# PITHAPUR RAJAH'S GOVERNMENT COLLEGE

An outcome based, NAAC accredited, green autonomous institution

4th Cycle NAAC accreditation grade: B++

Affiliated to Adikavi Nannaya University

Opp. Mc Laurin School, Raja Ram Mohan Roy Road, Kakinada 533001, Andhra Pradesh, India

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# UG BOARD OF STUDIES : 2025 - 26

# DEPARTMENT OF MATHEMATICS

**INDEX**


| S. No. | Year & Sem | Topic | Page No. |
|---|---|---|---|
| 1 | | Principal's proceedings for conduct of BoS | 5 - 6 |
| 2 | | University nominee order issued by affiliated AKNU, RJY | 7 |
| 3 | | BoS members nomination in Mathematics | 8 - 9 |
| 4 | | List if BoS Members | 10 - 11 |
| 5 | | Vision & Mission & objectives | 12 |
| 6 | | Agenda | 13 - 14 |
| 7 | | Resolutions | 14 - 15 |
| 8 | | Blue print of CBCS model curriculum in B.Sc Mathematics | 16 - 18 |
| 9 | | BOS changes | 19 |
| 10 | | Action plan for the Academic year : 2025-26 | 20 |
| 11 | | List of examiners and Paper setters | 21 |
| 12 | | Certificate of Submission | 22 |
| 13 | | Programme Outcomes | 23 - 24 |
| 14 | | Programme Specific Outcomes of Mathematics stream Courses | 25 |
| 15 | | Papers offered under B.Sc Mathematics stream | 26 |
| 16 | | Mathematics Course Outcomes | 27 – 31 |
| 17 | First Year,Sem-I&II | I-Semester Major Syllabus and Blue Print for Question Paper Pattern in Differential Equations. | 32 – 38 |
| 18 | First Year,Sem-I&II | I-Semester Major Syllabus and Blue Print for Question Paper Pattern in Solid Geometry. | 39 – 46 |
| | First Year,Sem-I&II | II-Semester Major Syllabus and Blue Print for Question Paper Pattern in Group Theory. | 47 – 52 |
| | First Year,Sem-I&II | II-Semester Major Syllabus and Blue Print for Question Paper Pattern in Elementary Real Analysis. | 53 – 59 |
| 19 | Second Year,Sem-III&IV | III-Semester Major & Minor Syllabus and Blue Print for Question Paper Pattern in Group theory and Problem Solving Session. | 60 – 65 |
| 20 | Second Year,Sem-III&IV | III-Semester Major & Minor Practical Syllabus and Blue Print for Question Paper Pattern in Group theory and Problem Solving Session. | 66 – 68 |
| 21 | Second Year,Sem-III&IV | III-Semester Major Syllabus and Blue Print for Question Paper Pattern in Numerical methods and Problem solving session. | 69 – 77 |
| 22 | Second Year,Sem-III&IV | III-Semester Major Practical Syllabus and Blue Print for Question Paper Pattern in Numerical methods and Problem solving session. | 78 – 80 |
| 23 | Second Year,Sem-III&IV | III -Semester Major Syllabus and Blue Print For Question Paper Pattern In Laplace Transformations and Problem Solving Session. | 81 – 87 |
| 24 | Second Year,Sem-III&IV | III -Semester Major Practical Syllabus and Blue Print for Question Paper Pattern in Laplace Transformations and Problem Solving Session. | 88 – 90 |
| 25 | Second Year,Sem-III&IV | III -Semester Major Syllabus and Blue Print for Question Paper Pattern in Special Functions & Problem Solving Sessions | 91 – 97 |
| 26 | Second Year,Sem-III&IV | III -Semester Major Practical Syllabus and Blue Print for Question Paper Pattern in Special Functions & Problem Solving Sessions | 98 – 100 |

| | | | |
|---|---|---|---|
| 27 | | IV -Semester Major and Minor Syllabus and Blue Print for Question Paper Pattern in Ring Theory and Problem Solving Session | 101 – 107 |
| 28 | | IV -Semester Major and Minor Practical Syllabus and Blue Print for Question Paper Pattern in Ring Theory and Problem Solving Session | 108 – 110 |
| 29 | | IV -Semester Major and Minor Syllabus and Blue Print for Question Paper Pattern in Introduction to Real Analysis and Problem Solving Session | 111 – 118 |
| 30 | | IV -Semester Major and Minor Practical Syllabus and Blue Print for Question Paper Pattern in Introduction to Real Analysis and Problem Solving Session | 119 – 121 |
| 31 | | IV -Semester Major Syllabus and Blue Print for Question Paper Pattern in Introduction to Integral Transformations and Problem Solving Session | 122 – 128 |
| 32 | | IV -Semester Major Practical Syllabus and Blue Print for Question Paper Pattern in Introduction to Integral Transformations and Problem Solving Session | 129 – 131 |
| 33 | Third Year ,Sem-V | V -Semester Major and Minor Syllabus and Blue Print for Question Paper Pattern in Linear Algebra and Problem Solving Session | 132 – 139 |
| 34 | | V -Semester Major and Minor Practical Syllabus and Blue Print for Question Paper Pattern in Linear Algebra and Problem Solving Session | 140 – 142 |
| 35 | | V -Semester Major and Minor Syllabus and Blue Print for Question Paper Pattern in Vector Calculus and Problem Solving Session | 143 – 149 |
| 36 | | V -Semester Major and Minor Practical Syllabus and Blue Print for Question Paper Pattern in Vector Calculus and Problem Solving Session | 150 – 152 |
| 37 | | V -Semester Major Syllabus and Blue Print for Question Paper Pattern in Advanced Numerical methods and Problem Solving Session | 153 – 160 |
| 38 | | V -Semester Major Practical Syllabus and Blue Print for Question Paper Pattern in Advanced Numerical methods and Problem Solving Session | 161 - 163 |
| 43 | | V -Semester Major Syllabus and Blue Print for Question Paper Pattern in Number theory and Problem Solving Session | 164 – 170 |
| 44 | | V -Semester Major Practical Syllabus and Blue Print for Question Paper Pattern in Number theory and Problem Solving Session | 171 – 173 |
| 45 | | MOOCs | 174 |
| 46 | | Certificate Course-I on Mathematics in India | 175 |
| 47 | | Certificate Course-II on Ancient Indian Mathematics | 176 – 177 |
| 48 | | Work Load for The Department of Mathematics (Odd Semester) | 178 |
| 49 | | Work Load for The Department of Mathematics (Even Semester) | 179 |
| 50 | | BOS members Suggestions | 180 – 182 |

**PROCEEDINGS OF THE PRINCIPAL (FAC), PITHAPUR RAJAH's GOVT. COLLEGE [A], KAKINADA**
**Present: Dr. Kandula Anjaneyulu, M.A, Ph.D.**

**Rc.No.9/A.C/BOS/2025-26** **Dt.31 July 2025**

Sub: Pithapur Rajah's Government College[A] Kakinada--Academic Cell- Conduct of BOS Meetings for the Academic Year 2025-26 - Guidelines issued - Regarding.

**ORDER:**

The autonomous colleges, in alignment with their vision, mission, stated objectives, and core values, are mandated to design and develop their own outcome-based curricula. This must be done with due consideration for societal, local, and global industry requirements, employability, and the development of industry-ready and transferable skills. Accordingly, every programme shall prescribe Course Outcomes (COs), Programme Outcomes (POs), and Programme Specific Outcomes (PSOs) along with a suitable learning outcome assessment management system, supported by a robust and transparent evaluation mechanism to measure attainment levels among students.

Further, the A.P. State Council of Higher Education (APSCHE) has introduced a revised curricular framework effective from the Academic Year 2025-26, incorporating Skill Enhancement Courses, Multi-Disciplinary courses, the Indian Knowledge System and a revised credit structure.

Our institution, from the Academic Year 2022–23 onwards, has defined a renewed vision and mission along with updated objectives and core values, necessitating the design and reorientation of its academic and research administration in line with these directives.

In light of the above responsibilities prescribed by the institution's vision and mission, NEP–2020, NAAC, NIRF, and the APSCHE's revised and new UG and P.G. curricular framework, it is imperative to customize, design, and re-orient our academic and research activities to meet the expectations of students, industries, and government stakeholders.

Accordingly, the Chairpersons of the U.G and P.G Boards of Studies (BoS) of various departments are hereby requested to make necessary arrangements to convene their BoS meetings before **09 Aug 2025**.

The Chairpersons are further instructed to:

1. Prepare the curricula and extracurricular activities for the Academic Year 2025–26 in line with the institution's vision, mission, NEP–2020, and NIRF norms.
2. Devise an appropriate evaluation system to ensure effective learning outcomes and holistic student development.
3. Ensure that the curriculum design includes a mandatory *20% revision* of the syllabus each year without deviating from the APSCHE prescribed syllabus.
4. If the syllabus is not prescribed by APSCHE/Affiliating University, then the syllabus is to be

framed by the BOS committee concerned with duly following the mandate prescribed above.

5. Engage stakeholders viz employers, parents, and alumni, to obtain feedback on the existing curricula and to invite suggestions for improvements.
6. Invite the University nominee, subject experts, industry representatives, student representatives, and parent representatives well in advance. The meeting notice shall clearly specify the date, venue, and agenda, and a soft copy of the agenda and relevant documents shall be circulated for their perusal.
7. Ensure that the subject experts invited preferably hold a Doctorate with at least 10 years of teaching experience and have relevant expertise in designing industry-related, market- and job-oriented curricula.
8. Facilitate thorough deliberations on curriculum design, evaluation methods, incorporation of research components, measures to enhance learning experiences, and optimal utilization of existing human, physical, and ICT resources.
9. Conduct all BoS meetings in offline mode. Online participation shall be permitted only under exceptional circumstances.
10. Prescribe benchmarking and quality initiatives in pedagogy and learning, including strategies for curriculum design and teaching-learning processes, in collaboration with the IQAC Coordinator, prior to the BoS meeting.
11. Ensure that a minimum student attendance of **75%** shall be required for eligibility to appear for I & II Mid-Term Examinations under the CIA component; this shall be formally approved in the BoS meeting.
12. Approve any new programmes to be introduced for the Academic Year 2025–26, the number and frequency of certificate courses, and SWAYAM MOOCs courses.
13. Submit the approved BOS copies in the prescribed format, in **quadruplicate (hard copies)** to the Academic Cell for onward submission to the IQAC, Examination Cell, and Library, within **three days** of the meeting and upload the soft copy in their respective department web pages in the college website.
14. Ensure strict alignment of all recommendations and curriculum changes with the institution's vision and mission.
15. Submit a request to receive advance funds from the Examination cell through Principal for conducting BoS meetings.

ADIKAVI NANNAYA UNIVERSITY RAJAMAHENDRAVARAM
OFFICE OF THE DEAN, ACADEMIC AFFAIRS

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No.ANUR PR (A)/BoS/2025/38 Dt.17.06.2025

**PROCEEDINGS OF THE VICE-CHANCELLOR**

Sub: ANUR – University Nominees – UG Board of Studies of Pithapur Rajah's Government College (A) Kakinada – Orders – Issued
Read: -Note orders of the Vice-Chancellor dated 13.06.2025

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ORDER:

With reference to above, the Vice-Chancellor is pleased to order that the following members be nominated as University Subject Experts for constitution of UG Board of Studies of Pithapur Rajah's Government College (A) Kakinada, for a period of 3 years from the date of orders issued as detailed against each subject.

| Sl. No | BOS | Name of the expert nominated |
|---|---|---|
| 1 | English | Prof.S.Prasanthi Sree, M.S.N Campus Kakinada |
| 2 | Telugu | Dr.S.Gopalayya, GDC Tadepalligudem |
| 3 | Hindi | Dr.N.V.Ramana, GDC Ramachandrapuram |
| 4 | Sanskrit | Dr.P.Umamaheswara Rao, Dr.V.S Krishna GDC (A), Visakhapatnam |
| 5 | Mathematics | Ms.Y.Padmaja GDC Ramachandrapuram |
| 6 | Statistics | Dr.N.Madavi GDC(A) RJY |
| 7 | Physics, Electronics & Renewable energy | Dr.M.V.K.Mehar, GDC, K.Perupalem |
| 8 | Chemistry, Organic Chemistry, Analytical Chemistry | Dr.T.Narasimha Murthy, GDC (A) RJY |
| 9 | Pharmaceutical Chemistry | P.Sai Kiran, Adithya University Kakinada |
| 10 | Botany | Dr.K.Usha sri GDC Pithapuram |
| 11 | Zoology | Dr.K.Ramaneswari, AKNU, RJY |
| 12 | Aquaculture | Dr.D.Kalyani, AKNU, RJY |
| 13 | Biotechnology | Dr.B.Nageswari, GDC (A) RJY |
| 14 | Microbiology | Dr.D.Aruna, SRR & CVR GDC (A) Vijayawada |
| 15 | Artificial Intelligence | N.Naga Subrahmanyeswari, ASD College for Women (A), Kakinada |
| 16 | Data Science | Sri.K.Rasmi Ranjan, GDC(A), Tuni |
| 17 | Internet of Things | Smt.Dr.K.Sobha Rani, GDC, Ramachandrapuram |
| 18 | Computer Applications | Smt.Dr.K.Sobha Rani, GDC, Ramachandrapuram |
| 19 | Information Technology | Smt.N.Naga Subrahmanyeswari, ASD College for Women (A), Kakinada |
| 20 | Economics | Dr.K.Yamuna, ASD GDC(W), Kakinada |
| 21 | History | Ch.Padmavathi, GDC, Pithapuram |
| 22 | Political Science & International relations | Dr.K.Swamiji, Ideal DC(A), Kakinada |
| 23 | Commerce & Management | Dr.G.Arun Kumar, Dr.VS Krishna GDC(A) Visakhapatnam |
| 24 | Philosophy | Dr.Ch.Lalitha, GDC(A) Tuni |

**(BY ORDER)**

17.6.25

Dean,
Academic Affairs

To
The Principal, Pithapur Rajah's Government College (A) Kakinada
The Above Members
The Principals concerned
PS to VC,
PA to R,
OOF

**Proceedings of the Principal, PITHAPUR RAJAH'S GOVERENMENT COLLEGE(A): Kakinada**

**Present : Dr.Kandula Anjaneyulu, M.A.,Ph.D**

**Rc.No.2/A.C./BOS-Members Nomination /2025-26, Dated: 31 JULY 2025**

**Sub: P.R.Government College (A), Kakinada-Board of Studies (BOS)- Nomination of members-Orders issued.**

**Ref: Proc.RC.No.1/A.C/BOS/2025-26, dated: 31 July 2025 of the Principal, Pithapur Rajah's Government College(A), Kakinada.**

**ORDER:**

The Principal, P.R.Govt.College(A), Kakinada is pleased to constitute UG Board of Studies in MATHEMATICS for framing the syllabi in Mathematics subject for all semesters duly following the norms of the UGC Autonomous guidelines.

| S.No | Name with Designation and Address | Designation |
|---|---|---|
| 1 | Dr. K.Jayadev<br>I/C of Mathematics<br>P. R. Govt. College (A), Kakinada | Chair Person |
| 2 | Ms.Y.Padmaja<br>Lecturer in Mathematics<br>Government Degree College<br>Ramachandrapuram | University Nominee |
| 3 | i) Smt. M. Madhavi,<br>Government Degree College,<br>Tuni.<br>ii) Sri. D.P.S.Kiran,<br>Lecturer in Mathematics,<br>Ideal College of Arts & Science,<br>Kakinada. | Subject expert |
| 4 | Sri. P. S. R. Subrahmanyam,<br>Rtd. HOD of Mathematics, Ideal College of Arts & Science (A), Kakinada | Alumnus |
| 5 | Sri. G .Syam Prasad | Faculty of the Department |
| 6 | Sri. G. Prasada Rao | Faculty of the Department |
| 7 | Smt. K.S.I.Priyadarshini | Faculty of the Department |
| 8 | Smt. L.S.B.R.Bhanu | Faculty of the Department |
| 9 | Smt. K. Samrajyam | Faculty of the Department |
| 10 | Kum T.G.S.Sandhya | Faculty of the Department |
| 12 | T. Bhhavyasri | Student Member<br>II B.Sc – Mathematics Major |
| 13 | Penumarthi Hyma Suji Bharathi | Student Member<br>III B.Sc –Mathematics Major |
| 14 | T. Akhila | Student Member<br>III B.Sc –Statistics Major |
| 15 | R.Surya | Student Member<br>III B.Sc –Chemistry Major |
| 16 | Mahalakshmi | Student Alumni Member<br>B.Sc(M.P.C-EM)-2021-24 |

The above members are requested attend the BOS meetings and share their valuable views, suggestions on the following functionaries:

a) Prepare syllabi for the subject keeping in view the objectives of the college, interest of the stake holders and National requirement for consideration and approval of the IQAC and Academic Council.

b) Suggest methodologies for innovative teaching and evaluation techniques.

c) Suggest panel of names to the Academic council for appointment of examiners.

d) Coordinate research, teaching, extension and other activities in the department of the college.

The Chairpersons of all Boards of Studies are hereby instructed to comply with these directives in letter and spirit to ensure the highest standards of academic and administrative excellence.

PRINCIPAL
P.R. Govt. College (Autonomous)
KAKINADA-533 001.

**PRINCIPAL**
**Pithapur Rajah's Government College(A)**
**Kakinada**

Copy to:

1. Lecturers-in-Charge (BOS Chairmen) of all the departments
2. Academic Coordinator
3. IQAC coordinator
4. Controller of Examinations
5. Office

## PROCEEDINGS OF THE PRINCIPAL, P.R. GOVERNMENT COLLEGE(A), KAKINADA-A. P

### Present: Dr. K.ANJANEYULU, M.A; Ph.D.

**Rc.No.2/A.C./BOS-Members Nomination /2025-26, Dated: 31 JULY 2025**

**SUB:** P.R. Government College(A), Kakinada-UG Board of Studies (BOS)- Program/Course- Nomination of Members-Orders issued.

**REF:** 1. Proc.Rc.no.1/A.C/BOS/2025-26 dated 31 July 2025 of the Principal, Pithapur Rajah's Government College(A), Kakinada

**ORDERS:**

The Principal, P.R. Government College(A), Kakinada is pleased to constitute UG Boards of Studies in MATHEMATICS for framing the syllabi in respective Subject for all Semesters duly following the norms of the UGC Autonomous guidelines.

| S. No | Name of the Person | Designation |
|---|---|---|
| 1 | Dr. K.Jayadev<br>I/C of Mathematics<br>P. R. Govt. College (A), Kakinada | 7/8/25 Lec in physics |
| 2 | Ms.Y.Padmaja<br>Lecturer in Mathematics<br>Government Degree College<br>Ramachandrapuram | Y.Padmaja 7/8/25 Lecturer in Mathematics GDC, RCPM |
| 3 | Smt. M. Madhavi,<br>Government Degree College,<br>Tuni. | M.Madhavi 7/8/25 Lec. in Mathematics GDC, Tuni |
| 4 | Sri. D.P.S.Kiran,<br>Lecturer in Mathematics,<br>Ideal College of Arts & Science,<br>Kakinada. | 7/8/25 HoD; Mathematics IQAC coordinator Ideal college of Arts & Sciences(A) |
| 5 | Sri. P. S. R. Subrahmanyam,<br>Rtd. HOD of Mathematics, Ideal College of Arts & Science (A), Kakinada | Rtd H.O.D of Math Ideal College of Arts & Sci |
| 6 | Sri. G .Syam Prasad | Syam prasad. |
| 7 | Sri. G. Prasada Rao | |
| 8 | Smt. K.S.I.Priyadarshini | K.S.I. priyadarshini |
| 9 | Smt. L.S.B.R.Bhanu | LSBRBhanu |
| 10 | Smt. K. Samrajyam | K. S |
| 11 | Kum T.G.S.Sandhya | T.G.S. Sandhya |
| 12 | T. Bhavyasri | T. Bhavyasri |
| 13 | P. Hyma Suji Bharathi | P. Hyma Suji |
| 14 | T.Akhila | T.Akhila. |
| 15 | R.Surya | R.Surya |
| 16 | U Mahalakshmi | U.S.K. Mahalakshmi |

The above members are requested to attend the BoS meeting on 17-07-2025 and share their valuable reviews, and suggestions on the following functionaries.

- Prepare syllabi for the subject keeping in view the objectives of the college, interest of the stake holders and National requirement for consideration and approval of the IQAC and Academic Council.
- Suggested methodologies for innovative teaching and evaluation techniques.
- Suggest the panel of Names to the academic council for appointment of Examiners.
- Coordinate research, teaching, extension and other activities in the Department of the college.

The Chairpersons of all boards of studies are here by instructed to comply with these directives in letter and spirit to ensure the highest standards of academic and administrative excellence.

7/8/25

PRINCIPLE
Pithapur Rajah's Government College(A)
Kakinada

Copy to:

1. Lecturers-in-charge (BOS Chairmen) of all the departments
2. Academic Coordinator
3. IQAC Coordinator
4. Controller of Examinations
5. Office

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

# Vision & Mission

**Vision :**

To enhance the career competencies of students in solving real word problems including environmental issues with Mathematics as a tool, make them appreciate the role of Mathematics and its research in scientific and technological progress and hence impress upon them contribute to the national development.

**Mission :**

Mathematics plays a crucial role in the education of every student. The mission of Mathematics is to:

- To develop logical, analytical and Mathematical thinking power in the mind of students in order to cater the Mathematical needs of the society.
- To create an environment that will identify, nurture and encourage mathematical intelligence.
- To enhance use of mathematical knowledge readily for problem solving, exploring all subjects by proper understanding of the mathematical content with various possible representations.
- To improve the skills of students in practical applications and life skills by means of a close and continuous monitoring of their progress through the course.
- To inculcate among students the value of commitment, quality and ethical behavior.

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

Meeting of the Board of studies is held at 10AM on 07-08-2025 in the Department of Mathematics, Pithapur Rajah's Government College (A), Kakinada with the following agenda.

# Agenda

1. a) To implement of APSCHE prescribed curriculum for first year students with effect from the academic year 2025-26

   b) To approve the curriculum, blue print and model paper for II & III year B.Sc Programme under CBCS based as per the directions of the APSCHE.

   c) To approve the curriculum, blue print and model paper of practical examinations for II & III year B.Sc Programme under CBCS based as per the directions of the AKNU .

2. To approve the two Certificate Courses, one is Mathematics in India and second one is Ancient Indian Mathematics are introduced in this academic year.

3. To approve the incorporation of additional inputs to various courses (where ever it is necessary) for enhancing students understanding over the concerned course and this shall not be considered for evaluation purpose.

4. To approve the evaluation procedure for the courses for II, III years of B.Sc ( 2024-25 & 2023-24 admitted batches).

5. Each theory subject is evaluated for 100 Marks ( II & III Years) out of which 50 Marks through semester end examination for I, II & III year and internal assessment would be for 50 Marks for II& III year.

**CIA structure for Single Major system**

- Out of 50 marks for CIA, 25 marks are allocated for Mid examinations. In each semester two mid examinations to be conducted and the average of the two will be considered.
- I mid examination is to be conducted in offline mode at college level and II mid examination is to be conducted in online/offline mode at department level.
- I mid examination to be conducted in offline mode in which **one essay** question for ten marks out of two questions, **two short** answer questions with five marks each out of fourquestions and five objective questions to be given for each course.
- For I mid examination to be conducted in off line mode, question paper is to be given as per the following structure for the courses .

| S.No | Unit No | Long Answer Question(10M) | Short Answer Question(5 M) | Objective Questions(1M) |
|---|---|---|---|---|
| 1 | I | 1 | 2 | 2 |
| 2 | II | 1 | 2 | 1+ two question from any unit with more syllabusweightage |
| 3 | III | 0 | 0 | 0 |
| 4 | IV | 0 | 0 | 0 |
| 5 | V | 0 | 0 | 0 |

- For II mid examination to be conducted in online/off line mode, question paper is to be given as per the following structure for the courses.

| S.No | Unit No | Long Answer Question(10M) | Short Answer Question(5M) | Objective Questions(1M) |
|---|---|---|---|---|
| 1 | I | 0 | 0 | 0 |
| 2 | II | 0 | 0 | 0 |
| 3 | III | 1 | 2 | 2 |
| 4 | IV | 1 | 2 | 2+ one question from anyunit(III or IV or V) with more syllabus weightage. |
| 5 | V | 0 | 0 | 0 |

- The remaining 25 marks for CIA are allocated as per the following structure.

| Project-10M | Viva on theory- 3M | Assignment- 5M | Seminar- 5M | Clean & green and Attendance- 2M |
|---|---|---|---|---|

6.Scheme of valuation for practical's

- Record - 10 M
- Viva Voce - 10 M
- Test - 30 M
- Total - 50 M

Answer any 5 questions. At least 2 questions from each section of Section A & Section B. Each question carries 6 marks.

