiom.

Unit – 2

Archemedian Property - It's corollaries – Integral part of a real number - Denseness of the real number system – Intervals – Neighbourhood of a point - Limit point of an aggregate – Derived Set - Bolzano - Weierstrass theorem – Interior point of a set - Open and closed Sets – It's properties (without proofs) - Countable and uncountable sets - Properties of countable sets.

Unit – 3

Sequences – Operations of sequences - Subsequences - Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence – Divergent sequence – Uniqueness of a limit – Sandwich theorem on sequences - Monotone sequences - Problems

Unit – 4

Limit Point of a Sequence - Bolzano-Weierstrass theorem on subsequences – Cauchy Sequences – Cauchy's general principle of convergence - Problems

Unit – 5

Infinite Series – Convergence and divergence of series - Cauchy's general principle of convergence for series – Series of non-negative terms - Convergence of geometric series – p series test - comparison test –D'Alemberts's ratio test – Cauchys's n^{th} root test – problems.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

An Introduction to Real Analysis by Robert G.Bartle and Donlad R. Sherbert, John Wiley and sons Pvt. Ltd

Reference Books

1. Elements of Real Analysis by Shanthi Narayan and Dr. M.D. Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.

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11.32.2 Blue Print for Course 4 (Major) : Elementary Real Analysis (w.e.f. 2025-26)at end of Semester-II

Course 4 (Major) : Elementary Real Analysis (w.e.f. 2025-26)

Admitted Batch: 2025–26 onwards (Single Major System)

Duration: 2 $\frac{1}{2}$ Hours **Total Marks: 50**

Part	Q.No.	Unit	Nature of Question (Bloom's Level)	Marks
A (Answer any 5) ($5 \times 3 = 15$)	1	I	Define supremum and infimum with one example. (L1)	3
	2	I	State the completeness axiom and Dedekind's theorem. (L1)	3
	3	II	State the Archimedean property of real numbers. (L1)	3
	4	III	Show that every convergent sequence is bounded. (L2)	3
	5	III	Test monotonicity for the sequence $a_n = \frac{1}{n}$. (L3)	3
	6	IV	State and illustrate Cauchy's criterion for sequences. (L2)	3
	7	V	Test convergence of $\sum \frac{1}{n^2}$. (L3)	3
	8	V	State D'Alembert's ratio test. (L1)	3
B (Attempt ONE question from each Unit) ($5 \times 7 = 35$)	9 **or** 10	I	Define the real number system. State field and order axioms. (OR) Prove that every nonempty set of real numbers bounded above has a least upper bound. (L1, L3)	7
	11 **or** 12	II	Prove that between any two real numbers there exists a rational number. (OR) State and prove Bolzano–Weierstrass theorem for bounded infinite sets. (L2, L3)	7
	13 **or** 14	III	Define convergence of a sequence. Prove uniqueness of limits. (OR) Prove the Sandwich theorem on sequences with an example. (L2, L3)	7
	15 **or** 16	IV	State and prove Cauchy's general principle of convergence. (OR) Show that every Cauchy sequence in $\mathbb{R}$ is bounded. (L3, L4)	7
	17 **or** 18	V	Test convergence of $\sum \frac{1}{n^p}, p > 1$. (OR) Apply root test to check convergence of $\sum \left(\frac{n}{n+1}\right)^n$. (L3, L5)	7

Table 11.32.1: Blueprint of End Examination: Course 4 — Elementary Real Analysis (Major) (w.e.f. 2025–26)

Model Question Paper for Course 4 — Elementary Real Analysis (Major) (w.e.f. 2025–26)

MODEL QUESTION PAPER

Course 4 — Elementary Real Analysis (Major) (w.e.f. 2025–26)

Total: 50 marks Time: $2\frac{1}{2}$ hours

Semester-IV

(Part–A: Answer any 5 short questions. Part–B: Answer one question from each Unit)

PART – A (Short questions) **15 marks**

Answer any FIVE questions. Each question carries 3 marks.

1. Define supremum and infimum with an example. (L1)
2. State the completeness axiom and Dedekind's theorem. (L1)
3. State the Archimedean property of real numbers. (L1)
4. Show that every convergent sequence is bounded. (L2)
5. Test monotonicity of the sequence $a_n = \frac{1}{n}$. (L3)
6. State and illustrate Cauchy's criterion for sequences. (L2)
7. Test convergence of $\sum \frac{1}{n^2}$. (L3)
8. State D'Alembert's ratio test. (L1)

PART – B (Long questions) **35 marks**

Attempt ONE question from each Unit. Each question carries 7 marks.

Unit 1

9. Define the real number system. State field and order axioms. (L1)
10. Prove that every nonempty set of real numbers bounded above has a least upper bound. (L3)

Unit 2

11. Prove that between any two real numbers there exists a rational number. (L2)

12. State and prove Bolzano–Weierstrass theorem for bounded infinite sets. (L3)

Unit 3

13. Define convergence of a sequence. Prove uniqueness of limits. (L2)

14. Prove the Sandwich theorem on sequences with an example. (L3)

Unit 4

15. State and prove Cauchy's general principle of convergence. (L3)

16. Show that every Cauchy sequence in $\mathbb{R}$ is bounded. (L4)

Unit 5

17. Test convergence of $\sum \frac{1}{n^p}, p > 1$. (L3)

18. Apply root test to check convergence of $\sum \left(\frac{n}{n+1}\right)^n$. (L5)

Bloom's Taxonomy – Marks Distribution Summary

Bloom's Level	**Description**	**Weightage (%)**	**Marks (out of 50)**
L1	Remembering	10%	5
L2	Understanding	10%	5
L3	Applying	60%	30
L4	Evaluating	10%	5
L5	Analyzing	10%	5