7.To award two extra credits to students who have registered and completed SWAYAM course successfully.

8.To award 4 credits for each first and second phase of Apprenticeship between 1st and 2nd year and 2nd and 3rd year (two summer vacations).

9. To implement pedagogical strategies such as Problem solving, Project based etc. to enrich teaching and learning process.

10. To approve the proposed departmental activities for 2025 – 26.

11. To approve the list of examiners and paper setters for the academic year 2025 – 26.

12. Any other item with the permission of the chair.

## Resolutions:

The following resolutions are approved by the university nominee and all the members of BOS

- It is resolved to implement APSCHE prescribed curriculum for the first year students with effect from the academic year 2025-26
- It is resolved to adopt single major curriculum of APSHE syllabus for the II and III year B.Sc Program.
- It is resolved to motivate the students towards community extension activities.
- It is suggested by the members of BOS to give more stress on thrust areas of each course.
- It is suggested to enlighten the students the accepts of the Programme outcomes, Programme specific outcomes and Course outcomes,
- It is resolved to introduce 4 new courses in semester V of III B.Sc (Major & Minor) for the Academic year 2025 – 2026.

| S.No | Course Code | Title of the new course | Programmes in which it is introduced |
|---|---|---|---|
| 1 | Course - XII | Linear Algebra & Problem solving session | III Mathematics Major & Statistics, chemistry Minors |
| 2 | Course - XIII | Vector Calculus & Problem solving Sessions | III Mathematics Major & Statistics, chemistry Minors |
| 3 | Course - XIV | Advanced Numerical methods & Problem solving session | III Mathematics Major |
| 4 | Course - XV | Number Theory & Problem Solvin Sessions | III Mathematics Major |

- It is resolved to approve the additional inputs in various courses :
  - i) Ramanujan's method in Numerical methods.
  - ii) Echelon form and Normal form of a matrices, Consistent and inconsistent in Linear Algebra.
  - iii) Boole's Rule in Advanced Numerical methods.
- It is resolved to designate the students of III B.Sc Mathematics to on job training / apprenticeship/off-site project in Semester VI as per the guidelines given by APSCHE.
- It is resolved to approve the proposed departmental activities for 2025-26 (Page No. )
- It is resolved to approve the list of examiners and paper setters for the academic year 2025-26.
- The college has instructed to see that the student attendance 75% is mandatory for both mid and semester end examinations and 90% attendance is mandatory to attend practical examinations. More over the student is eligible, the student should attend at least one internal exam to appear for the Semester end examination. In this connection, the members of BOS advised the department to adhere to the instructions.
- It is suggested to encourage the students to get extra credits by participating in extracurricular activities like MOOCS, N.S.S., N.C.C.,etc as per the guidelines of college authorities.
- It is resolved to approve the syllabus, Blue print and assessment pattern for certificate courses.
- It is resolved to conduct workshops/ seminars/ Guest lectures by the eminent mathematicians.

***

**Blue Print of C.B.C.S. Model Curriculum in B.Sc. Mathematics**

| Yr. | Course & Theory / Lab | Paper | Title | Workload Hrs / Week | Credits | Max. Marks | | | Practical |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Intrnl | Extrnl | Total | |
| I | Sem I | I (Major) | Differential Equations | 5 Hrs | 4 | 50 | 50 | 100 | Nil |
| | | II (Major) | Solid Geometry | 5 Hra | 4 | 50 | 50 | 100 | Nil |
| | Sem II | III (Major) | Group Theory | 5 Hra | 4 | 50 | 50 | 100 | Nil |
| | | IV (Major) | Elementary Real Analysis | 5 Hra | 4 | 50 | 50 | 100 | Nil |
| II | Sem III | V (Major) | Group Theory &Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | VI (Major) | Numerical Methods &Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | VII (Major) | Laplace Transforms & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | VIII (Major) | Special Functions & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | II (Minor) | Group Theory &Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | Sem IV | IX (Major) | Ring Theory & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | X (Major) | Introduction to Real Analysis & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | XI (Major) | Integral Transforms & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | III (Minor) | Ring Theory & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | IV (Minor) | Introduction to Real Analysis & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | Sem V | XII (Major) | Linear Algebra &Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | XIII (Major) | Vector Calculus & Problem solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **III** | | XIV (Major) | Functions of a complex variables & Problem solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | | (OR) | | | | | | |
| | | | Advanced Numerical Methods & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | XV (Major) | Number Theory & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | | (OR) | | | | | | |
| | | | Mathematical Statistics & Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | V (Minor) | Linear Algebra &Problem Solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |
| | | VI (Minor) | Vector Calculus & Problem solving Sessions | 5 Hrs (3T + 2P) | 3 + 1 | 50 | 50 | 100 | 50 |

**Note 1: For Semester–V,** the student select any one of the elective courses of two pairs of Courses shall be chosen as courses XIV and XV.

**Note 2:** To insert assessment methodology for Internship/ on the Job Training/Apprenticeship under the revised CBCS as per APSCHE Guidelines.

**Credit For Course:04 for 100 marks**

- **Second Internship (After 2nd Year Examinations):** Apprenticeship / Internship / on the job training / In-house Project / Off-site Project. To make the students employable, this shallbeundertakenbythestudentsintheinterveningsummervacationbetweenthe2nd and 3rd years (the detailed guidelines are enclosed).
- **CreditForCourse:04 for 100 marks**
- **Third internship/Project work(6th Semester Period):**

  During the entire 6thSemester, the student shall undergo Apprenticeship / Internship / On the Job Training. This is to ensure that the students develop hands on technical skills which will be of great help in facing the world of work (the detailed guidelines are enclosed).

- **Credit For Course:12for 200 marks**

| PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A), KAKINADA | | | | | | | |
|---|---|---|---|---|---|---|---|
| **BOS CHANGES FROM DEPARTMENT OF MATHEMATICS - ACADEMIC YEAR 2025-26** | | | | | | | |
| **S.No.** | **Semester, Program** | **Course Number & Course Title** | **Titles of Topics deleted** | **Topics to be added during BOS meeting October 2024** | **Percentage of changes made in syllabus** | **Justification per each topic deleted** | **Justification per each topic added** |
| 1 | I | Differential Equations | . | Newly introduced | 100% | - | These topics added for the continuation of higher studies. |
| 2 | I | Solid Geometry | · | Newly introduced | 100% | - | These topics added for the continuation of higher studies. |
| 3 | IV | Course X Introduction to Real Analysis & Problem Solving Sessions | - | Alternating Series– Leibnitz Test. | 5% | - | These topics added for the continuation of higher studies. |
| 4 | V | Course XII Linear Algebra &Problem Solving Sessions | - | Practical's are Introduced | 100% | - | Improve investigative skills, resourcefulness and creativity. |
| 5 | V | Course XIII Vector Calculus & Problem solving Sessions | - | Newly introduced | 100% | - | These topics added for the continuation of higher studies. |
| 6 | V | Course XIII Vector Calculus & Problem solving Sessions | - | Practical's are Introduced | 100% | - | Practical learning has the unique ability to help students apply their skills in a non-classroom environment. |
| 7 | V | Course XIV Advanced Numerical Methods & Problem Solving Sessions | | Newly introduced | 100% | | These topics added for the continuation of higher studies. |
| 8 | V | Course XIV Advanced Numerical Methods & Problem Solving Sessions | - | Newly introduced | 100% | - | Practical learning has the unique ability to help students apply their skills in a non-classroom environment. |
| 9 | V | Course XV Number Theory &Problem Solving Session | - | Newly Introduced | 100% | - | These topics added for the continuation of higher studies. |
| 10 | V | Course XV Number Theory | - | Practical's are Introduced | 100% | - | Improve investigative skills, resourcefulness and creativity. |
| 11 | V | Certificate Course-I | - | Certificate course on Ancient Indian Mathematics | Newly Introduced in IV semester | - | Helps an individual to showcase his competency, commitment for the profession, build expertise in his professional subject area, and helps with job advancement. |
| 12 | V | Certificate Course-2 | - | Certificate course on Mathematics in India | Newly Introduced in I semester | - | Helps an individual to showcase his competency, commitment for the profession, build expertise in his professional subject area, and helps with job advancement. |

Signature of the I/C of Department

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A), KAKINADA**

**ACTION PLAN FOR THE ACADEMIC YEAR 2025-2026**

# Department of Mathematics

| S.No | Activity planned | Dates/ Period | Outcomes/ Objectives |
|---|---|---|---|
| 1 | Bridge Course | July / II week | Recognize key terms and ideas in academic contexts within in the student's field of interest |
| 2 | Quiz ,Elocution, Essay Writing computations. | August/ I WEEK | The competitive spirit will be improved among the students. |
| 3 | Independence Day | August/ III WEEK | To understand the importance of commemoration of Independence Day and how they can make changes in the world. |
| 4 | Teacher's Day | September/ I WEEK | To knowledge the challenges, hardship and special roles that teachers play in our lives. |
| 5 | Guest / Extension Lecture | November/ II WEEK | Making the students to acquire the latest real-world applications of Mathematics. |
| 6 | Town level Quiz ,Elocution, Essay Writing computations. | December/ II WEEK | Involving the students in community extension activity to bring out the hidden inherent talents of High School students. |
| | Celebration of Mathematics Day on 22nd Dec-2025. | December/ III WEEK | Celebrating Ramanujan's birth anniversary as a mark of respect to make the students aware of the wondaful contributions done by Ramanujan |
| 7 | National Seminar | January/ IV WEEK | Learning and knowledge exchange among Conference participants through interdisciplinary discussions. |
| 8 | National Science Day Celebrations. | February/ IV WEEK | Students will get more interest to do projects and there is a scope to know the applicability of all subjects. |
| 9 | Pi Day Celebrations | March/ II WEEK | To import the knowledge on the significance of PI |
| 10 | Guest lecture. | April/ I WEEK | Making the students to acquire the latest real-world applications of Mathematics. |

**Signature of the I/C of Dept.**

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A), KAKINADA**

# Department of Mathematics

Board of Studies Meeting 2025 -26

**LIST OF EXAMINERS & PAPER SETTERS IN MATHEMATICS**

| S.No. | Name of the Lecturer | Address |
|---|---|---|
| 1 | Sri. G. Chandrasekhar | Lecturer in Mathematics, Government College (A), Rajamahendravaram - |
| 2 | Dr. Ch. Srinivasulu | Lecturer in Mathematics, Government College (A), Rajamahendravaram - 9948617181 |
| 3 | Sri. M.Rajeev | Lecturer in Mathematics, Government College (A), Rajamahendravaram - 9441240915 |
| 4 | Sri. K. Chitti Babu | Lecturer in Mathematics, Government Degree College, Mummidivaram. 9493654033 |
| 5 | P. Mahalakshmi Naidu | Lecturer in Mathematics, Government Degree College, Perumallapuram - 9491764463 |
| 6 | Ms. Y. Padmaja | Lecturer in Mathematics, Government Degree College, Ramachandrapuram. 9951773314 |
| 7 | Sri. T. Srinivas Reddy | Lecturer in Mathematics, Government Degree College, Ramachandrapuram. 7981598769 |
| 8 | Sri N. Kiran Kumar | Lecturer in Mathematics, Government Degree College, Mandapeta, 9866522999 |
| 9 | Dr. SK. Sajana | Lecturer in Mathematics, S.R.R. Government Degree College, Vijayawada. 7893918849 |
| 10 | Smt. M. Madhavi | Lecturer in Mathematics, Government Degree College, Tuni. 9247380632 |
| 11 | Sri. M. Sri Kameswara Rao | Lecturer in Mathematics, Government Degree College, Pithapuram - 9866219121 |
| 12 | K. Suresh | Lecturer in Mathematics, Government Degree College, Yeleswaram - 9700203074 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A) :: KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**Certificate of Submission**

The following documents are submitted to the academic coordinator and controller of Examination.

1. Hard copy of the approved curriculum which includes minutes of Board of Studies, Approved Syllabus, blue print for the question papers and model papers for all semesters and list of approved examiners.
2. Soft copy containing the approved curriculum which includes minutes of Board of Studies, Blue print for the question papers and model papers for all semesters and list of approved examiners.

**Chairman**

(Dr.K.Jayadev)

**Academic Coordinator** **Controller of Examinations**

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**Objectives of the Department**

- To impart knowledge on various Mathematical concepts like Differential Equations, Solid Geometry, Group Theory, Real Analysis, Ring Theory and Vector Calculus, Linear Algebra, Numerical Analysis and Special Functions.
- To equip our students with good quality to appear for competitive examinations.
- To make the students to understand the needs of Mathematics in Science and Technology.
- To inculcate research atmosphere among students by assigning projects.

**PROGRAMME OUTCOMES**

For every degree program expectations are listed out by the institution under the Program Outcomes. For all Degree Streams the following are set as Programme Outcomes.

| | | |
|---|---|---|
| **PO 1** | **Domain Expertise** | • Acquire comprehensive domain knowledge andskills.<br>• Make use of the knowledge in an innovativemanner |
| **PO 2** | **Life-long Learning and Research:** | • Learn "how to learn"- Self-motivated and self-learning.<br>• Adopt to the ever-emerging demands of workplace and life.<br>• Investigate the problem and report in a propermanner. |
| **PO 3** | **Modern Equipment Usage** | • Adopt ICT mode of learning effectively.<br>• Access, retrieve and use authenticatedinformation.<br>• Have knowledge of software applications toanalyze data<br>• Usage of technology without deviating from thededication of learning. |
| **PO 4** | **Computing Skills and Ethics** | • Develop rational and scientific thinking<br>• Ensure the human values & ethics and to followthem throughout the life. |
| **PO 5** | **Complex problem Investigation & Solving** | • Predict and analyze problems.<br>• Frame hypotheses.<br>• Investigate and interpret empirical data.<br>• Plan and execute action. |
| **PO 6** | **Perform effectivelyas Individuals and in Teams** | • Work efficiently as an individual<br>• Cooperate, coordinate and perform effectively indiverse teams/groups. |
| **PO 7** | **Efficient Communication & Life Skills** | • To face challenges and self-sustainability inovercoming the psychological problems.<br>• Listen, understand and express views in aconvincing manner.<br>• Develop skills to present information clearly andconcisely to interested groups. |

| | | |
|---|---|---|
| **PO 8** | **Environmental Sustainability** | • Following the green energy measures.<br>• Understand sensibly the environmentalchallenges.<br>• Think critically on preventing of environmental pollution.<br>• Propagate and follow environment friendlypractices. |
| **PO 9** | **Societal contribution** | • Involve voluntarily in social developmentactivities at Regional, National levels.<br>• Voluntary participation in serving the society from natural calamities viz. disasters, cyclones,epidemics.<br>• Be a patriotic citizen to uphold the constitutionalvalues of the Nation. |
| **PO 10** | **Effective Project Management** | • Adoption of changes time to time in accordancewith the situations.<br>• Identify the goals, objectives and components ofa project for its completion.<br>• Plan, organize and direct the endeavors of teamsto achieve the targets in time.<br>• Be competent in identifying opportunities anddevelop strategies and decision making for contingencies. |

## Programme Specific Outcomes of Mathematics Stream Courses

| PROGRAMME | Program Specific Outcomes |
|---|---|
| Mathematics Major | PSO 1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them. |
| | PSO 2: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains. |
| | PSO 3: Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions. |
| | PSO 4: Prepare and motivate students for research studies in mathematics and related fields. |
| | PSO 4: Nurture problem solving skills, thinking, creativity through assignments, project work. |
| Statistics Minor | PSO 1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them. |
| | PSO 2: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains. |
| | PSO 3: Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions. |
| | PSO 4: Prepare and motivate students for research studies in mathematics and related fields. |
| | PSO 4: Nurture problem solving skills, thinking, creativity through assignments, project work. |
| Chemistry Minor | PSO 1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them. |
| | PSO 2: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains. |
| | PSO 3: Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions. |
| | PSO 4: Prepare and motivate students for research studies in mathematics and related fields. |
| Data Science Minor | PSO 4: Nurture problem solving skills, thinking, creativity through assignments, project work. |
| | PSO 1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them. |
| | PSO 2: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains. |
| | PSO 3: Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions. |

**Courses (Papers) offered under B.Sc. Mathematics Stream**

| S. No. | Sem. No. | Domain Specific course/Clusters | Title |
|---|---|---|---|
| 1 | I | Major | Differential Equations |
| 2 | I | Major | Solid Geometry |
| 3 | II | Major | Group Theory |
| 4 | II | Major | Elementary Real Analysis |
| 5 | III | Major & Minor | Group Theory & Problem solving session |
| 6 | | Major | Numerical Methods & Problem Solving Session |
| 7 | | Major | Laplace Transforms & Problem Solving Session |
| 8 | | Major | Special Functions & Problem Solving Sessions |
| 9 | IV | Major & Minor | Ring Theory & Problem Solving Session |
| 10 | | Major & Minor | Introduction to Real Analysis & Problem Solving Session |
| 11 | | Major | Integral Transforms & Problem Solving Session |
| 12 | V | Major & Minor | Linear Algebra &Problem Solving Sessions |
| 13 | | Major & Minor | Vector Calculus & Problem solving Sessions |
| 14 | | Major | Functions of a complex variables & Problem solving Sessions |
| | | | (OR) |
| 15 | | Major | Advanced Numerical Methods & Problem Solving Sessions |
| 16 | | Major | Number Theory & Problem Solving Sessions |
| | | | (OR) |
| 17 | | Major | Mathematical Statistics & Problem Solving Sessions |

## MATHEMATICS COURSE OUTCOMES

| Year | Semester | Title of the Paper | Course Outcomes |
|---|---|---|---|
| I | I | Differential Equations | CO 1. Solve exact differential equations, linear equations, Bernoulli's equations, and equations reducible to exact form using integrating factors.<br>CO 2. Analyze and solve first-order differential equations that are solvable for p,and y, including Clairaut's equations.<br>CO 3. Solve homogeneous and non-homogeneous linear differential equations of higher order with constant coefficients using operator methods.<br>CO 4. Compute particular integrals for non-homogeneous equations when the right-hand side is a polynomial, exponential, or trigonometric function.<br>CO 5. Solve non-homogeneous differential equations using the method of variation of parameters and other applicable techniques. |
| | I | Solid Geometry | CO 1. Derive and interpret equations of planes and lines in various forms.<br>CO 2. Compute angles, distances, and intersection conditions between geometric elements (lines, planes, spheres).<br>CO 3. Determine coplanarity of lines and solve problems involving shortest distances in 3D space.<br>CO4. Analyse sphere-related problems, including tangents, intersections, and circle equations in 3D.<br>CO 5. Apply advanced concepts like polar planes, conjugate points, and orthogonality conditions of spheres. |
| | II | Group Theory | CO 1. Understand the definition and basic properties of groups, including finite and infinite groups, and construct composition tables.<br>CO 2.Analyze subgroups and cosets, apply Lagrange's Theorem, and understand the structure of a group through its subgroups.<br>CO 3. Identify and verify normal subgroups, and understand their role in forming quotient groups.<br>CO 4. Understand and apply homomorphisms and isomorphisms, including the fundamental homomorphism theorem and its applications.<br>CO 5. Work with permutations, transpositions, and cyclic groups, and understand their properties and |

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|---|---|---|---|
| | | | significance in group theory, including Cayley's Theorem. |
| | II | Elementary Real Analysis | CO 1. Understand the real number system, its axioms, and properties, including completeness, supremum, and infimum.<br>CO 2. Apply the Archimedean property, denseness, and concepts of neighborhoods, limit points, and derived sets in problem-solving.<br>CO 3. Analyse sequences for boundedness and convergence using definitions and the Cauchy criterion.<br>CO4. 4.Understand the concept of sub sequences, apply the Bolzano-Weierstrass theorem, and test convergence using Cauchy's general principle.<br>CO 5. Determine the convergence of infinite series using various tests and solve related analytical problems. |
| II | III | Group Theory | CO 1. Acquire the basic knowledge and structure of groups.<br>CO 2. Get the significance of the notation of a subgroup and cosets.<br>CO 3. Understand the concept of normal subgroups and properties of normal subgroup.<br>CO 4. Study the homomorphisms and isomorphisms with applications.<br>CO 5. Understand the properties of permutation and cyclic groups. |
| | III | Numerical Methods | CO 1. Difference between the operators, $\Delta$,$\nabla$,E and the relation between them.<br>CO 2. Know about the Newton – Gregory Forward and backward interpolation.<br>CO3. Know the Central Difference operators, $\delta$, $\mu$, $\sigma$ and relation between them.<br>CO 4. Solve Algebraic and Transcendental equations.<br>CO 5.Understand the concept of Curve fitting |
| | III | Laplace Transforms | CO 1. Understand the definition and properties of Laplace transformations<br>CO 2. Get an idea about first and second shifting theorems and change of scale property.<br>CO 3. Understand Laplace transforms of standard functions like Bessel, Error function etc.<br>CO 4. Know the reverse transformation of Laplace and properties.<br>CO 5. Get the knowledge of application of convolution theorem |
| | III | Special Functions | CO 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. |

| | | | |
|---|---|---|---|
| | | | CO 2. Find power series solutions of ordinary differential equations.<br>CO 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.<br>CO 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.<br>CO 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. |
| | IV | Ring Theory | CO 1. Acquire the basic knowledge of rings, fields and integral domains.<br>CO 2. Get the knowledge of subrings and ideals.<br>CO 3. Construct composition tables for finite quotient rings.<br>CO 4. Study the homomorphisms and isomorphisms with applications.<br>CO 5. Get the idea of division algorithm of polynomials over a field. |
| | IV | Introduction to Real Analysis | CO1.Get clear idea about the real numbers and real valued functions.<br>CO2. Obtain the skills of analysing the concepts and applying appropriate methods for testing convergence of a sequence/ series.<br>CO3. Test the continuity and differentiability and Riemann integration of a function.<br>CO4. Know the geometrical interpretation of mean value theorems.<br>CO 5. Know about the fundamental theorem of integral calculus. |
| | IV | Integral Transforms | CO 1. Understand the application of Laplace transforms to solve ODEs.<br>CO 2. Understand the application of Laplace transforms to solve Simultaneous Des.<br>CO 3. Understand the application of Laplace transforms to Integral equations.<br>CO 4. Basic knowledge of Fourier-Transformations.<br>CO 5. Comprehend the properties of Fourier transforms and solve problems related to finite Fourier transforms. |
| III | V | Linear Algebra | CO1. Understand the concepts of vector spaces, subspaces<br>CO2. Understand the concepts of basis, dimension and their properties<br>CO3. Understand the concept of linear transformation and its properties<br>CO4. Apply Cayley- Hamilton theorem to |

| | | | |
|---|---|---|---|
| | | | problems for finding the inverse of a matrix and higher powers of matrices without using routine methods<br>CO5. Learn the properties of inner product spaces and determine orthogonality in inner product spaces. |
| | | Vector Calculus | CO1. Learn multiple integrals as a natural extension of definite integral to a function of two variables in the case of double integral/three variables in the case of triple integral.<br>CO2.Learn applications in terms of finding surface area by double integral and volume by triple integral.<br>CO3. Determine the gradient, divergence and curl of a vector and vector identities.<br>CO4. Evaluate line, surface and volume integrals.<br>CO5. Understand relation between surface and volume integrals (Gauss divergence theorem), relation between line integral and volume integral (Green's theorem), relation between line and surface integral (Stokes theorem) |
| | | Advanced Numerical Analysis | CO1. Find derivatives using various difference formulae<br>CO2. Understand the process of Numerical Integration<br>CO3. Solve Simultaneous Linear systems of Equations.<br>CO4. understand Iterative methods<br>CO5. find Numerical Solution of Ordinary Differential Equations |
| | | Number Theory | CO1.Understand the fundamental theorem of arithmetic<br>CO2. understand Mobius function, Euler quotient function, The Mangoldt function , Liouville's function, The divisor functions and the generalized convolutions.<br>CO3. Understand Euler's summation formula, application to the distribution of lattice points and the applications to μ (n) and Λ (n)<br>CO4. Understand the concepts of congruencies, residue classes and complete residues systems.<br>CO5. Comprehend the concept of quadratic residues mod p and quadratic non residues mod p. |

| | P.R.Government College (Autonomous): KAKINADA | Program&Semester | | | |
|---|---|---|---|---|---|
| Course Code<br>MAT-101 T | **TITLE OF THE COURSE**<br>**DIFFERENTIAL EQUATIONS** | I B.Sc Major (I Sem)<br>w.e.f.2025-26 admitted Batch | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Calculus and Linear Algebra | 5 | - | - | 4 |

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

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Solve exact differential equations, linear equations, Bernoulli's equations, and equations reducible to exact form using integrating factors. |
| CO2 | Analyze and solve first-order differential equations that are solvable for p, , and y, including Clairaut's equations. |
| CO3 | Solve homogeneous and non-homogeneous linear differential equations of higher order with constant coefficients using operator methods. |
| CO4 | Compute particular integrals for non-homogeneous equations when the right-hand side is a polynomial, exponential, or trigonometric function. |
| CO5 | Solve non-homogeneous differential equations using the method of variation of parameters and other applicable techniques. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| Skill Development | | | Employability | | | Entrepreneurship | |
|---|---|---|---|---|---|---|---|

**COURSE SYLLABUS:**

**UNIT – I:**

Exact differential equations- Integrating factors- Equations reducible exact equations by integrating factors (i). 1 / Mx + Ny (ii) 1 / Mx – Ny - Linear Differential Equations – Bernoulli's equations

**UNIT – II:**

Equations solvable for p; Equations solvable for y, Equations solvable for x - Clairaut's Equation.

**UNIT – III: Higher order linear differential equations**

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)$Q(x) = b\ eax$ where b is a real constant - (ii) $Q(x) = Sin\ ax$ (or) $Cos\ ax$ where a is a real constant.

**UNIT – IV:**

Solution to a non-homogeneous linear differential equation 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 –V:**

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 Press.

## BLUE PRINT FOR QUESTION PAPER PATTERN

## COURSE-I- DIFFERENTIAL EQUATIONS

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | UNIT – I | 2 | 2 | 30 |
| II | UNIT – II | 1 | 1 | 15 |
| III | UNIT – III | 2 | 1 | 20 |
| IV | UNIT – IV | 1 | 1 | 15 |
| V | UNIT - V | 1 | 1 | 15 |
| **Total** | | 7 | 6 | 95 |

**S.A.Q.** **=** Short answer questions (5 marks)

**E.Q** **=** Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

……………….

Total Marks = 50 M

………………..

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**I year B.Sc., Degree Examinations - I Semester**
**Mathematics Course-I: Differential Equations**
**(w.e.f. 2025-26Admitted Batch)**
**Model Paper (w.e.f. 2025-2026)**

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**Time: 2 Hours** **Max Marks: 50M**

## Section -I

**Answer any three of the following questions. Must attempt atleast one question from each part. Each question carries 10 Marks. 3 X 10 = 30M**

### Part – A

1. Essay question from unit – I.
2. Essay question from unit – I
3. Essay question from unit – II.

### Part - B

4. Essay question from unit – III.
5. Essay question from unit – IV.
6. Essay question from unit - V.

## Section II

**Answer any four of the following questions. Each question carries 5 marks. 4 X 5 = 20M**

7. Short answer question from unit - I
8. Short answer question from unit - I.
9. Short answer question from unit - II.
10. Short answer question from unit - III.
11. Short answer question from Unit – III.
12. Short answer question from unit - IV.
13. Short answer question from unit - V.

# P.R. GOVT. COLLEGE (AUTONOMOUS), KAKINADA

## I year B.Sc., Degree Examinations - I Semester
## Mathematics Course Major - I: Differential Equations
## (w.e.f. 2025-2026 Admitted Batch)

**QUESTION BANK**

**Short Answer Questions**

**Unit-I**

1. Solve $(e^y + 1)\cos x\, dx + e^y \sin x\, dy = 0$.
2. Solve $\frac{dy}{dx} + \frac{ax+hy+g}{hx+by+f} = 0$ and show that this differential equation represents a family of conics.
3. Solve $x\, dy - y\, dx = xy^2\, dx$.
4. Solve $(1+xy)x\, dy + (1-xy)y dx = 0$.
5. Solve $x\frac{dy}{dx} + 2y - x^2 \log x = 0$
6. Solve $Cos^2 x\ \frac{dy}{dx} + y = \tan x$.
7. Solve $x\frac{dy}{dx} + y = y^2 \log x$
8. Solve $\frac{dy}{dx} + x \sin 2y = x^3 \cos^2 y$.

**Unit - II**

9. Solve $xyp^2 + p(3x^2 - 2y^2) - 6xy = 0$
10. Solve $y^2 \log y = xpy + p^2$ .
11. Solve $y = 2xp + x^2 p^4$.
12. Solve $(y - xp)(p - 1) = p$.
13. Solve $xy^2(p^2+2) = 2py^3 + x^3$ .

**Unit - III**

14. Solve $( D^4 - 4D^3 + 6D^2 - 4D + 1 )y = 0$ .
15. Solve $( D^4 + 8D^2 + 16 ) y = 0$ .
16. Solve $( D^2 - 2D - 3 ) y = 5$ .
17. Solve $(D^2 - 3D + 2)y = Coshx$.
18. Solve $(D^2 + 9)y = Cos\ 3x$.
19. Solve$(D^2 - 5D + 6)y = e^{4x}$.
20. Solve$(D^2 + 4)y = Sin2x$.

**Unit - IV**

21. Solve$(D^2 - 4D + 4)y = x^3$
22. Solve $(D^4 - 2D^3 + D^2)y = x^3$
23. Solve $( D^2 - 2D + 5 ) y = e^{2x} \sin x$
24. Solve$(D^2 - 2D + 1)y = x^2 e^{3x}$.
25. Solve $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 13y = 8e^{3x} sin2x$

## Unit – V

26. Solve $(D^2+4)y = x\,Sinx$

27. Solve $(D^2+2D+1)y = x\,Cosx$

28. Solve$(D^2+1)y = Secx$ by method of variation of parameters.

29. Solve$(D^2+1)y = cosec\,x$ by method of variation of parameters.

30. Solve $(D^2 - 2D)\, y = e^x \sin x$ by the method of variation of parameters.

## Essay Answer Questions

## Unit -I

1. Solve $x^2y\,dx - (x^3+y^3)dy = 0$.
2. Solve $(x^2y - 2xy^2)dx - (x^3 - 3x^2y)dy = 0$.
3. Solve $y(xy + 2x^2y^2)dx + x(xy - x^2y^2)dy = 0$.
4. Solve $\left(x^2y^2 + xy + 1\right)ydx + (x^2y^2 - xy + 1)xdy = 0$
5. Solve $x\,cosx\frac{dy}{dx} + (\,x\,sinx + cosx\,)y = 1$.
6. Solve $(1-x^2)\frac{dy}{dx} + 2xy = x\sqrt{1-x^2}$ .
7. Solve $\frac{dy}{dx}\left(x^2y^3 + xy\right) = 1$

## Unit - II

8. Solve $p^2 + 2py\cot x = y^2$
9. Solve $2px = 2\tan y + p^3\cos^2 y$
10. Solve $y + px = p^2 x^4$
11. Solve $2xp^3 - 6yp^2 + x^4 = 0$
12. Solve $(py + x)(px - y) = 2p$

## Unit - III

13. Solve $(D^2 - 4D + 3)y = sin3xCos2x$.
14. Solve $(D^2 - 3D + 2)y = Cos3x.Cos2x$.
15. Solve $(D^2+4)y = e^x + sin2x + Cos2x$.
16. Solve $(D^2+9)y = cos^3 x$
17. Solve $(D^2-4)y = e^x + \sin 2x + cos^2 x$

## Unit - IV

18. Solve $D^2(D^2+4)y = 320(x^3 + 2x^2)$
19. Solve $(\,D^2 - 2D + 4\,)\, y = 8\,(\,x^2 + e^{2x} + \sin 2x\,)$
20. Solve $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 13y = 8e^{3x}sin2x$
21. Solve $(D^2+4)y = x^2e^{3x} + e^xCos2x$

## Unit - V

22. Solve $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = xe^x sinx$
23. Solve $(D^2 - 4D + 4)y = 8x^2e^{2x}sin2x$

24. Solve $(D^4 + 2D^2 + 1)\, y = x^2 \cos x$

25. Solve $(D^2 + a^2)y = \sec ax$ by method of variation of parameters.

26. Solve $\frac{d^2y}{dx^2} + 4y = 4\, Tan\, 2x$ by method of variation of parameters.

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| | | |
|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program&Semester**<br>I B.Sc Major (I Sem)<br>w.e.f.2025-26 admitted Batch |
| CourseCode<br>MAT-102 T | **TITLEOFTHECOURSE**<br>**ANALYTICAL SOILD GEOMETRY** | |

| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
|---|---|---|---|---|---|
| Pre-requisites: | Basic Mathematics Knowledge on 2-D Geometry | 5 | - | - | 4 |

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:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Derive and interpret equations of planes and lines in various forms. |
| CO2 | Compute angles, distances, and intersection conditions between geometric elements (lines, planes, spheres). |
| CO3 | Determine coplanarity of lines and solve problems involving shortest distances in 3D space. |
| CO4 | Analyse sphere-related problems, including tangents, intersections, and circle equations in 3D. |
| CO5 | Apply advanced concepts like polar planes, conjugate points, and orthogonality conditions of spheres. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| Skill Development | | | Employability | | | Entrepreneurship | |
|---|---|---|---|---|---|---|---|

**SYLLABUS:**

**UNIT – I:**

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 – II:**

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 – III:**

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 – IV:**

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 –V:**

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.

**Prescribed 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. 2. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by TataMcGraw -Hill Publishers.
3. 3. Solid Geometry by B. Rama Bhupal Reddy, published by Spectrum University Press.

**BLUE PRINT FOR QUESTION PAPER PATTERN**

**COURSE-II- ANALYTICAL SOLID GEOMETRY**

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | UNIT - I | 2 | 1 | 20 |
| II | UNIT - II | 1 | 1 | 15 |
| III | UNIT - III | 1 | 1 | 15 |
| IV | UNIT – IV | 2 | 1 | 20 |
| V | UNIT - V | 1 | 2 | 25 |
| | | 7 | 6 | 95 |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q** = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

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Total Marks = 50 M

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**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**I year B.Sc., Degree Examinations - I Semester**

**Mathematics Course-II: Solid Geometry**

**(w.e.f. 2025-26 Admitted Batch)**

**Model Paper (w.e.f. 2025-2026)**

**Time: 2Hrs** **Max. Marks: 50M**

**……….……………………………………………………………………………………………**

## Section -I

**Answer any three of the following questions. Must attempt atleast one question from each part. Each question carries 10 Marks. 3 X 10 = 30M**

### Part – A

1. Essay question from unit - I.
2. Essay question from unit - II.
3. Essay question from unit - III.

### Part - B

4. Essay question from unit - IV.
5. Essay question from unit - V.
6. Essay question from unit - V.

## Section II

**Answer any four of the following questions. Each question carries 5 marks. 4 X 5 = 20M**

7. Short answer question from unit - I.
8. Short answer question from unit - I.
9. Short answer question from unit – II.
10. Short answer question from unit - III.
11. Short answer question from unit - IV.
12. Short answer question from unit – IV.
13. Short answer question from unit – V.

**P.R. GOVT. COLLEGE (AUTONOMOUS), KAKINADA**

**I year B.Sc., Degree Examinations - I Semester**
**Mathematics Course Major - II: Analytical Solid Geometry**
**(w.e.f. 2025-2026 Admitted Batch)**
**QUESTION BANK**
**Short Answer Questions**

**Unit-I**

1. Find the equation of the plane through ( 4, 4, 0)and perpendicular to the planes x + 2y + 2z = 5 and 3x + 3y + 2z – 8 = 0 .
2. Find the equation to the plane through the points (2, 2, 1), (9, 3, 6) and perpendicular to the plane 2x + 6y + 6z = 9 .
3. Show that the equation of the plane passing through the points (2, 2, -1), (3, 4, 2), (7, 0, 6) is 5x + 2y – 3z – 17 = 0 .
4. Find the angles between the planes 2x – y + z = 0 , x + y + 2z = 7 .
5. Find the equation of the plane through the point (-1, 3, 2) and perpendicular to the planes x+2y+2z =5 and 3x+3y+2z =8.
6. Find the equation of the plane through the line of intersection of x – y +3z = 5 = 0 and 2x + y – 2z + 6 = 0and passing through (-3, 1, 1).

**UNIT-II**

7. Find the image of the point (2, -1, 3) in the plane 3x - 2y + z = 9.

8. Find the image of the point (1, 6, 3) in the line $\frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{3}$

9. Find the symmetric form of the equation of the line $x + y + z + 1 = 0 = 4x + y - 2z + 2$.

10. Find the equation to the plane containing the line $\frac{x-1}{2} = \frac{y+1}{-1} = \frac{z-3}{4}$ and is perpendicular to the plane x + 2y + z – 12 = 0.

11. Find the equations of the line through the point (1, 1, 1) and intersecting the lines $2x - y - z - 2 = 0 = x + y + z - 1$; $x - y - z - 3 = 0 = 2x + 4y - z - 4$.

**UNIT-III**

12. Show that the equation to the plane containing the line $\frac{y}{b} + \frac{z}{c} = 1, x = 0$ and parallel to the line $\frac{x}{a} - \frac{z}{c} = 1, y = 0$ is $\frac{x}{a} - \frac{y}{b} - \frac{z}{c} = 1$ and if 2d is the S.D., prove that $\frac{1}{d^2} = \frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2}$.

13. Find the length of the perpendicular from the point (1, 2, 3) to the line through the point (6, 7, 7) whose d.rs. are 3, 2, -2.

14. If the position vectors of A, B, C, d are respectively -i + 2j – 3k, -16i + 6j + 4k, i – j + 3k and 4i + 9j + 7k , find the S.D between the lines $\overleftrightarrow{AB}$ *and* $\overleftrightarrow{CD}$.

15. Find the foot of the perpendicular from the origin to the line 2x + 3y + 4z + 5 = 0 = x + 2y + 3z + 4. Hence find the distance of the origin from the line.

**UNIT-IV**

16. Find the equation of the sphere through O = (0, 0, 0) and making intercepts a, b, c on the axes.

17. A plane passes through a fixed point (a, b, c) and intersect the axes in A, B, C . Show that the centre of the sphere OABC lies on $\frac{a}{x} + \frac{b}{y} + \frac{c}{z} = 2$

18. Find the equation of the sphere through the circle $x^2 + y^2 + z^2 = 9$ , $2x+3y+4z=5$.

19. Find the centre and radius of the circle $x^2 + y^2 + z^2 - 2y - 4z - 11 = 0$ , $x+2y+2z-15 = 0$ .

20. Find the equation of the sphere trough the points (1, -4, 3), (1, -5, 2), (1, -3, 0) and whose centre lies on the plane x + y + z = 0.

21. Find the equation of the sphere through the circle $x^2 + y^2 + z^2 + 2x + 3y + 6 = 0$ , $x-2y+4z=9$ and the centre of the sphere $x^2 + y^2 + z^2 - 2x + 4y - 6z + 5 = 0$ .

22. Find the equation of the sphere for which the circle $x^2 + y^2 + z^2 + 7y - 2z + 2 = 0$ , $2x+3y+4z=8$ is a great circle. Also find its centre and radius .

**UNIT-V**

23. Show that the spheres $x^2 + y^2 + z^2 + 6y + 2z + 8 = 0$, $x^2 + y^2 + z^2 + 6x + 8y + 4z + 20 = 0$ are orthogonal.

24. Find the equation of the sphere which touches the plane 3x + 2y – z + 2 = 0 at (1. -2, 1) and cuts orthogonally the sphere $x^2 + y^2 + z^2 - 4x + 6y + 4 = 0$.

25. Find the equation to the sphere with (1, 2, -3), (5, 0, 1) as the ends of one of its diameters. Also find as angle between it and the sphere $x^2 + y^2 + z^2 - 2x - 4y - 6z + 10 = 0$.

26. Find the equation to the sphere through the circle given by $x^2 + y^2 + z^2 - 2x - 4y - 11 = 0$, $x^2 + y^2 + z^2 + 2x - y + 12z + 5 = 0$ and through the point (1, -1, -1).

27. Find the equation of the radical plane of the coaxal system whose limiting points are (-1, 2, 1) and (-2, 1, -1).

**Essay Questions**

**UNIT-I**

1. If a plane meets the coordinate axes in A, B, C such that the centroid of the triangle ABC is the point $(p, q, r)$ then show that the equation of the plane is $\frac{x}{p} + \frac{y}{q} + \frac{z}{r} = 3$ .

2. Find the planes bisecting the angles between the planes $2x - y + 2z + 3 = 0$ and $3x - 2y + 6z + 8 = 0$. Point out which of the planes bisects the acute angle and which bisects the obtuse angle in which the origin lies.

3. Prove that the equation represents a pair of planes , and find the angle between them .
$6x^2 + 4y^2 - 10z^2 + 3yz + 4zx - 11xy = 0$

4. Show that the equation $x^2 + 4y^2 + 9z^2 - 12yz - 6zx + 4xy + 5x + 10y - 15z + 6 = 0$ represents a pair of parallel planes and find the distance between them.

**UNIT-II**

5. A variable plane makes intercepts on the axes, the sum of whose squares is $k^2$ (a constant). Show that the locus of the foot of the perpendicular from the origin to the plane is $x^{-2} + y^{-2} + z^{-2})(x^2 + y^2 + z^2)^2 = k^2$

6. Find the equation to the plane through the line $\frac{x-x_2}{l} = \frac{y-y_2}{m} = \frac{z-z_2}{n}$ and through the point $(x_1, y_1, z_1)$

7. Prove that the lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{4}$ ; $\frac{x-2}{3}=\frac{y-3}{4}=\frac{z-4}{5}$ are coplanar. Also find their point of intersection and the plane containing the lines.

8. Prove that $\frac{x+4}{3}=\frac{y+6}{5}=\frac{z-1}{-2}$ and 3x – 2y + z + 5 = 0 = 2x + 3y + 4z – 4 = 0 are coplanar. Find the point of intersection.

9. Prove that the lines x + 2y – 5z + 9 = 0 = 3x – y + 2z – 5; 4x – 5y + z + 3 = 0 = 2x = 3y – z – 3 are coplanar. Also find their point of intersection.

**UNIT – III**

10. Find the S.D between the lines $\frac{x-3}{3}=\frac{y-8}{-1}=\frac{z-3}{1}$ $and$ $\frac{x+3}{-3}=\frac{y+7}{2}=\frac{z-6}{4}$. find also the equation and the points in which the S.D meets the given lines.

11. Find the length and equations of shortest distance between the line $\frac{x}{2}=\frac{y}{-3}=\frac{z}{1}$ $and$ $\frac{x-2}{3}=\frac{y-1}{-5}=\frac{z+2}{2}$.

12. Find the length and equation of the shortest distance between the lines $\frac{x}{1}=\frac{y}{2}=\frac{z}{1}$ and $x + y + 2z - 3 = 0 = 2x + 3y + 3z - 4$.

13. Find the S.D and the equations of the line of S.D between the lines 3x – 9y + 5z = 0 = x + y –z and 6x + 8y + 3z – 10 = 0 = x + 2y + z – 3 .

**UNIT-IV**

14. A sphere of radius k passes through the origin and meet the axes in A, B, C. Show that the centroid of the triangle ABC lies on the sphere $9 (x^2 + y^2 + z^2) = 4k^2$

15. Show that the two circles $x^2 + y^2 + z^2 - y + 2z = 0$, $x - y + z = 2$; $x^2 + y^2 + z^2 + x - 3y + z - 5 = 0$, $2x - y + 4z - 1 = 0$ lie on the same sphere , and find its equation .

16. Find the equation of the sphere passing through the circle $x^2+y^2=4$ , z=0 and is intersected by the plane x+2y+2z=0 in circle of radius 3 .

17. Show that the plane 2x-2y+z+12=0 touches the sphere $x^2+y^2+z^2-2x-4y+2z-3=0$ and find the point of contact.

**UNIT-V**

18. Find the pole of the plane x - y - z + 9 = 0 w.r.t the sphere $x^2 + y^2 + z^2 - 2x + 4y - 6z + 5 = 0$

19. Show that the radical line of the spheres $x^2 + y^2 + z^2 - 4x + 3 = 0$, $x^2 + y^2 + z^2 - 6y + 3 = 0$, $x^2 + y^2 + z^2 + 4x + 2y - 4z + 3 = 0$, $is$ $\frac{x}{3}=\frac{y}{2}=\frac{z}{7}$.

20. Find the radical centre of the spheres $x^2 + y^2 + z^2 + 4y = 0$, $x^2 + y^2 + z^2 + 2x + 2y + 2z + 2 = 0$, $x^2 + y^2 + z^2 + 3x - 2y + 8z + 6 = 0$, $x^2 + y^2 + z^2 - x + 4y - 6z - 2 = 0$

21. If $r_1$ , $r_2$ are the radii of two orthogonal spheres then the radius of the circle of their intersection is $\frac{r_1 r_2}{\sqrt{{r_1}^2+{r_2}^2}}$ .

22. Find the limiting points of the coaxal system of spheres determined by $x^2 + y^2 + z^2 + 4x - 2y + 2z + 6 = 0$, $x^2 + y^2 + z^2 + 2x - 4y + 2z + 6 = 0$.

23. Find the limiting points of the coaxal system of spheres determined by $x^2 + y^2 + z^2 + 3x - 3y + 6 = 0$, $x^2 + y^2 + z^2 - 6y - 6z + 6 = 0$.

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|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous): KAKINADA** | **Program & Semester**<br>I B.Sc Major (II Sem)<br>w.e.f 2025-26 admitted batch | | | |
| CourseCode<br>MAT-201 T | **TITLE OF THE COURSE**<br>**GROUP THEORY** | | | | |
| Teaching | HoursAllocated:30(**Practical**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on sets and number system. | 5 | - | - | 4 |

## 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:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Understand the definition and basic properties of groups, including finite and infinite groups, and construct composition tables. |
| CO2 | Analyze subgroups and cosets, apply Lagrange's Theorem, and understand the structure of a group through its subgroups. |
| CO3 | Identify and verify normal subgroups, and understand their role in forming quotient |
| CO4 | Understand and apply homomorphisms and isomorphisms, including the fundamental homomorphism theorem and its applications. |
| CO5 | Work with permutations, transpositions, and cyclic groups, and understand their properties and significance in group theory, including Cayley's Theorem. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**UNIT – I:**

Binary Operation – Algebraic structure – Semi group - Monoid – Group definition and its elementary properties - Finite and Infinite groups – examples – order of a group - Composition tables with examples.

**UNIT – II:**

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 – III:**

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 – IV:**

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 –V:**

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.

**Prescribed 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

## BLUE PRINT FOR QUESTION PAPER PATTERN

### SEMESTER-II

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | UNIT – I | 2 | 1 | 20 |
| II | UNIT – II | 1 | 2 | 25 |
| III | UNIT – III | 1 | 1 | 15 |
| IV | UNIT – IV | 1 | 1 | 15 |
| V | UNIT - V | 2 | 1 | 20 |
| **Total** | | 7 | 6 | 95 |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q** = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

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Total Marks = 50 M

………………..

**Pithapur Rajah's Government College (Autonomous), Kakinada**
**I year B.Sc., Degree Examinations – II Semester**
**Mathematics Course III: Group Theory**
**Model Paper( w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

Answer any three questions. Selecting at least one question from each part

Part – I 3 X 10 = 30

1. Essay question from Unit -I.
2. Essay question from Unit – II.
3. Essay question from Unit – II.

**Part – II**

4. Essay question from Unit – III.
5. Essay question from Unit – IV.
6. Essay question from Unit – V.

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from Unit – I.
8. Short answer question from Unit – I.
9. Short answer question from Unit – II.
10. Short answer question from Unit – III.
11. Short answer question from Unit – IV.
12. Short answer question from Unit – V.
13. Short answer question from Unit – V.

**P.R. GOVT. COLLEGE (AUTONOMOUS), KAKINADA**

**I year B.Sc., Degree Examinations – II Semester**
**Mathematics Course Major – III: Group Theory**
**(w.e.f. 2025-2026 Admitted Batch)**
**QUESTION BANK**
**Short Answer Questions**

**UNIT-1**

1. Prove that in a group the identity element is unique and the inverse of every element is unique.
2. If $G$ is a group,for $a, b \in G$ prove that $(ab)^{-1} = b^{-1} a^{-1}$
3. If every element of a group G is its own inverse, prove that G is abelian.
4. Prove that in a group $G(\neq \emptyset)$, for $a, b, x, y \in G$,the equations $ax = b, ya = b, \forall\ a, b \in G$ have unique solutions.
5. Prove that the group (G, •) is abelian iff $(ab)^2 = a^2 b^2$

**UNIT-II**

6. If a non -empty complex H of a group G is a subgroup of G then prove that $H = H{-}1$.
7. If H is a subgroup of a group G then show that HH = H.
8. If $H$ and $K$ are two subgroups of a group $G$ then show that $H \cap K$ is also a subgroup of G.
9. Let h be a subgroup of a group of G and a, b ∈ G then prove that Ha = Hb iff $ab^{-1} \in H$.

**UNIT-III**

10. Prove that every subgroup of an abelian group is normal.
11. Show that a subgroup H of a group G is normal iff $xHx^{-1} = H$ for all x ∈ G
12. Prove that intersection of two normal sub-groups of a group is a normal sub-group.
13. Prove that a subgroup of index 2 in a group is a normal subgroup.

**UNIT-IV**

14. Prove that every quotient group of an abelian group is abelian.
15. If f is a homomorphism of a group G into a group G1 then show that the kernel of f is a normal subgroup of G.
16. Prove that every homomorphic image of an abelian group is abelian.
17. Let G be a group. If f : G → g defined by $f(x) = x^2$ for all x ∈ G is a homomorphism then show that G is abelian.

**UNIT-V**

18. Express the permutation (1 2 3 4 5 6 7 8 9) as a product of disjoint cycles.
19. Show that the permutation $\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 6 & 1 & 4 & 3 & 2 & 5 & 7 & 9 & 8 \end{pmatrix}$ is odd permutation .
20. Verify whether the permutation $\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 2 & 5 & 4 & 3 & 6 & 1 & 7 & 9 & 8 \end{pmatrix}$ is even or odd .
21. Prove that every cyclic group is an abelian group.
22. Prove that a group of prime order is cyclic.
23. Prove that if G is an infinite cyclic group, then G has exactly two generators

**Essay Questions**

**UNIT-1**

1. Show that the set $Q+$ of all positive rational numbers forms an abelian group under the composition defined by '$o$' such that $a\ ob = (ab)/3\ for\ a, b \in Q+$.
2. Prove that the set G of rational numbers other than 1 with operation * such that a * b = a + b – ab for all a, b ∈G is an abelian group.
3. Prove that the set of $nth$ roots of unity forms an abelian group w.r.t. '.'
4. Prove that a finite semi-group ( G , • ) satisfying the cancelation laws is a group.

## UNIT-II

5. Prove that a non-empty complex $H$ of a group $G$ is a subgroup of $G$ if and only if $a, b \in H \Rightarrow ab^{-1} \in H$ , where $b^{-1}$ is the inverse of b in G.

6. If H and K are two sub-groups of a group G , then $H \cup K$ is a subgroup iff either $H \subseteq K$ or $K \subseteq H$.

7. If H and K are two sub-groups of a group G , then show that HK is a sub-group of G if and only if HK = KH.

8. State and prove Lagrange's Theorem. Prove that the converse of Lagrange's theorem is not true.

9. Prove that any two left cosets of a subgroup are either disjoint or identical.

10. If H is a subgroup of a group G, then there is one to one corresponding between the set of all distinct left cosets of H in G and the set of all distinct right cosets of H in G.

## UNIT-III

11. Prove that H of a group G is normal sub-group of G if and only if each left coset of H in G is a right coset of H in G.

12. Prove that H is a normal sub-group of G if and only if product of two right right (left) cosets of H in G is again a right (left ) coset of H on G .

13. State and prove Fundamental theorem of homomorphism of groups.

14. If M, N are two normal subgroups of a group G such that $M \cap N = \{e\}$, then show that every element of M commutes with every element of N.

## UNIT-IV

15. Prove that the set G/H of all cosets of a normal subgroup H in a group G with respect to coset multiplication is a group.

16. State and prove fundamental theorem of homomorphism of groups.

17. Show that the necessary and sufficient condition for a homomorphism f of a group G onto a group $G^1$ with kernel K to be an isomorphism of G into $G^1$ is that K = {e}.

## UNIT-V

18. Let Sn be a symmetric group of n symbols and let An be the group of even permutations, then show that An is a normal in Sn and $O(An) = n!/2$.

19. State and prove Cayley's theorem.

20. Prove that every subgroup of a cyclic group is cyclic.

21. Prove that the order of a cyclic group is equal to the order of its generators.

22. Prove that a cyclic group of order n has $\phi(n)$ generators.

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| | P.R.Government College (Autonomous): KAKINADA | Program & Semester<br>I B.Sc Major (II Sem)<br>w.e.f 2025-26 admitted batch | | | |
|---|---|---|---|---|---|
| CourseCode<br>MAT-202 T | TITLE OF THE COURSE<br>**ELEMENTARY REAL ANALYSIS** | | | | |
| Teaching | HoursAllocated:30(**Practical**) | L | T | P | C |
| Pre-requisites: | | 5 | - | - | 4 |

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:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Understand the real number system, its axioms, and properties, including completeness, supremum, and infimum. |
| CO2 | Apply the Archimedean property, denseness, and concepts of neighborhoods, limit points, and derived sets in problem-solving. |
| CO3 | Analyze sequences for boundedness and convergence using definitions and the Cauchy criterion. |
| CO4 | Understand the concept of subsequences, apply the Bolzano-Weierstrass theorem, and test convergence using Cauchy's general principle. |
| CO5 | Determine the convergence of infinite series using various tests and solve related analytical problems. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| Skill Development | | | Employability | | | Entrepreneurship | |
|---|---|---|---|---|---|---|---|

**UNIT – I:**

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 – II:**

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 – III:**

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 – IV:**

Limit Point of a Sequence – Bolzano-Weierstrass theorem on subsequences – Cauchy Sequences – Cauchy's general principle of convergence – Problems

**UNIT –V:**

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 nth 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.

**Prescribed 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.

## BLUE PRINT FOR QUESTION PAPER PATTERN

### SEMESTER-II

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | UNIT – I | 1 | 1 | 15 |
| II | UNIT – II | 1 | 1 | 15 |
| III | UNIT – III | 2 | 1 | 20 |
| IV | UNIT – IV | 1 | 1 | 15 |
| V | UNIT - V | 2 | 2 | 30 |
| **Total** | | 7 | 6 | 95 |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q** = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

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Total Marks = 50 M

………………..

**Pithapur Rajah's Government College (Autonomous), Kakinada**
**I year B.Sc., Degree Examinations - II Semester**
**Mathematics Course IV: Elementary Real Analysis**
**Model Paper( w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

Answer any three questions. Selecting at least one question from each part

Part – I 3 X 10 = 30

1. Essay question from Unit -I.
2. Essay question from Unit – II.
3. Essay question from Unit – III.

**Part – II**

4. Essay question from Unit – IV.
5. Essay question from Unit – V.
6. Essay question from Unit - V.

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from Unit - I.
8. Short answer question from Unit – II.
9. Short answer question from Unit – III.
10. Short answer question from Unit - III.
11. Short answer question from Unit – IV.
12. Short answer question from Unit -V.
13. Short answer question from Unit - V.

## P.R. GOVT. COLLEGE (AUTONOMOUS), KAKINADA

### I year B.Sc., Degree Examinations - II Semester
### Mathematics Course Major - IV: Elementary Real Analysis
### (w.e.f. 2025-2026 Admitted Batch)

**QUESTION BANK**

**Short Answer Questions**

**UNIT-I**

a. Prove that Every finite aggregate is bonded.

b. Show that √3 is an irrational number.

c. If an aggregate A has supremum, then it is unique.

d. Find the infimum and supremum of $A = \left\{2 + \frac{(-1)^n}{n}, n \epsilon N\right\}$

e. Find the infimum and supremum of $A = \left\{\frac{1}{n} + \frac{1}{3^n}, n \epsilon N\right\}$

**UNIT-II**

f. Show that Z has no limit point.

g. Find the limit point of $A = \left\{\frac{n}{2n+1}, n \epsilon N\right\}$

h. Show that $A = \left\{\frac{1}{n}, n \epsilon N\right\}$ has a unique limit point.

i. Give an example to show that the union of arbitrary family of closed sets is not closed.

j. Prove that every subset of a countable set is countable.

**UNIT - III**

11. Every convergent sequence has unique limit.

12. Every convergent sequence is bounded.

13. Show that $\log \sqrt[n]{n} = 1$.

14. Discuss the nature of the sequence $\{r^n\} for\ all -1 < r \leq 1$.

15. Prove that $\log\{\frac{1}{(n+1)^2} + \frac{1}{(n+2)^2} + \cdots + \frac{1}{(n+n)^2}\} = 0$.

16. Prove that the sequence $\{S_n\}$ defined by $S_1 = \sqrt{C} > 0$, $S_{n+1} = \sqrt{(C+S_n)}$ for all $n \in Z^+$ converges to the positive root of $x^2 - x - C = 0$.

**UNIT - IV**

17. Every convergent sequence is a Cauchy sequence.

18. If $\{S_n\}$ is a Cauchy sequence then $\{S_n\}$ is convergent.

19. Apply Cauchy's general principle of convergence to show that the sequence $\{S_n\}$ where $S_n = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots + \frac{1}{n^2}$ is convergent.

20. Prove that $\lim_{n\to\infty} \frac{n!}{n^n} = 0$

**UNIT - V**

21. If $\sum u_n\ converges\ then\ \log u_n = 0$

22. Test for convergence $\sum_{n=1}^{\infty} \frac{2n-1}{n(n+1)(n+2)}$

23. Test for convergence $\sum_{n=1}^{\infty} (\sqrt{n^3+1} - \sqrt{n^3})$

24. test for convergence $\sum_{n=1}^{\infty} \frac{1.3.5....(2n-1)}{2.4.6....2n}$

25. Test for convergence $\sum_{n=1}^{\infty} \frac{n!}{n^n}$

26. Test for convergence $\sum_{n=1}^{\infty} \frac{\sqrt{n}}{\sqrt{n^2+1}} x^n \ (x > 0)$

**Essay Questions**

**UNIT - I**

1. State and prove Well ordering principle.
2. Prove that Dedekind's axiom if and only if Completeness axiom.
3. Prove that the set of rational numbers is not a complete order field.

**UNIT - II**

4. State and prove Archimede's property.
5. Prove that every real number lies between two consecutive integers.
6. State and prove Bolzano-Weierstrass theorem for aggregate.
7. The intersection of finite number of open sets is an open set.

**UNIT - III**

8. State and prove Sandwich theorem.
9. A monotone sequence is convergent if and only if it is bounded.
10. Prove that $\lim_{n\to\infty} \{ \frac{1}{\sqrt{n^2+1}} + \frac{1}{\sqrt{n^2+2}} + \cdots + \frac{1}{\sqrt{n^2+n}} \} = 1$
11. Show that the sequence $\{s_n\}$ where $s_n = \frac{1}{n+1} + \frac{1}{n+2} + \cdots + \frac{1}{n+n}$ is convergent .
12. Prove that the sequence $\{s_n\}$ defined by $s_n = 1 + \frac{1}{1!} + \frac{1}{2!} + \cdots + \frac{1}{n!}$ is convergent.

**UNIT - IV**

13. State and prove Bolzano – Weier strass theorem.
14. A sequence is convergent iff it is bounded and has only one limit point.
15. State and prove Cauchy's general principle of convergence.
16. State and prove first theorem on limits.

**UNIT - V**

17. State and prove Limit comparison test.
18. State and prove Cauchy's $n^{th}$ root test.
19. State and prove D'Alembert's Ratio test.
20. Test for convergence of $\sum_{n=1}^{\infty} \frac{1}{2^n+3^n}$
21. Test for convergence of i) $\sum_{n=1}^{\infty} \left(\sqrt[3]{n^3+1} - n\right)$
22. Test for convergence of $\sum \frac{n^{n^2}}{(n+1)^{n^2}}$
23. Test for convergence of $\frac{1}{2} + \frac{1.3}{2.4} + \frac{1.3.5}{2.4.6} + \cdots$

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| | | | | | |
|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous) KAKINADA** | **Program&Semester**<br>II B.Sc Major & Minor (III Sem)<br>w.e.f 2025-26 admitted batch | | | |
| Course Code<br>**MAT – 301 T** | **TITLEOFTHECOURSE**<br>**Group Theory &Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on sets and number system. | 3 | - | - | 3 |

Course Objectives:

To provide the learner with the skills, knowledge and competencies to carry out their duties and responsibilities in pure Mathematic environment.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Acquire the basic knowledge and structure of groups |
| CO2 | Get the significance of the notation of a subgroup and cosets. |
| CO3 | Understand the concept of normal subgroups and properties of normal subgroup, permutation and cyclic groups. |
| CO4 | Study the homomorphisms and isomorphisms with applications. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**UNIT I :**

**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 II:**

**SUBGROUPS**: 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 III**:

**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 IV**

**HOMOMORPHISM:**

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 V:**

**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.

**Co-Curricular Activities**

Seminar/ Quiz/ Assignments/ Group theory and its applications / Problem Solving.

**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

**BLUE PRINT FOR QUESTION PAPER PATTERN**

**SEMESTER-III**

| **Unit** | **TOPIC** | **S.A.Q** | **E.Q** | **Marks allotted to the Unit** |
|---|---|---|---|---|
| I | Groups | 2 | 1 | 20 |
| II | Subgroups , Co-sets and Lagrange's Theorem | 1 | 2 | 25 |
| III | Normal subgroups | 1 | 1 | 15 |
| IV | Homomorphism | 1 | 1 | 15 |
| V | Permutations and Cyclic Groups | 2 | 1 | 20 |
| **Total** | | 7 | 6 | 95 |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q** = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

……………….

Total Marks = 50 M

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**Pithapur Rajah's Government College (Autonomous), Kakinada**
**II year B.Sc., Degree Examinations - III Semester**
**Course: Major V & Minor II : Group Theory & Problem Solving Session**
**Model Paper( w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

Answer any three questions. Selecting at least one question from each part

Part – I 3 X 10 = 30

1. Essay question from Unit -I.
2. Essay question from Unit – II.
3. Essay question from Unit – II.

**Part – II**

4. Essay question from Unit – III.
5. Essay question from Unit – IV.
6. Essay question from Unit - V.

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from Unit - I.
8. Short answer question from Unit – I.
9. Short answer question from Unit – II.
10. Short answer question from Unit - III.
11. Short answer question from Unit – IV.
12. Short answer question from Unit -V.
13. Short answer question from Unit - V.

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**DEPARTMENT OF MATHEMATICS**
**Question Bank**
**PAPER–Major V & Minor II : Group Theory & Problem Solving Session**

## Short Answer Questions

### UNIT-1

1. Prove that in a group the identity element is unique and the inverse of every element is unique.
2. If $G$ is a group,for $a, b \in G$ prove that $(ab)^{-1} = b^{-1} a^{-1}$
3. If every element of a group G is its own inverse, prove that G is abelian.
4. Prove that in a group $G(\neq \emptyset)$, for $a, b, x, y \in G$,the equations $ax = b$, $ya = b$, $\forall\ a, b \in G$ have unique solutions.
5. Prove that the group (G, •) is abelian iff $(ab)^2 = a^2 b^2$

### UNIT-II

6. If a non -empty complex H of a group G is a subgroup of G then prove that $H = H{-}1$.
7. If H is a subgroup of a group G then show that HH = H.
8. If $H$ and $K$ are two subgroups of a group $G$ then show that $H \cap K$ is also a subgroup of G.
9. Let h be a subgroup of a group of G and a, b $\in$ G then prove that Ha = Hb iff $ab^{-1} \in$ H.

### UNIT-III

10. Prove that every subgroup of an abelian group is normal.
11. Show that a subgroup H of a group G is normal iff $xHx^{-1} = H$ for all x $\in$ G
12. Prove that intersection of two normal sub-groups of a group is a normal sub-group.
13. Prove that a subgroup of index 2 in a group is a normal subgroup.

### UNIT-IV

14. Prove that every quotient group of an abelian group is abelian.
15. If f is a homomorphism of a group G into a group G1 then show that the kernel of f is a normal subgroup of G.
16. Prove that every homomorphic image of an abelian group is abelian.
17. Let G be a group. If f : G → g defined by f(x) = $x^2$ for all x $\in$ G is a homomorphism then show that G is abelian.

### UNIT-V

18. Express the permutation (1 2 3 4 5 6 7 8 9) as a product of disjoint cycles.
19. Show that the permutation (1 2 3 4 5 6 7 8 9) is odd permutation.
20. Verify whether the permutation (1 2 3 4 5 6 7 8 9) is even or odd.
21. Prove that every cyclic group is an abelian group.
22. Prove that a group of prime order is cyclic.
23. Prove that if G is an infinite cyclic group, then G has exactly two generators

## Essay Questions

### UNIT-1

1. Show that the set $Q+$ of all positive rational numbers forms an abelian group under the composition defined by '$o$' such that $a\ ob = (ab)/3\ for\ a, b \in Q+$.
2. Prove that the set G of rational numbers other than 1 with operation * such that a * b = a + b – ab for all a, b $\in$G is an abelian group.
3. Prove that the set of $nth$ roots of unity forms an abelian group w.r.t. '.'
4. Prove that a finite semi-group ( G , • ) satisfying the cancelation laws is a group.

### UNIT-II

5. Prove that a non-empty complex $H$ of a group $G$ is a subgroup of $G$ if and only if $a, b \in H \Rightarrow ab^{-1} \in H$ , where $b^{-1}$ is the inverse of b in G.
6. If H and K are two sub-groups of a group G , then H $\cup$ K is a subgroup iff either H $\subseteq$ K or K $\subseteq$ H.

7. If H and K are two sub-groups of a group G , then show that HK is a sub-group of G if and only if HK = KH.

8. State and prove Lagrange's Theorem. Prove that the converse of Lagrange's theorem is not true.

9. Prove that any two left cosets of a subgroup are either disjoint or identical.

10. If H is a subgroup of a group G, then there is one to one corresponding between the set of all distinct left cosets of H in G and the set of all distinct right cosets of H in G.

**UNIT-III**

11. Prove that H of a group G is normal sub-group of G if and only if each left coset of H in G is a right coset of H in G.

12.Prove that H is a normal sub-group of G if and only if product of two right right (left) cosets of H in G is again a right (left ) coset of H on G .

13. State and prove Fundamental theorem of homomorphism of groups.

14. If M, N are two normal subgroups of a group G such that $M \cap N = \{e\}$, then show that every element of M commutes with every element of N.

**UNIT-IV**

15. Prove that the set G/H of all cosets of a normal subgroup H in a group G with respect to coset multiplication is a group.

16. State and prove fundamental theorem of homomorphism of groups.

17. Show that the necessary and sufficient condition for a homomorphism f of a group G onto a group $G^1$ with kernel K to be an isomorphism of G into $G^1$ is that K = {e}.

**UNIT-V**

18. Let Sn be a symmetric group of n symbols and let An be the group of even permutations, then show that An is a normal in Sn and $O(An) = n!/2$.

19. State and prove Cayley's theorem.

20. Prove that every subgroup of a cyclic group is cyclic.

21. Prove that the order of a cyclic group is equal to the order of its generators.

22. Prove that a cyclic group of order n has $\phi(n)$ generators.

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| | P.R.Government College (Autonomous) KAKINADA | Program&Semester<br>II B.Sc Major & Minor (III Sem)<br>w.e.f 2025-26 admitted batch | | | |
|---|---|---|---|---|---|
| Course Code<br>MAT-301P | **TITLEOFTHECOURSE**<br>**Group Theory &Problem Solving Sessions Practical Course** | | | | |
| Teaching | HoursAllocated:30(**Practicals**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on sets and number system. | - | - | 2 | 1 |

**UNIT I :**

**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 II:**

**SUBGROUPS**: 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 III**:

**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 IV**

**HOMOMORPHISM:**

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 V:**

**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.

TEXT BOOK :

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

REFERENCE BOOKS :

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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

**Semester – III End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-MAJOR V & MINOR II – GROUP THEORY& PROBLEM SOLVING SESSION**

| **Unit** | **TOPIC** | **E.Q** | **Marks allotted to the Unit** |
|---|---|---|---|
| I | Groups | 1 | 06 |
| II | Sub groups Co-sets and Lagrange's Theorem | 2 | 12 |
| III | Normal subgroups | 2 | 12 |
| IV | Homomorphism | 1 | 06 |
| V | Permutations and Cyclic Groups | 2 | 12 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations - III Semester**
**Course-Major V & Minor II: Group Theory & Problem Solving Session**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

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**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – II.
3. Unit - II.
4. Unit – III.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – V.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | P.R.Government College (Autonomous) KAKINADA | Program&Semester<br>II B.Sc Major (III Sem)<br>w.e.f 2025-26 admitted batch | | | |
|---|---|---|---|---|---|
| CourseCode<br>MAT-302 T | TITLEOFTHECOURSE<br>**Numerical Methods &Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Advanced Calculus, Linear Algebra and Differential Equations | 3 | - | - | 3 |

Course Objectives:

This course will cover the classical fundamental topics in numerical methods such as, approximation, finite differences, Interpolation with equal and unequal intervals, solution of Algebraic and Transcendental equations and Curve fitting.

Course Outcomes:

| On Completion of the course, the students will be able o- | |
|---|---|
| CO1 | Difference between the operators, $\Delta$, $\nabla$, E and the relation between them. |
| CO2 | Know about the Newton – Gregory Forward and backward interpolation, Central Difference operators, $\delta$, $\mu$, $\sigma$ and relation between them |
| CO3 | Solve Algebraic and Transcendental equations. |
| CO4 | Understand the concept of Curve fitting. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| Skill Development | | | Employability | | | Entrepreneurship | |
|---|---|---|---|---|---|---|---|

**Unit – 1:**

**The calculus of finite differences**

The operators,$\Delta$, $\nabla$, E - Fundamental theorem of difference calculus- properties of, $\Delta$, $\nabla$, 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 $\Delta$ - 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, $\delta$, $\mu$, $\sigma$ 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.

Additional Input:

Absolute error, Relative error and Percentage error (there are no questions from this in the semester exam)

Text Book

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

**References:**

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

2.Introductory Methods of Numerical Analysis by S.S. Sastry, (6th 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), 6$^{th}$ edition.

**Co-Curricular Activities:**

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

BLUE PRINT FOR QUESTION PAPER PATTERN
SEMESTER-III : PAPER-MAJORVI

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | The calculus of finite differences | 2 | 1 | 20 |
| II | Interpolation with Equal and Unequal intervals | 2 | 2 | 30 |
| III | Central Difference Interpolation formulae | 1 | 1 | 15 |
| IV | Solution of Algebraic and Transcendental equation | 1 | 1 | 15 |
| V | Curve fitting | 1 | 1 | 15 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20

Essay questions : 3X10 = 30

……………….

Total Marks = 50

…………

**Pithapur Rajah's Government College (Autonomous), Kakinada**

**II year B.Sc., Degree Examinations - III Semester**

**Course: Major VI: NUMERICAL METHODS & PROBLEM SOLVING SESSION**

**Model Paper (w.e.f. 2025-26)**

……………………………………………………………………………………………………

**Time: 2Hrs** **Max. Marks: 50**

## SECTION-A

**Answer Any Three Questions, Selecting At Least One Question from Each Part.**

**Part – A** **3 X 10 = 30 M**

1. Essay question from unit - I.
2. Essay question from unit – II.
3. Essay question from unit – II.

Part – B

4. Essay question from unit - III.
5. Essay question from unit - IV.
6. Essay question from unit - V.

## SECTION-B

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from unit – I.
8. Short answer question from unit – I.
9. Short answer question from unit – II.
10. Short answer question from unit – II.
11. Short answer question from unit - III.
12. Short answer question from unit - IV.
13. Short answer question from unit – V.

***

P.R. GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA
DEPARTMENT OF MATHEMATICS
Question Bank for
PAPER–:MAJOR VI - NUMERICAL METHODS
Short Answer Questions
Unit-I

1. Prove that i) $\Delta = E - 1$ ii) $\nabla = 1 - E^{-1}$
2. Prove that i) $(1 + \Delta)(1 - \nabla) = 1$ ii) $E\nabla = \Delta$ iii) $\Delta - \nabla = \Delta\nabla$
3. Prove that (i) $\mu^2 = 1 + \frac{\delta^2}{4}$, (ii) $\Delta = \frac{\delta^2}{2} + \delta\sqrt{1 + \frac{\delta^2}{4}}$
4. Prove that i) $u_3 = u_2 + \Delta u_1 + \Delta^2 u_0 + \Delta^3 u_0$ ii) $u_4 = u_3 + \Delta u_2 + \Delta^2 u_1 + \Delta^3 u_1$
5. Given $y_0 = 3$, $y_1 = 12$, $y_2 = 81$, $y_3 = 200$, $y_4 = 100$. Find $\Delta^4 y_0$ without forming difference table.
6. Find the missing term in the following data.

| x | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| y | 1 | 3 | 9 | ? | 81 |

**UNIT - II**

7. Compute f(1.1) from the following data.

| x | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| f(x) | 7 | 12 | 29 | 64 | 123 |

8. From the following table find y value at x = 0.26

| x | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 |
|---|---|---|---|---|---|
| y = Tanx | 0.1003 | 0.1511 | 0.2027 | 0.2553 | 0.3093 |

9. Show that $f(x_0, x_1, x_2, \ldots, x_n) = \frac{\Delta^n f(x_0)}{n!h^n}$.
10. Find the third divided difference with arguments 2 , 4 , 9 , 10 of the function $f(x) = x^3 - 2x$.
11. By Lagrange's interpolation formula , find the value of y at x = 5 , given that

| x | 1 | 3 | 4 | 8 | 10 |
|---|---|---|---|---|---|
| f( x) | 8 | 15 | 19 | 32 | 40 |

12. Using Lagrange's interpolation formula , prove that
$$y_0 = \frac{1}{2}(y_1 + y_{-1}) - \frac{1}{8}\left[\frac{1}{2}(y_3 - y_1) - \frac{1}{2}(y_{-1} - y_{-3})\right]$$

UNIT - III

13. Using Gauss forward formula find $u_{30}$ from the given data $u_{21} = 18.4708$, $u_{25} = 17.8144$, $u_{29} = 17.1070$, $u_{33} = 16.3432$, $u_{37} = 15.5154$.
14. Given that $\sqrt{12500} = 111.803399$, $\sqrt{12510} = 111.848111$, $\sqrt{12520} = 111.892806$, $\sqrt{12530} = 111.937483$, show $\sqrt{12516} = 111.8749301$ by using Gauss backward interpolation formula.

15. State and prove Stitling’s formula
16. Apply Stirling’s formula to find $y_{28}$ given that $y_{20}$=49225, $y_{25} = 48316$, $y_{30} = 47236$, $y_{35} = 45926$, $y_{40} = 44300$.
17. Given $y_{20} = 24$ , $y_{24} = 32$ , $y_{28} = 35$ , $y_{32} = 40$ , find $y_{25}$ by Bessel’s formula .

**Unit - IV**

18. Find a real root of the equation $x^3 - 6x - 4 = 0$ by bisection method.
19. Find a real root of the equation $x^3 - x - 1 = 0$ by bisection method.
20. Find the root of the equation $x^3 + x^2 - 1 = 0$ by iteration method.
21. Find the square root of 2.
22. Find a real root of the equation $x = e^{-x}$ , using the Newton – Raphson method

**UNIT - V**

23. Obtain the normal equations to the least square line y = a + bx .
24. Find the least square line y = a + bx and y(5) for the data.

| x | 0 | 2 | 5 | 7 |
|---|---|---|---|---|
| y | -1 | 5 | 12 | 20 |

25. Find the least square line For the data points (-1, 10), (0, 9), (1, 7), (2, 5), (3, 4), (4, 3), (5, 0) and (6, -1).
26. Fit a polynomial of the second degree to the data points

| x | 0 | 1 | 2 |
|---|---|---|---|
| y | 1 | 6 | 17 |

27. Fit the exponential curve $y = ae^{bx}$ to the following data.

| x | 2 | 4 | 6 | 8 |
|---|---|---|---|---|
| y | 25 | 38 | 56 | 84 |

**UNIT - I**

1. State and prove fundamental theorem of Difference calculus.
2. Show that $\Delta^n \cos(ax + b) = (2sin\frac{ah}{2})^n \cos\left[a + bx + n\left(\frac{ah+\pi}{2}\right)\right]$
3. Obtain the estimate of the missing terms in the following data.

| x | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| f(x) | 1 | 8 | ? | 64 | ? | 216 | 343 | 512 |

4. Prove that $\Delta^n x^{(n)} = n!\, h^n \; and \; \Delta^{n+1} x^{(n)} = 0$

**UNIT - II**

5. State and prove Newton’s – Gregory formula for forward interpolation with equal intervals .
6. The area of a circle of diameter d is given for the following values , find the approximate value for the area of a circle of diameter 82 .

| d(Diameter) | 80 | 85 | 90 | 95 | 100 |
|---|---|---|---|---|---|
| A(Area) | 5026 | 5674 | 6362 | 7088 | 7854 |

7. From the following table , find the number of students who obtain less than 56 marks .

| Marks | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 |
|---|---|---|---|---|---|
| No.of students | 31 | 42 | 51 | 35 | 31 |

8. Given

| x | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| f(x) | 1 | 8 | 27 | 64 | 125 | 216 | 343 | 512 |

Find f(7.5)

9. The population of a country in the decennial census were as under . Estimate the population for the year 1925 .

| Year(x) | 1891 | 1901 | 1911 | 1921 | 1931 |
|---|---|---|---|---|---|
| Population(y) (in thousands) | 46 | 66 | 81 | 93 | 101 |

10. State and prove Netown's divided difference formula .
11. By means of Newton's divided difference formula, find the values of $f(8), f(15)$ from the following table.

| $x$ | 4 | 5 | 7 | 10 | 11 | 13 |
|---|---|---|---|---|---|---|
| $f(x)$ | 48 | 100 | 294 | 900 | 1210 | 2028 |

## UNIT - III

12. Using Gauss forward formula find $u_{32}$ from the given data $u_{20} = 14.035$ , $u_{25} = 13.674$ ,$u_{30} = 13.257$ , $u_{35} = 12.734$ , $u_{40} = 12.089$ , $u_{45} = 11.309$ .
13. Apply Gauss forward formula to find the value of $u_9$ if $u_0 = 14$ , $u_4 = 24$ , $u_8 = 32$ , $u_{16} = 40$ .
14. Interpolate by means of Gauss backward interpolation formula the sales for the concern for the year 1936, given that

| $year$ | 1901 | 1911 | 1921 | 1931 | 1941 | 1951 |
|---|---|---|---|---|---|---|
| $sales(in\ thousands)$ | 12 | 15 | 20 | 27 | 39 | 52 |

15. Apply Stirling's formula to find a polynomial of degree four which takes

| x | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| y | 1 | -1 | 1 | -1 | 1 |

16. Apply Bessel's formula to obtain find $y_{25}$ given that $y_{20}$=2854, $y_{24} = 3162$, $y_{28} = 3544$, $y_{32} = 3992$.

## UNIT - V

17. Find a real root of the equation $f(x) = x^3 - 2x - 5 = 0$ by the method of false position up to three places of decimals.
18. Find a real root of the equation $x^3 - x - 4 = 0$ correct to three decimal places by the method of Regula - False position.
19. Find a real root of the equation $\cos x = 3x - 1$, correct to three decimal places, using iteration method.
20. Solve $x = 0.21 \sin(0.5 + x)$ by iteration method starting with $x = 0.12$.
21. Find the real root of the equation $x^2 - 5x + 2 = 0$ by Newton- Raphson's method.
22. Using Newton -Raphson method, establish the iterative formula to calculate the cube root of N and hence find the cube root of 12.

## UNIT - V

23. Obtain the normal equations to the parabola $y = a + bx + cx^2$ by using least square method.
24. Fit a second-degree parabola to the following data.

| x | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| y | 1 | 5 | 10 | 22 | 38 |

25. Determine the constants a and b by the least squares method such that $y = ae^{bx}$, fits the following data.

| x | 1.0 | 1.2 | 1.4 | 1.6 |
|---|---|---|---|---|
| y | 40.170 | 73.196 | 133.372 | 243.02 |

26. Fit a curve of the form $y = ax^b$ to the following data.

| x | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|
| y | 0.973 | 3.839 | 8.641 | 15.987 | 23.794 |

27. Fit a curve of the form $y = ab^x$ to the following data.

| x | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| y | 4 | 11 | 35 | 100 |

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<table>
<tr><td></td><td>P.R.Government College (Autonomous)<br>KAKINADA</td><td colspan="4" rowspan="2">Program&Semester<br>II B.Sc Major<br>(III Sem)<br>w.e.f 2025-26 admitted batch</td></tr>
<tr><td>Course Code<br>MAT-302 P</td><td>TITLEOFTHECOURSE<br>Numerical Methods &Problem Solving Sessions Practical Course</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:30(Practicals)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Advanced Calculus, Linear Algebra and Differential Equations</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

**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.

**Additional Inputs:** Ramanujan's Method

Text Book

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

**References:**

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

2.Introductory Methods of Numerical Analysis by S.S. Sastry, (6th 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.

**Semester – III End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

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**COURSE-VI - NUMERICAL METHODS**

| **Unit** | **TOPIC** | **E.Q** | **Marks allotted to the Unit** |
|---|---|---|---|
| I | The calculus of finite differences | 2 | 06 |
| II | Interpolation with Equal and Unequal intervals | 2 | 12 |
| III | Central Difference Interpolation formulae | 1 | 12 |
| IV | Solution of Algebraic and Transcendental equation | 2 | 06 |
| V | Curve Fitting | 1 | 12 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations - III Semester**
**Mathematics Course-VI: NUMERICAL METHODS**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

……………………………………………………………………………………………………………

**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – IV.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | P.R.Government College (Autonomous) KAKINADA | Program&Semester | | | |
|---|---|---|---|---|---|
| CourseCode<br>MAT- 303 T | TITLEOFTHECOURSE<br>**Laplace Transforms & Problem Solving Sessions** | II B.Sc. Major (III Sem) w.e.f 2025-26 admitted batch | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Knowledge of Calculus, specifically integration and differentiation and an understanding of Complex numbers. | 3 | - | - | 3 |

Course Objectives:

To formalise the study of numbers and functions and to investigate important concepts such as limits and continuity. These concepts underpin calculus and its applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Understand the definition and properties of Laplace transformations. |
| CO2 | Get an idea about first and second shifting theorems and change of scale property. |
| CO3 | Understand Laplace transforms of standard functions like Bessel, Error function etc |
| CO4 | Know the reverse transformation of Laplace and properties. |
| CO5 | Get the knowledge of application of convolution theorem. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**UNIT I**

**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 II:

**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 III**:

**LAPLACE TRNASFORM – III**

Laplace Transform of Integrals - Multiplication by t, Multiplication by tn - division by t -Laplace transform of Bessel Function - Laplace Transform of Error Function – Laplace transform of Sine and Cosine integrals.

**UNIT IV:**

**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 V:**

**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 its Applications.

**Co-Curricular 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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SEMESTER-III

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | LAPLACE TRANSFORMS – I | 1 | 1 | 15 |
| II | LAPLACE TRANSFORMS – II | 2 | 2 | 30 |
| III | LAPLACE TRNASFORM – III | 2 | 1 | 20 |
| IV | INVERSE LAPLACE TRANSFORMS – I | 1 | 1 | 15 |
| V | INVERSE LAPLACE TRANSFORMS – II | 1 | 1 | 15 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

……………….

Total Marks = 50 M

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**Pithapur Rajah's Government College (Autonomous), Kakinada**

**II year B.Sc., Degree Examinations - III Semester**

**Mathematics Course VII: LAPLACE TRANSFORMS**

**Model Paper (w.e.f. 2025-26)**

………………………………………………………………………………………………………..

**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer any three questions selecting atleast one question from each part**

**Part – A** **3 X 10 = 30**

1. Essay question from unit - I.
2. Essay question from unit - II.
3. Essay question from unit - II.

**Part – B**

4. Essay question from unit - III.
5. Essay question from unit - IV.
6. Essay question from unit - V.

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from unit – I.
8. Short answer question from unit - II.
9. Short answer question from unit – II.
10. Short answer question from unit - III .
11. Short answer question from unit – III.
12. Short answer question from unit – IV.
13. Short answer question from unit - V

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A), KAKINADA**
**DEPARTMENT OF MATHEMATICS**

# Question Bank

**PAPER–VII : LAPLACE TRANSFORMS**

## Short answers

### Unit - I

1. Find the Laplace transform of $(t^2 + 1)^2$
2. Find the Laplace transform of $e^{2t} + 4t^3 - 2\ sin3t + 3\ cos3t$
3. Find $L\{7e^{2t} + 9e^{-2t} + 5\ cost + 7t^3 + 5\ sin3t + 2\}$
4. Find the Laplace transform of F(t), where $F(t) = \begin{cases} e^{t-a}, t > a \\ 0, t < a \end{cases}$
5. Prove that the function F(t) = $t^2$ is of exponential order 3.

### Unit - II

6. Find the Laplace transform of $e^{-t}(3\ sin2t - 5 \cosh 2t)$.
7. Find $L\{(t + 3)^2 e^t\}$
8. Find $L\{(1 + te^{-t})^3\}$
9. Find the Laplace transform of G(t), where $G(t) = \begin{cases} \cos\left(t - \frac{\pi}{3}\right), t > \frac{\pi}{3} \\ 0, t < \frac{\pi}{3} \end{cases}$
10. Find the Laplace transform of $e^{-3t}u(t - 2)$
11. State and prove Change of Scale property.
12. Apply change of scale property, if $L\{F(t)\} = \frac{p^2-p-1}{(2p+1)^2(p-1)}$
13. If $L\{sin\sqrt{t}\} = \frac{\sqrt{\pi}}{2p^{\frac{3}{2}}} e^{\frac{-1}{4p}}, find\ L\left\{\frac{cos\sqrt{t}}{\sqrt{t}}\right\}$

### Unit – III

14. Find $L\left\{\int_0^t e^{-t} cost\ dt\right\}$
15. Find $L\left\{\int_0^t \int_0^t \cosh au\ \ du\ \ du\right\}$
16. Evaluate $L\{\sin at - at \cos at\}$
17. Find $l\{\ te^{3t} \sin 2t\ \}$
18. Find the Laplace transform of $\frac{e^{-at}-e^{-bt}}{t}$
19. Find the Laplace transform of $\frac{\sin at}{t}$
20. Show that $L\left\{\frac{\cosh at}{t}\right\}$ does not exists.
21. Prove that $L\{J_1(t)\} = 1 - \frac{p}{\sqrt{p^2+1}}$

### Unit – IV

22. State and prove second shifting theorem
23. State and prove change of scale property.
24. Find $L^{-1}\left\{\frac{3p-2}{\frac{5}{p^2}} - \frac{7}{3p+2}\right\}$

25. Find $L^{-1}\left\{\frac{1}{(p+1)(p-2)}\right\}$

26. Prove that $L^{-1}\left\{\frac{p^2}{(p+2)^3}\right\} = e^{-2t}(1-4t+2t^2)$

27. Find $L^{-1}\left\{\frac{e^{-5p}}{(p-2)^4}\right\}$

28. If $L^{-1}\left\{\frac{p}{(p^2+1)^2}\right\} = \frac{1}{2} t \sin t$ find $L^{-1}\left\{\frac{8p}{(4p^2+1)^2}\right\}$

## Unit – V

29. Evaluate $L^{-1}\left\{\frac{p}{(p^2+a^2)^2}\right\}$
30. Evaluate $L^{-1}\left\{\frac{p}{(p^2-a^2)^2}\right\}$
31. Evaluate $L^{-1}\left\{\frac{p}{(p^2-a^2)}\right\}$
32. Find $L^{-1}\left\{\frac{1}{p}\log\left(\frac{p+2}{p+1}\right)\right\}$
33. Find the inverse Laplace transforms of $\frac{1}{p^3(p^2+1)}$

## Essay Questions

## UNIT - I

1. Find the Laplace transform of F(t) = | t – 1 | + | t + 1 |, t □ 0.
2. Find the Laplace Transform of $(\sin t - \cos t)^3$.
3. Obtain the Laplace transform the function $F(t) = \begin{cases} (t-1)^2, t > 1 \\ 0, 0 < t < 1 \end{cases}$
4. Find the Laplace Transform of $F(t) = \begin{cases} 0,\ t > \pi \\ \sin t, 0 < t < \pi \end{cases}$
5. Using the expansion $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$, show that $L(sin\sqrt{t}) = \frac{\sqrt{\pi}}{2p^{\frac{3}{2}}} e^{\frac{-1}{4p}}$

## UNIT - II

6. State and prove First Shifting theorem.

7. State and prove Second Shifting theorem.

8. Find $L\{\sinh at \cos at\}$

9. Prove that $L\{ F^{(n)}(t) \} = p^n f(p) - p^{n-1}F(0) - p^{n-2}F^1(0) - ..- F^{(n-1)}(0)$.
10. State and prove Initial Value theorem.

11. State and prove Final value theorem.

12. Show that $L\{t \sin at\} = \left\{\frac{2ap}{(p^2+a^2)^2}\right\}$ $and$ $L\{t \cos at\} = \left\{\frac{p^2-a^2}{(p^2+a^2)^2}\right\}$

13. If $L\{t \sin at\} = \left\{\frac{2ap}{(p^2+a^2)^2}\right\}$, then prove that $L\{\sin at + at \cos at\} = \left\{\frac{2ap}{(p^2+a^2)^2}\right\}$

## UNIT - III

14. Find $L\{(t^2 - 3t + 2) \sin 3t\}$

15. Find $L\left\{\frac{\cos 2t - \cos 3t}{t}\right\}$

16. Using Laplace transform , evaluate $\int_0^\infty \frac{\cos at - \cos bt}{t} dt$

17. Find $L\{erf\sqrt{t}\}$ and hence prove that $L\{t\ \mathrm{erf}(2\sqrt{t})\} = \frac{3p+8}{p^2(p+4)^{\frac{3}{2}}}$

18. Prove that $L\{J_0(t)\} = \frac{1}{\sqrt{p^2+1}}$

19. Find the Laplace transform of $S_i(t)$.

20. Find the Laplace transform of $C_i(t)$.

**UNIT - IV**

21. Find $L^{-1}\left\{\frac{3}{p^2-3} - \frac{3p+2}{p^3} - \frac{3p-27}{p^2+9} + \frac{6-30\sqrt{p}}{p^4}\right\}$

22. Find $L^{-1}\left\{\frac{3p+1}{(p-1)(p^2+1)}\right\}$

23. Find the inverse Laplace transform of $\left\{\frac{4p+5}{(p-1)^2(p+2)}\right\}$

24. Find $L^{-1}\left\{\frac{e^{-\pi p}(p+1)}{p^2+p+1}\right\}$

25. For a □ 0, prove that $L^{-1}\{f(p)\} = F(t)\ implies\ that\ L^{-1}\{f(ap+b)\} = \frac{1}{a}e^{\frac{-bt}{a}}F\left(\frac{t}{a}\right)$

**UNIT - IV**

26. Find $L^{-1}\left\{\frac{p-3}{p^2+4p+13}\right\}$

27. Using Convolution theorem, find $L^{-1}\left\{\frac{p}{(p^2+a^2)^2}\right\}$

28. Using Convolution theorem, find $L^{-1}\left\{\frac{p+1}{(p^2+2p+2)^2}\right\}$

29. Apply Heaviside's expansion formula to find $L^{-1}\left\{\frac{6p^2+22p+18}{p^3+6p^2+11p+6}\right\}$

30. Using Heaviside's expansion formula, find $L^{-1}\left\{\frac{3p+1}{(p-1)(p^2+1)}\right\}$

***

<table>
<tr><td rowspan="1"></td><td>P.R.Government College<br>(Autonomous)<br>KAKINADA</td><td colspan="4" rowspan="2">Program&Semester<br><br>II B.Sc. Major<br>(III Sem)<br>w.e.f 2025-26 admitted batch</td></tr>
<tr><td>CourseCode<br><br>MAT- 303 P</td><td>TITLEOFTHECOURSE<br><br>Laplace Transforms & Problem Solving Sessions</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:30(Practical)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Knowledge of Calculus, specifically integration and differentiation and an understanding of Complex numbers.</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

**UNIT I**

**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 II:

**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 III**:

**LAPLACE TRNASFORM – III**

Laplace Transform of Integrals - Multiplication by t, Multiplication by tn - division by t -Laplace transform of Bessel Function - Laplace Transform of Error Function – Laplace transform of Sine and Cosine integrals.

**UNIT IV:**

**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 V:**

**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 its Applications.

**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.

**Semester – III End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-VII - LAPLACE TRANSFORMS**

| Unit | TOPIC | E.Q | Marks allotted to the Unit |
|---|---|---|---|
| I | LAPLACE TRANSFORMS – I | 2 | 12 |
| II | LAPLACE TRANSFORMS – II | 2 | 12 |
| III | LAPLACE TRNASFORM – III | 1 | 06 |
| IV | INVERSE LAPLACE TRANSFORMS – I | 2 | 12 |
| V | INVERSE LAPLACE TRANSFORMS – II | 1 | 06 |
| | **Total** | 08 | 48 |

**PITHAPUR GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations - III Semester**
**Mathematics Course-VII: LAPLACE TRANSFORMS**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

……………………………………………………………………………………………………………

**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – IV.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | P.R.Government College (Autonomous) KAKINADA | Program&Semester<br>II B.Sc. Major (III Sem)<br>w.e.f 2025-26 admitted batch | | | |
|---|---|---|---|---|---|
| Course Code<br>MAT- 304 T | TITLEOFTHECOURSE<br>**SPECIAL FUNCTIONS & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Multivariable calculus and Differential Equations | 3 | - | - | 3 |

Course Objectives:

To formalise the study of numbers and functions and to investigate important concepts such as limits and continuity. These concepts underpin calculus and its applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Understand the Beta and Gamma functions, their properties and relation between these two functions, understand the orthogonal properties of Chebyshev polynomials and recurrence relations. |
| CO2 | Find power series solutions of ordinary differential equations |
| CO3 | Solve Hermite equation and write the Hermite Polynomial of order (degree) n, also |
| CO4 | 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. |
| CO5 | 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 with focus on employability/entrepreneurship /Skill Development modules**

| Skill Development | | | Employability | | | Entrepreneurship | |
|---|---|---|---|---|---|---|---|

**UNIT I**

**Beta and Gamma functions, Chebyshev polynomials**

Euler's Integrals-Beta and Gamma Functions, Elementary properties of Gamma Functions, Transformation of Gamma Functions.

Another form of Beta Function, Relation between Beta and Gamma Functions.

Chebyshev polynomials, orthogonal properties of Chebyshev polynomials, recurrence relations, generating functions for Chebyshev polynomials.

**UNIT II:**

**Power series and Power series solutions of ordinary differential equations.**

Introduction, summary of useful results, power series, radius of convergence, theorems on Power series
Introduction of power series solutions of ordinary differential equation Ordinary and singular points, regular and irregular singular points, power series solution.

**UNIT III**:

**Hermite polynomials**

Hermite Differential Equations, Solution of Hermite Equation, Hermite polynomials, generating function for Hermite polynomials. Other forms for Hermite Polynomials, Rodrigues formula for Hermite Polynomials, to find first few Hermite Polynomials. Orthogonal properties of Hermite Polynomials, Recurrence formulae for Hermite Polynomials.

**UNIT IV:**

**Legendre polynomials**

1. Definition, Solution of Legendre's equation, Legendre polynomial of degree n, generating function of Legendre polynomials. ,

2. Definition of $P_n(x)$ and $Q_n(x)$, General solution of Legendre's Equation (derivations not required )to show that $P_n(x)$ is the coefficient of $h^n$ , in the expansion of $(1 - 2xh + h^2)^{-1/2}$

3. Orthogonal properties of Legendre's polynomials, Recurrence formulas for Legendre's Polynomials.

**UNIT V:**

**Bessel's equation**

1. Definition, Solution of Bessel's equation, Bessel's function of the first kind of order n, Bessel's function of the second kind of order n.

2. Integration of Bessel's equation in series form=0, Definitionof $J_n(x)$, recurrence formulae for $J_n(x)$. 3. Generating function for $J_n(x)$, orthogonally of Bessel functions.

**Co-Curricular 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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SEMESTER-III

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | Beta and Gamma functions, Chebyshev polynomials. | 2 | 2 | 30 |
| II | Power series and Power series solutions of ordinary differential equations. | 2 | 1 | 20 |
| III | Hermite polynomials | 1 | 1 | 15 |
| IV | Legendre polynomials | 1 | 1 | 15 |
| V | Bessel's equation | 1 | 1 | 15 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

……………….

Total Marks = 50 M

………………..

**Pithapur Rajah's Government College (Autonomous), Kakinada**
**II year B.Sc., Degree Examinations - III Semester**
**Mathematics Course VIII: SPECIAL FUNCTIONS**
**Model Paper (w.e.f. 2025-26)**

……………………………………………………………………………………………………..

**Time: 2Hrs** **Max. Marks: 50**

## SECTION-A

**Answer any three questions selecting atleast one question from each part**

**Part – A** **3 X 10 = 30**

1. Essay question from unit - I.
2. Essay question from unit - I.
3. Essay question from unit - II.

**Part – B**

4. Essay question from unit - III.
5. Essay question from unit - IV.
6. Essay question from unit - V.

## SECTION-B

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from unit – I.
8. Short answer question from unit - I.
9. Short answer question from unit – II.
10. Short answer question from unit - II .
11. Short answer question from unit – III.
12. Short answer question from unit – IV.
13. Short answer question from unit - V

**P. R. GOVERNMENT COLLEGE (AUTOMONOUS), KAKINADA**

**II B.SC MATHEMATICS MAJOR – III SEMESTER**

# Mathematics Course VIII: SPECIAL FUNCTIONS

**QUESTION BANK**

**Short Answer questions**

**Unit - I**

1. Prove that $\int_0^1 x^m (\log x)^n dx = \frac{(-1)^n n!}{(m+1)^{n+1}}$
2. Evaluate $\int_0^1 \frac{dx}{\sqrt{-log_e x}}$
3. Prove that $\Gamma(n) = \frac{1}{n}\int_0^\infty e^{-y^{1/n}} dy$ *and hence show that* $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$
4. Prove that $\Gamma(n)\Gamma(1-n) = \frac{\pi}{\sin n\pi}$
5. Prove that $(1 - x^2)T^1_n(x) = - n\, x\, T_n(x) + n\, T_{n-1}(x)$
6. Prove that $U_{n+1}(x) - 2x\, U_n(x) + U_{n-1}(x) = 0$
7. Find the first four Chebyshev polynomials.
8. Prove that $T_n(-1) = (-1)^n$ and $U_n(-1) = 0$

**Unit – II**

9. If the power series $\sum a_n x^n$ is such that $a_n \neq 0$ for all n and $\lim_{n\to\infty} | \frac{a_{n+1}}{a_n} | = \frac{1}{R}$ then $\sum a_n x^n$ is convergent for $|x| < R$ and divergent for $|x| > R$ .
10. Find the radius of convergence of the series $\frac{x}{2} + \frac{1.3}{2.5}x^2 + \frac{1.3.5}{2.5.8}x^3 + \cdots$
11. Find the radius of the convergence of the series $\sum(-1)^n \frac{x^{2n+1}}{(2n+1)!}$
12. Determine whether x = 0 is an ordinary point or a regular singular point of the differential equation $2x^2\left(\frac{d^2y}{dx^2}\right) + 7x(x+1)\frac{dy}{dx} - 3y = 0.$
13. Show that x = 0 and x = -1 are singular points of $x^2(x+1)^2y'' + (x^2-1)y' + 2y = 0$ where the first is irregular and the other is regular.
14. Solve by power series method $y' - y = 0$ .

**Unit - III**

15. Prove that $H_{2n}(0) = (-1)^n \frac{(2n)!}{n!}$ *and* $H_{2n+1}(0) = 0.$
16. Find Hermit Polynomials for n=0, 1, 2, 3, 4 .
17. Prove that $H_n'' = 4n(n-1)H_{n-2}$
18. Prove that $H_n'(x) = 2xH_n(x) - H_{n+1}(x)$
19. Prove that $H_n(-x) = (-1)^n H_n(x)$ .
20. Prove that, if $m < n,\ \frac{d^m}{dx^m}\{H_n(x)\} = \frac{2^m n!}{(n-m)!}H_{n-m}(x).$

**Unit - IV**

21. Prove that $P_n(-x) = (-1)^n P_n(x)$ *and hence deduce that* $P_n(-1) = (-1)^n$
22. Prove that $P_n' = \frac{n(n+1)}{2}$
23. Prove that $(2n+1)P_n = P_{n+1}' - P_{n-1}'.$
24. Prove that $xP_n' - P_{n-1}' = nP_n.$
25. Prove that $(n+1)P_n = P_{n+1}' - xP_n'.$
26. Prove that $(1-x^2)P_n' = n(P_{n-1} - xP_n).$
27. Prove that $P_3(x) = \frac{1}{2}(5x^3 - 3x).$

## Unit – V

28. Prove that, when $n$ is a positive integer $J_{-n}(x) = (-1)^n J_n(x)$.

39. Show that $J_n(-x) = (-1)^n J_n(x)$ for positive or negative integers.

30. Prove that $J_n(x) = \frac{x}{2n}[J_{n-1}(x) + J_{n+1}(x)]$

31. Prove that $\frac{d}{dx}[x^{-n}J_n(x)] = -x^{-n}J_{n+1}(x)$

32. Prove that $J_0(x) = \frac{1}{\pi}\int_0^{\pi} \cos(x\, sin\theta)\, d\theta$

33. Show that $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}} \sin x$.

34. Show that $\int_0^{\infty} e^{-ax} J_0(bx)dx = \frac{1}{\sqrt{(a^2+b^2)}}$ , $a > 0$

## Essay Questions

## Unit –I

1. When n is a positive integer, prove that $\Gamma\left(-n + \frac{1}{2}\right) = \frac{(-1)^n 2^n \sqrt{\pi}}{1.3.5.....(2n-1)}$

2. Prove that $\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$

3. Prove that $\int_0^{\pi/2} sin^{2l-1}\,\theta . cos^{2m-1}\theta\; d\theta = \frac{\Gamma(l)\Gamma(m)}{2\Gamma(l+m)}$.

4.State and prove orthogonal properties of Chebyshev polynomials.

5. prove that $T_n(x)$ and $U_n(x)$ are independent solution of Chebyshev's differential equation.

6. Show that $\frac{1}{\sqrt{1-x^2}} U_n(x)$ satisfies the differential equation $(1 - x^2)\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + (n^2 - 1)y = 0$.

## Unit – II

1. If the power series $\sum a_n x^n$ is such that $a_n \neq 0$ for all n and $\lim_{n\to\infty} |a_n|^{\frac{1}{n}} = \frac{1}{R}$ then $\sum a_n x^n$ is convergent for $|x| < R$ and divergent for $|x| > R$ .

2. Find the radius of convergence the exact interval of convergence of the power series $\sum \frac{(n+1)}{(n+2)(n+3)} x^n$

3. Determine the interval of convergence of the power series $\sum\{\frac{1}{n}(-1)^{n+1}(x - 1)^n\}$

4. Find the power series solution of the equation $(x^2 + 1)y'' + xy' - xy = 0$ in powers of x.

5. Find the solution in series of $\left(\frac{d^2y}{dx^2}\right) + x\left(\frac{dy}{dx}\right) + x^2y = 0$ about x = 0 .

6. Find the general solution of $y'' + (x - 3)y' + y = 0$ near x = 2 .

## Unit – III

1. State and Prove generating function of the Hermit's polynomial.

2. State and Prove Rodrigues formula for $H_n(x)$.

3. State and Prove Orthogonal Properties of Hermite Polynomials.

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

5. Prove that $H_n'(x) = 2nH_{n-1}(x) \quad n \geq 1$ and $H_0'(x) = 0$.

6. Prove that $H_n(x) = (-1)^n e^{x^2} \frac{d^n}{dx^n}\left(e^{-x^2}\right)$

**Unit – IV**

1. Show that $P_n(x)$ is the coefficient of $h^n$ in the expansion of $(1-2xh+h^2)^{-1/2}$ in

   Ascending powers of h for | x | ≤ 1 and | h | < 1 .

2. Prove that $P_n(x) = \frac{1}{n!2^n} . \frac{d^n}{dx^n}(x^2-1)^n$.
3. Prove that $\int_{-1}^{1} [P_n(x)]^2 dx = \frac{2}{2n+1}$ .
4. Prove that $\int_{-1}^{1} P_m(x).P_n(x)dx = 0 \;\; if \; m \neq n$. and 2/(2n+1) if m = n .
5. Prove that $(2n+1)xP_n = (n+1)P_{n+1} + nP_{n-1}$
6. Prove that $\int_{-1}^{1} (x^2-1)P_{n+1}P_n' \, dx = \frac{2n(n+1)}{(2n+1)(2n+3)}$.

**Unit V**

1. Prove that when n is a positive integer, $J_n(x)$ is the coefficient of $z^n$ in the expansion of $e^{\frac{x\left(z-\frac{1}{z}\right)}{2}}$ in ascending and descending powers of $z$.

2. Prove that $xJ_n'(x) = nJ_n(x) - xJ_{n+1}(x)$.

3. Prove that $xJ_n'(x) = -nJ_n(x) + xJ_{n-1}(x)$.

4. Prove that $x^2 J''_n(x) = (n^2 - n - x^2)J_n(x) + xJ_{n+1}(x)$

5. Prove that $i) \frac{d}{dx}[x^n J_n(x)] = x^n J_{n-1}(x)$ $(ii) \frac{d}{dx}[x^{-n} J_n(x)] = -x^{-n} J_{n+1}(x)$ .

6. Prove that $\sqrt{\frac{\pi x}{2}} J_{3/2}(x) = \frac{1}{x} \sin x - \cos x$.

<table>
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<tr><td>Course Code<br><br>MAT- 304 P</td><td>TITLEOFTHECOURSE<br><br>Special Functions &Problem Solving Sessions Practical Course</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:30(Practical)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Multivariable calculus and Differential Equations</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

## UNIT I

**Beta and Gamma functions, Chebyshev polynomials**

Euler's Integrals-Beta and Gamma Functions, Elementary properties of Gamma Functions, Transformation of Gamma Functions.

Another form of Beta Function, Relation between Beta and Gamma Functions.

Chebyshev polynomials, orthogonal properties of Chebyshev polynomials, recurrence relations, generating functions for Chebyshev polynomials.

**UNIT II:**

**Power series and Power series solutions of ordinary differential equations.**

Introduction, summary of useful results, power series, radius of convergence, theorems on Power series Introduction of power series solutions of ordinary differential equation Ordinary and singular points, regular and irregular singular points, power series solution.

**UNIT III**:

**Hermite polynomials**

Hermite Differential Equations, Solution of Hermite Equation, Hermite polynomials, generating function for Hermite polynomials. Other forms for Hermite Polynomials, Rodrigues formula for Hermite Polynomials, to find first few Hermite Polynomials. Orthogonal properties of Hermite Polynomials, Recurrence formulae for Hermite Polynomials.

**UNIT IV:**

**Legendre polynomials**

1. Definition, Solution of Legendre's equation, Legendre polynomial of degree n, generating function of Legendre polynomials. ,
2. Definition of $P_n(x)$ and $Q_n(x)$, General solution of Legendre's Equation (derivations not required )to show that $P_n(x)$ is the coefficient of $h^n$ , in the expansion of $(1 - 2xh + h^2)^{-1/2}$
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**UNIT V:**

**Bessel's equation**

1. Definition, Solution of Bessel's equation, Bessel's function of the first kind of order n, Bessel's function of the second kind of order n.
2. Integration of Bessel's equation in series form=0, Definitionof $J_n(x)$, recurrence formulae for $J_n(x)$. 3. Generating function for $J_n(x)$, orthogonally of Bessel functions.

**TEXT BOOK:**

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**Semester – III End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-VIII - SPECIAL FUNCTIONS**

| Unit | TOPIC | E.Q | Marks allotted to the Unit |
|---|---|---|---|
| I | Beta and Gamma functions, Chebyshev polynomials. | 2 | 12 |
| II | Power series and Power series solutions of ordinary differential equations. | 2 | 12 |
| III | Hermite polynomials | 1 | 06 |
| IV | Legendre polynomials | 2 | 12 |
| V | Bessel's equation | 1 | 06 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVRENMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations - III Semester**
**Mathematics Course-VIII: SPECIAL FUNCTIONS**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

…………………………………………………………………………………………………………

**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – IV.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | P.R.Government College (Autonomous) KAKINADA | Program&Semester<br>II B.Sc.<br>Major & Minor<br>(IV Sem)<br>w.e.f 2025-26 admitted batch | | | |
|---|---|---|---|---|---|
| Course Code<br>MAT- 401 T | **TITLE OF THE COURSE**<br>**Ring Theory & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Basic set theory and Linear Algebra | 3 | - | - | 3 |

Course Objectives:

To formalise the study of numbers and functions and to investigate important concepts such as limits and continuity. These concepts underpin calculus and its applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Acquire the basic knowledge of rings, fields and integral domains. |
| CO2 | Get the knowledge of subrings and ideals. |
| CO3 | Construct composition tables for finite quotient rings. |
| CO4 | Study the homomorphisms and isomorphisms with applications. |
| CO5 | Get the idea of division algorithm of polynomials over a field. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Unit** | Skill Development | | | Employability | | | Entrepreneurship | | **– 1** |

**Rings and 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.

**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

**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.

**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 .

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

BLUE PRINT FOR QUESTION PAPER PATTERN
SEMESTER-IV

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | Rings and Fields | 1 | 1 | 15 |
| II | Sub Rings and Ideals | 2 | 1 | 20 |
| III | Principal Ideals and Quotient Rings | 1 | 1 | 15 |
| IV | Homomorphisms of Rings | 1 | 2 | 25 |
| V | Rings of Polynomials | 2 | 1 | 20 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

……………….

Total Marks = 50 M

………………..

**Pithapur Rajah's Government College (Autonomous), Kakinada**

**II year B.Sc., Degree Examinations - IV Semester**

**Mathematics Course: Major IX & Minor III : Ring Theory**

**Model Paper (w.e.f. 2025-26)**

…………………………………………………………………………………………………………..

**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer any three questions selecting atleast one question from each part**

**Part – A** **3 X 10 = 30**

1. Essay question from unit - I.
2. Essay question from unit - II.
3. Essay question from unit - III.

**Part – B**

4. Essay question from unit - IV.
5. Essay question from unit - IV.
6. Essay question from unit - V.

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from unit – I.
8. Short answer question from unit - II.
9. Short answer question from unit – II.
10. Short answer question from unit - III .
11. Short answer question from unit – IV.
12. Short answer question from unit – V.
13. Short answer question from unit - V

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE(A):: KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**Question Bank**

**PAPER–Major IX & Minor III : RING THEORY**

**Short Answer Questions**

**Unit – 1**

**Rings and Fields**

1. A commutative ring R is an integral domain if and only if the cancellation laws hold in R.
2. A division ring has no zero divisors.
3. Every field is an integral domain.
4. Give an example of a division ring which is not a field.
5. Prove that the characteristic of a Boolean ring is 2.

**Unit – II**

**Subrings and Ideals**

1. The intersection of two subrings of a ring R is a subring of R.
2. If R is a ring and C(R) = { x $\in$ R / xa = ax $\forall$ a $\in$ R } the prove that C (R) is a subring of R.
3. Prove that $S_1$ = {0, 3} and $S_2$ = {0, 2, 4} are subrings of $Z_6$ = {0, 1, 2, 3, 4, 5} with respect to addition and multiplication of residue classes. Also show that intersection is a subring but union need not be a subring.
4. A field has no proper ideals.
5. The intersection of two ideals of a ring R is an ideal of R.
6. Show that the set of matrices $\left\{ \begin{pmatrix} a & b \\ 0 & 0 \end{pmatrix} / a, b \in Z \right\}$ is a right ideal but not a left ideal of the ring R of 2 × 2 matrices over integers.
7. Define subring and Ideal of a ring. Give an example of a subring which is not an ideal.

**Unit – III**

**Principal ideals and Quotient rings**

1. Every field is a principal ideal ring.
2. If R/U is the quotient ring prove that i) R/U is commutative if R is commutative and ii) R/U has unity element if R has unity element.
3. If U is an ideal of the ring R and a, b $\in$ R then prove that a + U = b + U $\Leftrightarrow$ a – b $\in$ U.
4. If U = { 0, 3 } be an ideal of the ring $Z_6$ then write the quotient ring $Z_6$ / U.

**Unit – IV**

**Homomorphism of Rings**

1. Define a prime ideal and show that for an integral domain R, the null ideal is a prime ideal.
2. The homomorphic image of a ring is a ring.
3. If f is a homomorphism of a ring into a ring R' then Ker f is an ideal of R.
4. If f: R $\rightarrow$ $R^1$ be a homomorphism and U be an ideal of R then f(U) is an ideal of f ( R ).
5. If f: R $\rightarrow$ R is defined by f(x) = 2x, is f a homomorphism of rings? Give reason.

**Unit – V**

**Rings of Polynomials**

1. State and prove the Remainder theorem.
2. Find the sum and product of $f(x) = 7 + 9x + 5x^2 + 11x^3 - 2x^4$ and $g(x) = 3 - 2x + 7x^2 + 8x^3$ over the ring of integers. Also find their degrees.
3. Find the sum and product of $f(x) = 5 + 4x + 2x^2 + 2x^3$ and $g(x) = 1 + 4x + 5x^2 + 3x^3$ over the ring $Z_6$. Also find deg{f(x) + g(x)} and deg{f(x).g(x)}.

4. Let $Z_7 = \{0,1,2,3,4,5,6\}$ the set of all integers modulo 7. For $5 \in Z_7$ if $\phi_5 : Z_7[x] \rightarrow Z_7$ is an evaluation homomorphism find $\phi_7\{ (3 + 4x^2) (2 + x^3) (1 + 3x^2 + x^7) \}$.
5. Find the zeros of $f(x) = 1 + x^2 \in Z_5[x]$ in $Z_5$.
6. Find the factors of $x^4 + 4$ in $Z_5[x]$.
7. Prove that $f(x) = 25x^5 - 9x^4 + 3x^2 - 12 \in Z[x]$ is irreducible over Q.
8. Prove that $f(x) = x^4 - 22 x^2 + 1 \in Z[x]$ is irreducible over Q.

**Essay Questions**

**Unit – 1**

**Rings and Fields**

1. A finite integral domain is a field.
2. Prove that the set $\{ a + bi / a, b \in Z, i^2 = -1 \}$ of gaussian integers is an integral domain with respect to addition and multiplication of numbers. Is it a field?
3. Prove that $Q(\sqrt{2}) = \{ a + b\sqrt{2} / a. b \in Q \}$ is a field.
4. The characteristic of an integral domain is either a prime or zero.

**Unit – II**

**Subrings and Ideals**

1. Let S be a non-empty set of a ring R. Then S is a subring of R if and only if $a - b \in S$ and $ab \in S$ for all $a, b \in S$.
2. If $S_1$, $S_2$ are two subrings of a ring R then $S_1 \cup S_2$ is a subring of R if and only if one is containing to the other one.
3. If $U_1$, $U_2$ are two ideals of a ring R then $U_1 \cup U_2$ is an ideal of R if and only if one is containing to the other one.
4. If $U_1$, $U_2$ are two ideals of a ring R then $U_1 + U_2 = \{ x + y / x \in U_1, y \in U_2 \}$ is also an ideal of R.

**Unit – III**

**Principal ideals and Quotient rings**

1. The ring of integers is a principal ideal ring.
2. If R is a commutative ring with unit element and $a \in R$ then the set $U = \{ ra / r \in R \}$ is a principal ideal of R generated by the element 'a'.
3. If U is an ideal of a ring R then the set $R / U = \{ x + U / x \in R \}$ is a ring w.r.t the addition and multiplication of cosets defined by $( a + U ) + ( b + U ) = ( a + b ) + U$ and $( a + U ) . ( b + U ) = ab + U$ for $a + U, b + U \in R / U$.

**Unit – IV**

**Homomorphism of Rings**

1. An ideal U of a commutative ring R, is a prime ideal if and only if R / U is an integral domain.
2. In the ring Z of integers, the ideal generated by prime integer is a maximal ideal.
3. An ideal U of commutative ring R with unity is maximal if and only if the quotient ring R / U is a field.
4. If f is a homomorphism of a ring R into the ring $R'$ then f is an into isomorphism if and only if Ker f $= \{0\}$.
5. State and prove fundamental theorem of homomorphism.
6. Let $Z(\sqrt{2}) = \{m + n \sqrt{2} / m, n \in Z\}$ be a ring under addition and multiplication of numbers. Prove that $f : Z(\sqrt{2}) \rightarrow Z(\sqrt{2})$ defined by $f(m + n \sqrt{2}) = m - n \sqrt{2}$ for all $m + n\sqrt{2} \in Z(\sqrt{2})$.

## Unit – V
## Rings of Polynomials

1. If f(x), g(x) be two non-zero polynomials of R[x], where R is a ring.
   Then i) deg { f(x) + g(x) } $\leq$ max { deg f(x), deg g(x) } if f(x) + g(x) $\neq$ O(x)
   ii) deg { f(x) . g(x) } $\leq$ deg f(x) + deg g(x) if f(x).g(x) $\neq$ O(x) where O(x) is the zero polynomial.
2. State and prove the Division algorithm.
3. If F is a field then F[x] is a principal ideal domain.
4. If $f(x) = x^6 + 3x^5 + 4x^2 - 3x + 2$ and $g(x) = x^2 + 2x - 3$ are polynomials in $Z_7[x]$. Find q(x) and r(x) in f(x) = g(x) q(x) + r(x).

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<table>
<tr><td></td><td colspan="1">P.R.Government College (Autonomous)<br>KAKINADA</td><td colspan="4" rowspan="2">Program&Semester<br><br>II B.Sc.<br>Major & Minor<br>(IV Sem)<br>w.e.f 2025-26 admitted batch</td></tr>
<tr><td>Course Code<br><br>MAT- 401 P</td><td>TITLEOFTHECOURSE<br><br>Ring Theory & Problem Solving Sessions</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:30(Practical)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Basic set theory and Linear Algebra</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

**Unit – 1**

**Rings and 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.

**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.

**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.

**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 homomorphism -- The Division Algorithm in $F[x]$ – Irreducible Polynomials – Ideal Structure in $F[x]$.

**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

**Semester – IV End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-Major IX & Minor III - RING THEORY**

| **Unit** | **TOPIC** | **E.Q** | **Marks allotted to the Unit** |
|---|---|---|---|
| I | Rings and Fields | 2 | 12 |
| II | Sub Rings and Ideals | 2 | 12 |
| III | Principal Ideals and Quotient Rings | 1 | 06 |
| IV | Homomorphisms of Rings | 1 | 06 |
| V | Rings of Polynomials | 2 | 12 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations - IV Semester**
**Mathematics Course-Major IX & Minor III: RING THEORY**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

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**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – V.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | P.R.Government College (Autonomous) KAKINADA | Program&Semester II B.Sc. Major & Minor (IV Sem) w.e.f 2025-26 admitted batch | | | |
|---|---|---|---|---|---|
| Course Code MAT- 402 T | **TITLE OF THE COURSE** **Introduction to Real Analysis & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Knowledge of Multivariate Calculus and Linear Algebra | 3 | - | - | 3 |

Course Objectives:

To formalise the study of numbers and functions and to investigate important concepts such as limits and continuity. These concepts underpin calculus and its applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Get clear idea about the real numbers and real valued functions. |
| CO2 | Obtaintheskillsofanalysingtheconceptsandapplyingappropriatemethodsfortesting |
| CO3 | Test the continuity and differentiability and Riemann integration of a function. |
| CO4 | Know the geometrical interpretation of mean value theorems and the fundamental theorem of integral calculus |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**Unit – I**

**REAL NUMBERS, 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 -Sub sequences and the Bolzano-weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence.

**Unit – II**

**INFINITIE SERIES**

Introduction to series -convergence of series -Cauchy's general principle of convergence for series tests or convergence of series - Series of non-negative terms - P- test - Cauchy's nth root test -D'-Alembert's Test – Alternating Series–Leibnitz Test.

**Unit – III**

**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 IV:**

**DIFFERENTIATION ANDMEANVALUETHEORMS**

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

**Unit – V**

**RIEMANNINTEGRATION**

Riemann Integral - Riemann integral functions - Darboux theorem -Necessary and sufficient condition for R integrability - Properties of integrable functions - Fundamental theorem of integral calculus - Mean value Theorems.

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

BLUE PRINT FOR QUESTION PAPER PATTERN SEMESTER-IV

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | REAL NUMBERS, REAL SEQUENCES | 1 | 1 | 15 |
| II | INFINITIE SERIES | 2 | 2 | 30 |
| III | LIMITS & CONTINUITY | 2 | 1 | 20 |
| IV | DIFFERENTIATION AND MEAN VALUE THEORMS | 1 | 1 | 15 |
| V | RIEMANNINTEGRATION | 1 | 1 | 15 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

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Total Marks = 50 M

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**Pithapur Rajah's Government College (Autonomous), Kakinada**

**II year B.Sc., Degree Examinations - IV Semester**

**Mathematics Course: Major X & Minor IV: Introduction to Real Analysis**

**Model Paper (w.e.f. 2025-26)**

……………………………………………………………………………………………………..

**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer any three questions selecting atleast one question from each part**

**Part – A** **3 X 10 = 30 M**

1. Essay question from unit - I.
2. Essay question from unit - II.
3. Essay question from unit - II.

**Part – B**

4. Essay question from unit - III.
5. Essay question from unit - IV.
6. Essay question from unit - V.

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from unit – I.
8. Short answer question from unit - II.
9. Short answer question from unit – II.
10. Short answer question from unit - III .
11. Short answer question from unit – III.
12. Short answer question from unit – IV.
13. Short answer question from unit - V

**P.R. GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**DEPARTMENT OF MATHEMATICS**

# Question Bank

**PAPER–MAJOR X & MINOR IV: INTRODUCTION OF REAL ANALYSIS**

## Short Answer Questions

### UNIT-I

1. Show that every convergent sequence is bounded . Give an example to show the converse is not true .
2. Prove that $\lim \left[\frac{1}{(n+1)^2}+\frac{1}{(n+2)^2}+\cdots+\frac{1}{(n+n)^2}\right] = 0$
3. Show that $\lim_{n\to\infty}\left[\sqrt{\frac{1}{n^2+1}}+\sqrt{\frac{1}{n^2+2}}+\cdots+\sqrt{\frac{1}{n^2+n}}\right]=1.$
4. State and prove sandwich theorem .
5. Define a Cauchy's sequence . Prove that every convergent sequence is a Cauchy sequence
6. Prove that if $\{S_n\}$ is a Cauchy sequence, then $\{S_n\}$ is bounded.
7. Prove that every Cauchy's sequence is convergent.

### UNIT-II

8. If $\sum u_n$ convergence then show that lim $u_n$ = 0 . Is the converse true ? Justify your answer .
9. Test for convergence of $\sum\frac{1}{2^n+3^n}$
10. Test for convergence of $\sum\left(1+\frac{1}{n}\right)^{-n}$
11. Examine the convergence of $\sum_{n=1}^{\infty}(\sqrt{n^3+1}-\sqrt{n^3})$.
12. Test for convergence of $\sum_{n=1}^{\infty}(\sqrt{n^3+1}-\sqrt{n^3-1})$
13. Test the convergence of $\sum_{n=1}^{\infty}\frac{1}{n^3}\left(\frac{n+2}{n+3}\right)^n x^n,\ \forall\, x>0$
14. Test for convergence of $\sum_{n=1}^{\infty}\frac{n!}{n^n}$
15. Test for the convergence of $\sum_{n=1}^{\infty}\frac{1.3.5\ldots(2n-1)}{2.4.6\ldots2n}x^{n-1}\ (x>0)$.

### UNIT-III

16. If f: [a, b] → R is continuous on [a, b] then f is bounded on [a, b].
17. Examine the continuity of the function defined by f(x) = $|x|$ +$|x-1|$ at x = 0, 1.
18. Show that $f: R\to R$ defined by f(x) = 1 if x ∈ $Q$ ; f(x) = -1 if x ∈ $R-Q$ is discontinuous for all x ∈ $R$ .
19. Discuss the continuity of the following function at the origin $f(x)=x\left(\frac{e^{1/x}-1}{e^{1/x}+1}\right)$ $if\ x\neq 0$ and f(0)=0 .
20. Prove that the function defined by f(x) = $x^2$ sin(1/x) for x ≠ 0 and f(x) = 0 for x = 0 is continuous at x = 0.
21. Discuss the continuity of $f(x)=x\left(\frac{e^{1/x}}{e^{1/x}+1}\right)$ $if\ x\neq 0$ and f(0) = 0 at the origin.
22. From the definition prove that f(x) = $x^2$ is uniformly continuous on [-a, a].
23. From the definition show that f(x) = $x^2$ + 3x is uniformly continuous on [-1, 1]

## UNIT-IV

24. If $f:[a,b] \to R$ is derivable at $c \in [a,b]$, then prove that $f$ is continuous on $[a,b]$. Is its converse true? Justify your answer.

25. Find c of Cauchy's mean value theorem for $f(x) = \sqrt{x}, g(x) = \frac{1}{\sqrt{x}}$ in [a, b] where $0 < a < b$.

26. Verify Cauchy's mean value theorem for $f(x) = x^2$ , $g(x) = x^3$ in [1,2] .

27. Examine the applicability of Rolle's theorem for $f(x) = 1 - (x-1)^{2/3}$ on [0, 2].

28. Discuss the applicability of Rolle's theorem for the function $f(x) = log\frac{x^2+ab}{x(a+b)}$ [a,b] where $0 \notin [a,b]$ .

29. Using Lagrange's Mean Value theorem prove that $1 + x < e^x < 1 + xe^x$ , $\forall x > 0$

## UNIT-V

30. If $f(x) = x^2 \ \forall \ x \in [0,1]$ and P= {0,1/4 , 2/4, 3/4, 1}, then find $U(P,f)$ and $L(P,f)$.

31. Find the lower and upper Riemann sums of f(x) = 2x -1 on [0,1] when P= { 0, 1/3 , 2/3 , 1 } .

32. If $f \in R[a,b]$ and m , M are the infimum and supremum of f on [a,b] then prove that $m(b-a) \le \int_a^b f(x)dx \le M(b-a)$ .

33. If f is R-integrable on [a,b] then show that | f | is R-integrable on [a,b] .

34. Evaluate $\int_0^{\frac{\pi}{4}}(sec^4 x - tan^4 x)dx$

## Essay Questions

## UNIT-I

1. Show that a monotonic sequence is convergent iff it is bounded .

2. Prove that the sequence $\{s_n\}$ defined by $s_n = 1 + \frac{1}{1!} + \frac{1}{2!} + \cdots + \frac{1}{n!}$ is convergent.

3. Show that the sequence $\{s_n\}$ where $s_n = \frac{1}{n+1} + \frac{1}{n+2} + \cdots + \frac{1}{n+n}$ is convergent .

4.If $S_n = \frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \cdots + \frac{1}{n(n+1)}$ the show that $\{s_n\}$ is convergent .

5.State and prove Cauchy's general principle of convergence .

## UNIT –II

6.State and prove Limit comparison test.

7.State and prove Cauchy's $n^{th}$ root test .

8.State and prove D'Alemberts ratio test.

9.Test for convergence $\sum \frac{x^n}{x^n+a^n}$ ( x>0, a>0 ).

10.Test for convergence of i) $\sum_{n=1}^{\infty}\left(\sqrt[3]{n^3+1} - n\right)$ ii) $\sum_{n=1}^{\infty}\left(\sqrt{n^4+1} - \sqrt{n^4-1}\right)$.

11. Test for convergence of $\frac{1}{2} + \frac{1.3}{2.4} + \frac{1.3.5}{2.4.6} + \cdots$

## UNIT-III

12. State and Prove Intermediate value theorem.

13.If $f: [a, b] \to R$ is continuous on $[a, b]$, then $f$ is bounded on $[a, b]$ and attains its bounds or infimum and supremum.

14.Test the continuity of of $f(x) = \frac{e^{1/x} - e^{-1/x}}{e^{1/x} + e^{-1/x}}\ if\ x \neq 0\ and\ f(0) = 1$ at $x = 0$.

15.Let f: R→ R be such that f(x) = $\frac{sin(a+1)x + sinx}{x}$ for $x < 0, f(x) = c\ for\ x = 0$ and

$f(x) = \frac{(x+bx^2)-x^{\frac{1}{2}}}{bx^{\frac{3}{2}}}$ for x >0. Determine the values of a, b, c which the function is continuous at x = 0.

16. Determine the constants a,b so that the function defined by f(x) = 2x + 1 if x ≤ 1 ;

f(x) = $ax^2$ + b if 1< x < 3 ; f(x) = 5x + 2a if x ≥ 3 is continuous every where .

## UNIT-IV

17. State and prove Roll's theorem .
18. State and Prove Lagrange's mean value theorem .
19. State and Prove Cauchy's mean value theorem.
20. Using Lagrange's mean value theorem, show that

$$x > log(1 + x) > \frac{x}{1 + x}\ if\ f(x) = log(1 + x)\ \forall x > 0$$

21. Show that $\frac{v-u}{1+v^2} < tan^{-1}v - tan^{-1}u < \frac{v-u}{1+u^2}\ for\ 0 < u < v$. Hence deduce that

$$\frac{\pi}{4} + \frac{3}{25} < tan^{-1}\frac{4}{3} < \frac{\pi}{4} + \frac{1}{6}.$$

## UNIT-V

22. State and prove Necessary and Sufficient condition for integrability.
23. If $f$ is continuous on the $[a, b]$ then prove that $f$ is Riemann Integrable on the $[a, b]$.
24. If $f$ is monotonic on the $[a, b]$ then prove that $f$ is Riemann Integrable on the $[a, b]$.
25. State and prove fundamental theorem of Integral Calculus.
26. Prove that $\frac{\pi^3}{24} \leq \int_0^{\pi} \frac{x^2}{5+3\ cosx}\ dx \leq \frac{\pi^3}{6}$.
27. Show that $\frac{1}{\pi} \leq \int_0^1 \frac{\sin \pi x}{1+x^2} dx \leq \frac{2}{\pi}$

***

<table>
<tr><td rowspan="1"></td><td>P.R.Government College (Autonomous)<br>KAKINADA</td><td colspan="4" rowspan="2">Program&Semester<br><br>II B.Sc.<br>Major & Minor<br>(IV Sem)<br>w.e.f 2025-26 admitted batch</td></tr>
<tr><td>Course Code<br><br>MAT- 402 P</td><td>TITLE OF THE COURSE<br><br>Introduction to Real Analysis & Problem Solving Sessions</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:60(Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Knowledge of Multivariate Calculus and Linear Algebra</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

**Unit – I**

**REAL NUMBERS, 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 -Sub sequences and the Bolzano-weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence.

**Unit – II**

**INFINITIE SERIES**

Introduction to series -convergence of series -Cauchy's general principle of convergence for series tests or convergence of series - Series of non-negative terms - P- test - Cauchy's nth root test - D'-Alembert's Test – Alternating Series–Leibnitz Test.

**Unit – III**

**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 IV:**

**DIFFERENTIATION ANDMEANVALUETHEORMS**

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

**Unit – V**

**RIEMANNINTEGRATION**

Riemann Integral - Riemann integral functions - Darboux theorem -Necessary and sufficient condition for R integrability - Properties of integrable functions - Fundamental theorem of integral calculus - Mean value Theorems.

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

**Semester – IV End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-Major X & Minor IV: INTRODUCTION TO REAL ANALYSIS**

| Unit | TOPIC | E.Q | Marks allotted to the Unit |
|---|---|---|---|
| I | REAL NUMBERS, REAL SEQUENCES | 2 | 12 |
| II | INFINITIE SERIES | 2 | 12 |
| III | LIMITS & CONTINUITY | 2 | 12 |
| IV | DIFFERENTIATION AND MEAN VALUE THEORMS | 1 | 06 |
| V | RIEMANNINTEGRATION | 1 | 06 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations – IV Semester**
**Mathematics Course-Major X & Minor IV: Introduction to Real Analysis**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

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**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION – A**

1. Unit – I.
2. Unit – I.
3. Unit – II.
4. Unit – II.

**SECTION – B**

5. Unit – III.
6. Unit – III.
7. Unit – IV.
8. Unit – V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | | | | | |
|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program&Semester**<br>II B.Sc. Major (IV Sem)<br>w.e.f 2025-26 admitted batch | | | |
| Course Code<br>MAT- 403 T | **TITLE OF THE COURSE**<br>**Integral Transforms with Applications & Problem**<br>**Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Ordinary differential Equations and complex variables | 3 | - | - | 3 |

Course Objectives:

To formalise the study of numbers and functions and to investigate important concepts such as limits and continuity. These concepts underpin calculus and its applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Understand the application of Laplace transforms to solve ODEs. |
| CO2 | Understand the application of Laplace transforms to solve Simultaneous Des and the application of Laplace transforms to Integral equations |
| CO3 | Basic knowledge of Fourier-Transformations |
| CO4 | Comprehend the properties of Fourier transforms and solve problems related to finite Fourier transforms. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**Unit – I**

**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 – II**

**Application of Laplace Transform to solutions of Differential Equations**

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

**Unit – III**

**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 IV:**

**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 – V**

**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 ring theory concepts to Real life Problem /Problem Solving Sessions.

**Text book**

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

**Reference books**

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)

BLUE PRINT FOR QUESTION PAPER PATTERN
SEMESTER-IV

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | Application of Laplace Transform to solutions of Differential Equations | 2 | 1 | 20 |
| II | Application of Laplace Transform to solutions of Differential Equations | 2 | 2 | 30 |
| III | Application of Laplace Transforms to Integral Equations | 1 | 1 | 15 |
| IV | Fourier Transforms - I | 1 | 1 | 15 |
| V | Fourier Transforms - II | 1 | 1 | 15 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20 M

Essay questions : 3 X 10 = 30 M

……………….

Total Marks = 50 M

………………..

**Pithapur Rajah's Government College (Autonomous), Kakinada**
**II year B.Sc., Degree Examinations - IV Semester**
**Mathematics Course XI: Integral Transform with Applications**
**Model Paper (w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

## SECTION-A

**Answer any three questions selecting at least one question from each part**

**Part – A** **3 X 10 = 30**

1. Essay question from unit - I.
2. Essay question from unit - II.
3. Essay question from unit - II.

**Part – B**

4. Essay question from unit - III.
5. Essay question from unit - IV.
6. Essay question from unit - V.

## SECTION-B

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from unit – I.
8. Short answer question from unit - I.
9. Short answer question from unit – II.
10. Short answer question from unit - II .
11. Short answer question from unit – III.
12. Short answer question from unit – IV.
13. Short answer question from unit - V

**P.R. GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

# Question Bank

# PAPER: MAJOR XI: Integral Transform with Applications

## Short Answer Questions

## UNIT - I

### Application of Laplace Transform to solutions of Differential Equations

1. Using the Laplace transform of $(D^2 + 4D + 5)\, y = 5$
2. Using Laplace transform solve $(D^2 + 1)\, y = 6 \cos 2t$ if y = 3, Dy = 1 when t = 0.
3. Solve (D + 1) y = 0 if y = $y_0$ when t = 0.
4. Solve $\frac{dy}{dt} + y = 1$, given y = 2 when t = 0.
5. Solve $(D^2 + 1)\, y = 0$ under the condition that y = 1, $\frac{dy}{dt} = 0$ when t = 0.
6. Solve $ty'' + 2y' + ty = 0$ if y(0) = 1 and y($\pi$) = 0.
7. Solve the equation $t\frac{d^2y}{dx^2} + (1 - 2t)\frac{dy}{dx} - 2y = 0, y(0) = 1, y'(0) = 2$
8. Solve $ty'' + y' + ty = 0$ gives that y(0) = 1.

## UNIT – II

### Application of Laplace Transform to solutions of Differential Equations

1. Using Laplace transform solve $\frac{dx}{dt} - 2x + 3y = 0, \frac{dy}{dt} + 2x - y = 0$ given x = 8, y = 3 when t = 0.
2. Solve the equation $\frac{dx}{dt} + y = \sin t$ , $\frac{dy}{dt} + x = \cos t$ given that x = 2, y = 0 at t = 0.
3. Solve $(D^2 - 3)\, x - 4y = 0$, $x + (D^2 + 1)\, y = 0$, t > 0 when t = 0, x = y = Dy = 0, Dx = 2.
4. If y(x, t) is a function of x and t, prove that i) $L\left\{\frac{\partial y}{\partial x}\right\} = p\bar{y}(x,p) - y(x,0)$ ii) $L\left\{\frac{\partial^2 y}{\partial t^2}\right\} = p^2\bar{y}(x,p) - p\, y(x,0) - y_t(x,0)$ where $L\{y(x,t)\} = \bar{y}(x,p) and\ y_t(x,0) = (\frac{\partial y}{\partial t})_{t=0}$.
5. Solve $\frac{\partial y}{\partial x} = 2\frac{\partial y}{\partial t} + y, y(x,0) = 6e^{-3x} which\ is\ bounded\ for\ x > 0, t > 0$
6. Solve $\frac{\partial^2 y}{\partial x^2} - \frac{\partial^2 y}{\partial t^2} = xt\ where\ y = 0 = \frac{\partial y}{\partial t}\ at\ t = 0\ and\ y(0,t) = 0$

## UNIT – III

## Application of Laplace Transforms to Integral Equations

1. Solve the integral equation $F(t) = e^{-t} - 2\int_0^t \cos(t - u)\, F(u) du$.
2. Solve the integral equation $\int_0^t F(u)F(t - u) du\ = 16\ sin4t$.
3. Using Laplace transform, solve $F(t) = 1 - e^{-t} + \int_0^t y(t - u) \sin u\, du$.
4. Solve the equation $F'(t) = sint + \int_0^t F(t - u) cosu\ du$, for with the condition that F(0) = 0
5. Solve the integral equation $\int_0^t \frac{F(u)du}{\sqrt{(t-u)}} = 1 + t + t^2$.

## UNIT – IV

### Fourier Transforms - I

1. Find the relation between Fourier transform and Laplace transform.
2. Find the Fourier transform of $f(x) = \begin{cases} x, |x| \le a \\ 0, |x| > a \end{cases}$
3. Show that the Fourier transform of $f(x) = e^{\frac{-x^2}{2}} is e^{\frac{-p^2}{2}}$
4. Find the cosine transform of the function of f(x) if $f(x) = \begin{cases} \cos x, 0 < x < a \\ 0, x > a \end{cases}$
5. Find the sine transform of the function of f(x) if $f(x) = \begin{cases} 0, 0 < x < a \\ x, a \le x \le b \\ 0, x > b \end{cases}$

**UNIT – V**

**Fourier Transforms – II**

1. Show that $\int_0^\infty \frac{\cos \lambda x}{\lambda^2+1} d\lambda = \frac{\pi}{2} e^{-x}$
2. Solve the integral equation $\int_0^\infty f(x) \cos \lambda x \, dx = e^{-\lambda}$
3. Find the finite Fourier sine and cosine transform of f(x) = 1.
4. Find the finite sine transform of f(x) = x where 0 < x < 4.
5. Find the cosine transform of f(x) = sin nx in (0, π).

**Essay Questions**

**UNIT - I**

**Application of Laplace Transform to solutions of Differential Equations**

1. Using Laplace transform method, solve $(D^2+ 1)\, y = \sin t \,.\, \sin 2t$ , t > 0 if y = 1, Dy = 0 when t = 0.
2. Solve $(D^2 - 3D + 2)\, y = 1- e^{2t}$, y=1, Dy = 0 when t = 0.
3. Solve $(D^2 - D - 2)\, y = 20 \sin(2t)$, y = -1, Dy = 2 when t = 0.
4. Solve the equation $ty'' + y' + 4ty = 0$ if y(0) = 3, $y'(0) = 0$.
5. Solve $y'' + ty' - y = 0 \; if \; y(0) = 0, y'(0) = 1$ .

**UNIT – II**

**Application of Laplace Transform to solutions of Differential Equations**

1. Solve $(D - 2)\, x - (D + 1)\, y = 6 e^{3t}$ , $(2D - 3)\, x + (D - 3)\, y = 6 e^{3t}$ if x = 3, y = 0 when t = 0.
2. Solve by Laplace transform method $(D - 2)\, x - (D - 2)\, y = 1 - 2t$, $(D^2 + 1)\, x + 2Dy = 0$ if x(0) = 0, y(0) = 0 and $x'(0) = 0$.
3. Solve $(D^2 + 2)\, x - Dy = 1$, $Dx + (D^2 + 2)\, y = 0$ if x = 0 = Dx = y = Dy when t = 0.
4. Solve $\frac{\partial y}{\partial t} = 2\frac{\partial^2 y}{\partial x^2}$ where y(0, t) = 0 = y(5, t) and y(x, 0) = 10 sin 4πx.
5. Solve $\frac{\partial y}{\partial t} = \frac{\partial^2 y}{\partial x^2} \; where \; y\left(\frac{\pi}{2}, t\right) = 0, (\frac{\partial y}{\partial x})_{x=0} = 0 \; and \; y(x,0) = cos3x$

Solve $\frac{\partial y}{\partial t} = \frac{\partial^2 y}{\partial x^2}., y(x,0) = 3\, sin2\pi x, y(0,t) = 0 = y(1,t)$**IT – III**

## Application of Laplace Transforms to Integral Equations

1. Solve the integral equation $F(t) = 1 + \int_0^t \sin(t-u)\, F(u) du$ and verify your solution.
2. Solve the integral equation $\int_0^t \frac{F(u) du}{(t-u)^{\frac{1}{3}}} = t(1+t)$.
3. Solve $F'(t) = t + \int_0^t F(t-u) cosu \, du \,, F(0) = 4$.
4. Convert the integral equation $F(t) = t^2 - 3t - 4 - 3\int_0^t (t-u)^2\, F(u) du$ into differential and associated conditions.
5. Convert $y''(t) - 3y'(t) + 2y(t) = 4sint, y(0) = 1, y'(0) = -2$ into integral equation.

**UNIT – IV**

**Fourier Transforms - I**

1. a) State and prove change of scale property.

   b) State and prove Modulation theorem.

2. Find the Fourier transform of f(x) defined by $f(x) = \begin{cases} 1, |x| < a \\ 0, |x| > a \end{cases}$ and hence evaluate $\int_{-\infty}^{\infty} \frac{\sin pa \cos pa}{p} dp$.

3. Find Fourier sine transform of $\frac{e^{-ax}}{x}$ and hence deduce that

$$\int_0^\infty \frac{e^{-ax}-e^{-bx}}{x}\sin px\,dx = tan^{-1}\frac{p}{a} - tan^{-1}\frac{p}{b}$$

4. Find Fourier cosine transform of $\frac{e^{-ax}}{x}$ and hence deduce that

$$\int_0^\infty \frac{e^{-ax}-e^{-bx}}{x}\cos px\,dx = \frac{1}{\sqrt{2\pi}} log\frac{p^2+b^2}{p^2+a^2}$$

5.Find the Fourier transform of $f(x) = \begin{cases} 1-x^2, |x| \le 1 \\ 0, x > 1 \end{cases}$ and hence evaluate $\int_0^\infty (\frac{x\cos x - \sin x}{x^3}) \cos\frac{x}{2} dx$

**UNIT – V**

**Fourier Transforms – II**

1. State and prove Parseval's identity for Transforms.
2. Use Parseval's identity to prove that $\int_0^a \frac{dx}{(x^2+a^2)(x^2+b^2)} = \frac{\pi}{2ab(a+b)}$.
3. Solve for F(x) the integral equation $\int_0^\infty F(x)\sin xt\,dt = \begin{cases} 1, 0 \le t < 1 \\ 2, 1 \le t < 2 \\ 0, t \ge 2 \end{cases}$
4. Find the finite Fourier sine and cosine transform of the function f(x) = 2x, 0 < x < 4.
5. Find the finite Fourier sine and cosine transform of f(x) if $f(x) = \begin{cases} 1, 0 < x < \frac{\pi}{2} \\ -1, \frac{\pi}{2} < x < \pi \end{cases}$

***

<table>
<tr><td rowspan="1"></td><td>P.R.Government College (Autonomous)<br>KAKINADA</td><td colspan="4" rowspan="2">Program&Semester<br>II B.Sc. Major<br>(IV Sem)<br>w.e.f 2023-24 admitted batch</td></tr>
<tr><td>Course Code<br><br>MAT- 403 P</td><td>TITLE OF THE COURSE<br><br>Integral Transforms with Applications & Problem Solving Sessions</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:30(Practicals)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Ordinary differential Equations and complex variables</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

**Unit – I**

**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 – II**

**Application of Laplace Transform to solutions of Differential Equations**

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

**Unit – III**

**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 IV:**

**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 – V**

**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.

**Text book**

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

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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)

**Semester – IV End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-XI: INTEGRAL TRANSFORMS WITH APPLICATIONS**

| Unit | TOPIC | E.Q | Marks allotted to the Unit |
|---|---|---|---|
| I | Application of Laplace Transform to solutions of Differential Equations | 2 | 06 |
| II | Application of Laplace Transform to solutions of Differential Equations | 2 | 12 |
| III | Application of Laplace Transforms to Integral Equations | 1 | 12 |
| IV | Fourier Transforms - I | 2 | 06 |
| V | Fourier Transforms - II | 1 | 12 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**II year B.Sc., Degree Examinations - IV Semester**
**Mathematics Course-XI: Integral Transform with Applications**
**(w.e.f. 2024-25 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

…………………………………………………………………………………………………………

**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – IV.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | | |
|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program&Semester**<br><br>III B.Sc. Mathematics Major & Statistics, Chemistry Minors (V Sem) |
| CourseCode<br><br>MAT-501 T | **TITLEOFTHECOURSE**<br>**Linear Algebra &Problem Solving Sessions** | |

| | | L | T | P | C |
|---|---|---|---|---|---|
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Advanced Calculus, Linear Algebra and Differential Equations | 3 | - | - | 3 |

Course Objectives:

This course will cover the classical fundamental topics in numerical methods such as, approximation, numerical integration, numerical linear algebra, solution of nonlinear algebraic systems and solution of ordinary differential equations.

Course Outcomes:

| On Completion of the course, the students will be able o- | |
|---|---|
| CO1 | understand the concepts of vector spaces, subspaces |
| CO2 | understand the concepts of basis, dimension and their properties |
| CO3 | understand the concept of linear transformation and its properties |
| CO4 | apply Cayley- Hamilton theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods |
| CO 5 | learn the properties of inner product spaces and determine orthogonality in inner product spaces. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**Unit – 1: 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 – 2: 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 – 3: 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 – 4: Matrices**

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

**Unit – 5: 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.

**Additional Inputs:**

Echelon form and Normal form of a matrices, Consistent and inconsistent in Matrices.

**III. References:**

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. 4 th 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

**IV Suggested Co-Curricular Activities:**

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

BLUE PRINT FOR QUESTION PAPER PATTERN
SEMESTER-V : PAPER-MAJOR XII & MINOR V

| Unit | TOPIC | S.A.Q | E.Q | Marks allotted to the Unit |
|---|---|---|---|---|
| I | Vector Spaces-I | 2 | 1 | 20 |
| II | Vector Spaces-II | 2 | 1 | 20 |
| III | Linear Transformations | 1 | 1 | 15 |
| IV | Matrices | 1 | 2 | 25 |
| V | Inner product space | 1 | 1 | 15 |
| Total | | 7 | 6 | 95 |

S.A.Q. = Short answer questions (5 marks)

E.Q = Essay questions (10 marks)

Short answer questions : 4 X 5 = 20

Essay questions : 3X10 = 30

……………….

Total Marks = 50

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**Pithapur Rajah's Government College (Autonomous), Kakinada**

**III Year B.Sc., Degree Examinations - V Semester**

**Mathematics Course MajorXII & Minor V : LINEAR ALGEBRA**

**(Model Paper w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer Any Three Questions, Selecting At Least One Question from Each Part.**

**Part – A** **3 X 10 = 30**

1.Essay question from Unit - I.

2. Essay question from Unit – I

3. Essay question from Unit - III.

Part – B

4.Essay question from Unit - IV .

5. Essay question from Unit - IV.

6. Essay question from Unit - V .

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from Unit - I.
8. Short answer question from Unit - I .
9. Short answer question from Unit – II.
10. Short answer question from Unit – II.
11. Short answer question from Unit - III.
12. Short answer question from unit – IV.
13. Short answer question from Unit – V.

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**P.R. GOVERNMENT COLLEGE (A), KAKINADA**
**DEPARTMENT OF MATHEMATICS**
**Question Bank**
**PAPER–Major XII & Minor V: LINEAR ALGEBRA**
**Short answers**

**UNIT-I**

1. Prove that the intersection of any two subspaces $W_1$ and $W_2$ of vector space V(F) is subspace of V(F).
2. Let $p, q, r$ be the fixed elements of a field $F$. Show that the set $W$ of all triads $(x, y, z)$ of elements of $F$ such that $px + qy + rz = 0$ is a vector sub space of $V_3(F)$.
3. Prove that the linear span $L(S)$ of any subset $S$ of a vector space $V(F)$ is a subspace of $V(F)$.
4. Express the vector α = (1, -2, 5) as a linear combination of the vectors $e_1$ = (1, 1, 1), $e_2$ = (1, 2, 3) and $e_3$ = (2, -1, 1).
5. Show that the system of vectors (1, 3, 2), (1, -7, -8), (2, 1, -1) of $V_3$(R) is linearly dependent.
6. If $\alpha, \beta, \gamma$ are linearly independent vectors of $V(R)$, then show that $\alpha + \beta, \beta + \gamma, \gamma + \alpha$ are also linearly independent.

**UNIT-II**

7. Show that the set of vectors {(1, 2, 1), (2, 1, 0), (1, -1, 2)} form a basis of $V_3$(F).
8. Show that the set $\{(1,0,0), (1,10), (1,1,1)\}$ is a basis of $C^3(C)$. Hence find the coordinates of the vector (3+4i, 6i, 3+7i) in $C^3(C)$.
9. Find the coordinates of α with respect to the basis set {x, y, z} where α = (4, 5, 6), x = (1, 1, 1), y = (-1, 1, 1), z = (1, 0, -1).
10. Prove that any two bases of a finite dimensional vector space V(F) have the same number of elements.
11. If U = {(1,2,1),(0,1,2)}, W = [(1,0,0),(0,1,0)} determine the dimension of U + W.

**UNIT-III**

12. The mapping $T: V_3(R) \to V_2(R)$ defined by $T(x, y, z) = (x - y, x - z)$. Show that T is a linear transformation.
13. Show that the transformation $T: R^3 \to R^3$ defined by $T(x, y, z) = (x - y, 0, y + z)$ is a linear transformation.
14. Find a linear transformation $T: R^3 \to R$ such that $T(1,1,1) = 3, T(0,1,-2) = 1, T(0,0,1) = -2$.
15. Find the null space, range, and nullity of the transformation $T: R^2 \to R^3$ defined by T(x, y) = (x + y, x – y, y).

**UNIT-IV**

16. Prove that the square matrices A and A′ have the same characteristic values.

22. If $\lambda_1, \lambda_2, \ldots. \lambda_n$ are the characteristic values of a n-rowed square matrix A then $\lambda^2_1, \lambda^2_2, \ldots. \lambda^2_n$ are the characteristic roots of $A^2$.

23. Find the eigen values and eigen vectors of the square matrix A=$\begin{pmatrix} 2 & 1 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 2 \end{pmatrix}$.

24. Find the inverse of the matrix A=$\begin{pmatrix} 1 & -1 & 0 \\ 0 & 1 & 1 \\ 2 & 1 & 2 \end{pmatrix}$ by using Cayley-Hamilton theorem.

**UNIT-V**

25. State and Prove Triangle-Inequality.

26. State and prove Parallelogram law in an inner product space V(F).

27. State and prove Parseval's inequality in an inner product space V(F).

28. Prove that the set S = $\left\{\left(\frac{1}{3}, \frac{-2}{3}, \frac{-2}{3}\right), \left(\frac{2}{3}, \frac{-1}{3}, \frac{2}{3}\right), \left(\frac{2}{3}, \frac{2}{3}, \frac{-1}{3}\right)\right\}$ is an orthonormal set in the inner product space $R^3(R)$ with the standard inner product.

**Essay questions**

**UNIT-I**

1. Let V(F) be a vector space and $W \subseteq V$. Then necessary and sufficient condition for $W$ to be a subspace of $V$ is $a, b \in F,\ \alpha, \beta \in W \Longrightarrow a\alpha + b\beta \in W$

2. Prove that the union of two subspaces of a vector space is a subspace if and only if one is contained in the other.

3. If $S$ and $T$ are the subsets of a vector space $V(F)$ then prove that

   (i) $S \subseteq T \Rightarrow L(S) \subseteq L(T)$ and (ii) $L(S \cup T) = L(S) + L(T)$.

4. Let $V(F)$ be a vector space and $S = \{\alpha_1, \alpha_2, \ldots, \alpha_n\}$ is a finite subset of non-zero vectors of $V(F)$. Then prove that $S$ is linearly dependent if and only if some vector $\alpha_k \in S, 2 \leq k \leq n$ can be expressed as a linear combination of its preceding vectors.

**UNTI-II**

5. State and Prove Basis Existence theorem.

6. Let $W_1$ and $W_2$ be two subspaces of a finite dimensional vector space V(F). Then prove that $dim(W_1 + W_2) = \dim W_1 + \dim W_2 - \dim(W_1 \cap W_2)$.

7. Let W be a subspace of a finite dimensional vector space V(F) then prove that $\dim\left(\frac{V}{W}\right) = \dim\ V - \dim W$.

8. Let $W_1$ and $W_2$ be two subspaces of $R^4$ given by $W_1$ = {(a,b,c,d) / b – 2c + d = 0}, $W_2$ = {(a,b,c,d) / a =d, b = 2c}. Find the basis and dimension of i) $W_1$ ii) $W_2$ iii) $W_1 \cap W_2$ and hence find $\dim(W_1 + W_2)$.

## UNIT-III

9. Let $U(F)$ and $V(F)$ be two vector spaces and and S = { $\alpha_1, \alpha_2, \alpha_3 \dots \alpha_n$ } be a basis of U. Let { $\delta_1, \delta_2, \dots. \delta_n$ } be a set of n vectors in V. then there exists a unique linear transformation T : U → V such that $T(\alpha_i) = \delta_i$ for i = 1, 2, … n.

10. Let $U(F)$ and $V(F)$ be two vector spaces and $T$: U → V is a linear transformation. Then prove that the range space $R(T)$ is a subspace of $V(F)$ and null space $N(T)$ is a subspace of $U(F)$.

11. State and prove Rank - Nullity theorem.
12. Let $T: R^3 \to R^3$ be defined by $T(x, y, z) = (x - y,\ 2y + z,\ x + y + z)$. Then verify Rank-nullity theorem.

## UNIT-IV

13. Find the characteristic roots and the corresponding vectors of the square matrix $A = \begin{pmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{pmatrix}$
14. Find the characteristic roots and the corresponding vectors of the square matrix $A = \begin{pmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{pmatrix}$
15. State and prove Cayley-Hamilton theorem.
16. A = $\begin{pmatrix} 1 & 2 & -4 \\ 3 & -1 & 2 \\ 2 & 5 & 0 \end{pmatrix}$ verify Cayley-Hamilton theorem and hence find $A^{-1}$. .
17. State Cayley -Hamilton theorem and use it to find the inverse of the matrix A= $\begin{pmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & -1 \end{pmatrix}$.

## UNIT-V

18. State and prove Cauchy- Schwarz's inequality.

19. State and prove Bessel's inequality.

20. Given { (2,1,3), (1,2,3), (1,1,1) } is a basis of $R^3$(R). Construct an orthonormal basis using Gram-Schmidt orthogonalization process.

21. Given $\{(1, -1, 2),\ (0, 2, 1), (1, 2, 0)\}$ is a basis of $R^3$(R). Construct an orthonormal basis using Gram-Schmidt orthogonalization process.

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|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous) KAKINADA** | **Program&Semester**<br>III B.Sc. Mathematics Major & Statistics, Chemistry Minors (V Sem) | | | |
| CourseCode<br>MAT-501 P | **TITLEOFTHECOURSE**<br>**Linear Algebra &Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:30(**Practicals**) | L | T | P | C |
| Pre-requisites: | | - | - | 2 | 1 |

**Unit – 1: 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 – 2: 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 – 3: 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 – 4: Matrices**

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

**Unit – 5: 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.

**III. References:**

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. 4 th 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

**IV Suggested Co-Curricular Activities:**

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

**Semester – V End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-Major XII & Minor V: Linear Algebra &Problem Solving Sessions**

| Unit | TOPIC | E.Q | Marks allotted to the Unit |
|---|---|---|---|
| I | Vector Space - I | 2 | 12 |
| II | Vector Space - II | 1 | 06 |
| III | Linear Transformation | 2 | 12 |
| IV | Matrices | 2 | 12 |
| V | Inner product spaces | 1 | 06 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**III year B.Sc., Degree Examinations - V Semester**
**Mathematics Course-Major XII & Minor V : Linear Algebra &Problem Solving Sessions**
**(w.e.f. 2023-24 Admitted Batch)**
**Practical Model Paper (w.e.f. 2025-2026)**

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**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – III.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – IV.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

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|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program&Semester**<br>III B.Sc. Mathematics Major & Statistics, Chemistry Minors (V Sem) | | | |
| CourseCode<br>**MAT- 502 T** | **TITLEOFTHECOURSE**<br>**Vector Calculus & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on Integration | 3 | - | - | 3 |

Course Objectives:

This course will cover the particular mathematical functions that have more or less established names and notations due to their importance in mathematical analysis, functional analysis, geometry, physics, or other applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Learn multiple integrals as a natural extension of definite integral to a function of two variables in the case of double integral/three variables in the case of triple integral. |
| CO2 | Learnapplicationsintermsoffindingsurfaceareabydoubleintegralandvolumebytripleintegral. |
| CO3 | Determine the gradient, divergence and curl of a vector and vector identities. |
| CO4 | Evaluate line, surface and volume integrals. |
| CO 5 | understand relation between surface and volume integrals (Gauss divergence theorem), relation between line integral and volume integral(Green's theorem), relation between line and surface integral(Stokes theorem) |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**Syllabus:**

**Unit – 1: MultipleIntegrals-I.**

Introduction -Double integrals -Evaluation of double integrals –Properties of double integrals - Region of integration -double integration in Polar Co-ordinates –Change of variables in double integrals - change of order of integration.

**Unit– 2: Multipleintegrals-II**

Triple integral -region of integration -change of variables -Plane areas by double integrals - Surface area by double integral -Volume as a double integral, volume as a triple integral.

**Unit – 3: Vector differentiation**

Vector differentiation –ordinary – derivatives of vectors – Differentiability –Gradient –Divergence - Curl operators – Formulae involving the separators.

**Unit – 4: Vector integration**

1. Line Integrals with examples - Surface Integral with examples – Volume integral with examples.

**Unit – 5: Vector integration applications**

1. Gauss theorem and applications of Gauss theorem - Green's theorem in plane and Applications of Green's theorem - Stokes's theorem and applications of Stokes theorem.

**II. Reference Books:**

Text Book

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

ReferenceBooks

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

**III. Co-Curricular Activities:**

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

BLUE PRINT FOR QUESTION PAPER PATTERN,

Paper –Major XIII & Minor VI : **Vector Calculus & Problem solving Sessions**

| UNIT | TOPIC | S.A.Q | E.Q | Marks Allotted |
|---|---|---|---|---|
| I | Multiple Integrals-I | 02 | 01 | 20 |
| II | Multiple Integrals-II | 02 | 01 | 20 |
| III | Vector differentiation | 01 | 01 | 15 |
| IV | Vector integration | 01 | 01 | 15 |
| V | Vector integration applications | 01 | 02 | 25 |
| Total | | 07 | 06 | 95 |

S.A.Q. = Short answer questions (5 marks)
E.Q . = Essay questions ( 10 marks)

Short answer questions : 4 x 5 M = 20
Essay questions : 3 x 10 M = 30

Total Marks : = 50

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**Pithapur Rajah's Government College (Autonomous), Kakinada**

**III Year B.Sc., Degree Examinations - V Semester**

**Mathematics Course: Major XIII & Minor VI : Vector Calculus & Problem solving Sessions**

**(Model Paper w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer Any Three Questions, Selecting At Least One Question From Each Part**

**Part – A** **3 X 10 = 30**

1.Essay question from Unit - I.

2. Essay question from Unit – II

3. Essay question from Unit - III.

Part – B

4.Esay question from Unit - IV.

5.Essay question from Unit - V.

6. Essay question from Unit - V .

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from Unit - I.
8. Short answer question from Unit - I .
9. Short answer question from Unit – II.
10. Short answer question from Unit – II.
11. Short answer question from Unit - III.
12. Short answer question from unit – IV.
13. Short answer question from Unit – V.

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**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**DEPARTMENT OF MATHEMATICS**
**Question Bank for**
**PAPER–Major XIII & Minor VI : Vector Calculus & Problem solving Sessions**
**Short Answer Questions**

**Unit-I**

1. Evaluate $\int_0^1 \int_x^{\sqrt{x}} (x^2 + y^2)\ dx\,dy$
2. Evaluate $\iint xy(x+y)\,dx\,dy$ over the area between y = $x^2$ and y = x.
3. Evaluate $\iint (x^2+y^2)\,dx\,dy$ over the area bounded by x + y ≤ 1in the first quadrant.
4. Evaluate $\iint r\sqrt{a^2-r^2}\,d\theta\,dr$ over the upper half of the circle r = a cosθ.
5. By changing into polar coordinates evaluate the integral $\int_0^{2a} \int_0^{\sqrt{2ax-x^2}} (x^2+y^2)\,dx\,dy$
6. Change the order of integration in the double integral $\int_0^\infty \int_x^\infty \frac{e^{-y}}{y}\,dx\,dy$ and hence find the value.

**Unit-II**

7. Evaluate $\int_1^e \int_1^{\log y} \int_1^{e^x} \log z\,dx\,dy\,dz.$
8. Evaluate $\iiint_V (x^2+y^2+z^2)\,dx\,dy\,dz$ where V is the volume of the cube bounded by the coordinate planes and the planes x = y = z = a.
9. Find the smaller of the areas bounded by y = 2 – x and $x^2 + y^2 = 4$ using double integral.
10. Find the area of a loop of the curve t = a sin3θ.
11. Find the area of the surface of the sphere of radius r.
12. Find the volume of the sphere $x^2 + y^2 + z^2 = a^2$.

**Unit-III**

13. If $\boldsymbol{r} = e^{-t}i = \log(t^2+1)\,j - \tan t\ k$ then find

$$i)\ \frac{d\boldsymbol{r}}{dt}, \frac{d^2\boldsymbol{r}}{dt^2}, \left|\frac{d\boldsymbol{r}}{dt}\right|, \left|\frac{d^2\boldsymbol{r}}{dt^2}\right|\ at\ t=0 \quad ii)\ \left(\frac{d\boldsymbol{r}}{dt} \times \frac{d^2\boldsymbol{r}}{dt^2}\right) at\ t=0$$

14. If $\emptyset = 2xz^4 - x^2y$ then find $\left|\frac{\partial\emptyset}{\partial x}i + \frac{\partial\emptyset}{\partial y}j + \frac{\partial\emptyset}{\partial z}k\right|$ at (2,-2,-1).
15. Find the directional derivative of f = $x^2 - y^2 + 2z^2$ at the point P(1,2,3) in the direction of the line $\overrightarrow{PQ}$ where Q = (5,0,4).
16. Find div F and Curl F where $F = xy^2i + 2x^2yzj - 3yz^2k$ at (1,-1,1).
17. If $F = grad(x^3+y^3+z^3-3xyz)$ then find div F, curl F.

**Unit-IV**

18. If $A = t\ i - t^2j + (t-1)k, B = 2t^2i + 6t\ k$ find $i)\ \int_0^2 (A.B)\,dt \quad ii)\ \int_0^2 (A \times B)\,dt$
19. If $F = x^2y^2\ i + yj$, evaluated $\int_c F.dr$ where c is the curve $y^2 = 4x$ in the xy – plane from (0, 0) to (4, 4).
20. Evaluate $\int_c F.dr$ where F = $3x^2$ i + (2xz – y) j + z k along the straight line C from (0,0,0,) to (2,1,3).
21. Evaluate $\int_S F.N\,ds$ where F = z i + x j – $3y^2$ z k and S is the surface $x^2 + y^2 = 16$ included in the first octant between z = 0 and z = 5.

22. If $\emptyset = 45x^2y$, evaluate $\iiint_V \emptyset\ dv$ where V is the closed region bounded by the plane 4x + 2y + z = 8, x = 0, y = 0, z = 0.

## Unit-V

23. If F = ax i + by j + cz k and a, b, c are constants. Show that $\int F.N\ ds = \frac{4\pi}{3}(a+b+c)$ where S is the surface of the unit sphere.
24. Compute $\int_S (ax^2 + by^2 + cz^2)\, ds$ over the sphere $x^2 + y^2 + z^2 = 1$.
25. State and prove Green's theorem in a plane.
26. Evaluate $\int_c (\cos x\ \sin y - xy)dx + \sin x\ \cos y\ dy$, by Green's theorem where C is the circle $x^2 + y^2 = 1$.
27. Evaluate $\int_S \nabla \times F.N\ ds$ using Stoke's theorem, where F = (2x – y)i – $yz^2$j – $y^2$z k and S is the upper half of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary.

## Essay Questions

## Unit-I

1. Evaluate $\iint (x+y)^2\, dx\, dy$ over the area bounded by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
2. Change into polar coordinates and evaluated $\int_0^a \int_0^{\sqrt{a^2-x^2}} e^{-(x^2+y^2)}\, dx\, dy$
3. By changing into polar coordinates evaluate $\iint \frac{x^2y^2}{x^2+y^2} dx\, dy$ over the angular region between the circles $x^2 + y^2 = a^2, x^2 + y^2 = b^2 (b > a)$.
4. By changing the order of integration, evaluate $\int_0^3 \int_1^{\sqrt{4-y}} (x+y)\, dx\, dy$.

## Unit-II

5. Evaluate $\iiint_V (x^2 + y^2 + z^2)\, dx\, dy\, dz$ taken over the volume enclosed by the sphere $x^2 + y^2 + z^2 = 1$.
6. Find the area inside the circle r = a sinθ but lying outside the cardiod r = a(1 - cosθ).
7. Find the volume of the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ by using double integral.
8. Find the volume of the tetrahedron bounded by coordinates planes and the plane $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$.

## Unit-III

9. If $\boldsymbol{r} = a\cos t\ i + a\sin t\, j + at\tan\theta\, k$ then find i) $\left(\frac{dr}{dt} \times \frac{d^2r}{dt^2}\right) at\ t = 0$ ii) $\left|\frac{dr}{dt} \times \frac{d^2\boldsymbol{r}}{dt^2}\right|$ and iii) $\left[\frac{d\boldsymbol{r}}{dt}\ \frac{d^2\boldsymbol{r}}{dt^2}\ \frac{d^3\boldsymbol{r}}{dt^3}\right]$
10. If A, B are two differentiable vector point functions then $grad(A.B) = (B.\nabla)A + (A.\nabla)B + B \times curl\ A + A \times curl\ B$.
11. If A, B are two differentiable vector point functions then $div(A \times B) = B.curl\ A - A.curl\ B$.
12. If A, B are two differentiable vector point functions then $Curl(A \times B) = A\ div\ B - B\ div\ A + (B.\nabla)A - (A.\nabla)B$
13. If F is a differentiable vector point function, then $\nabla \times (\nabla \times F) = \nabla(\nabla.F) - \nabla^2 F$.

**Unit-IV**

14. Evaluate $\int_S F.N\, ds$ where F = 18 z i – 12 j + 3y k and S is the part of the plane 2x + 3y + 6z = 12 located in the first octant.
15. If F = $(x + y^2)$ i – 2x j + 2yz k, evaluate $\int_S F.N\, ds$ where S is the surface of plane 2x + y + 2z = 6 in the first octant.
16. If F = 2xz i – x j + $y^2$ k, evaluate $\iiint_V F\, dv$ where V is the region bounded by the surface x = 0, y = 0, y = 6, z = $x^2$, z = 4.
17. If F = $(2x^2 – 3z)$ i – 2xy j – 4x k, then evaluate $\iiint_V \nabla.F\, dv$ where v is closed region bounded by the planes x = 0, y = 0, z = 0 and 2x + 2y +z = 4. Also evaluate $\iiint_V \nabla \times F\, dv$.

**Unit-V**

18. State and prove Gauss's divergence theorem.
19. Verify Gauss's divergence theorem to evaluate $\int_S \{(x^3 - yz)i - 2x^2yj + zk\}.N\, ds$ over the surface of a cube bounded by the coordinate planes x = y = z = a.
20. By transforming into triple integral, evaluate $\iint_S (x^3\, dy\, dz + x^2y\, dz\, dx + x^2z\, dx\, dy)$ where S is the closed surface consisting of the cylinder $x^2 + y^2 = a^2$ and the circular disc z = 0, and z = b.
21. Verify Green's theorem in the plane for $\int_c (3x^2 - 8y^2)dx + (4y - 6xy)dy$ where C is the region bounded by $y = \sqrt{x} and\ y = x^2$.
22. State prove Stoke's theorem.
23. Verify Stoke's theorem for F = - $y^3$ i + $x^3$ j where S is the circle disc $x^2 + y^2 \leq 1, z = 0$.
24. Verify Stoke's theorem for F = (2x – y) i – $yz^2$ j – $y^2z$ k, where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ and C is boundary.

<table>
<tr><td rowspan="1"></td><td>P.R.Government College (Autonomous)<br>KAKINADA</td><td colspan="4" rowspan="2">Program & Semester<br><br>III B.Sc. Mathematics Major & Statistics, Chemistry Minors (V Sem)</td></tr>
<tr><td>CourseCode<br>MAT-502 P</td><td>TITLEOFTHECOURSE<br><br>Vector Calculus & Problem solving Sessions</td></tr>
<tr><td>Teaching</td><td>HoursAllocated:30(Practicals)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td>Basic Mathematics Knowledge on Integration</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
</table>

**Syllabus:**

**Unit – 1: MultipleIntegrals-I.**

Introduction -Double integrals -Evaluation of double integrals –Properties of double integrals -
Region of integration -double integration in Polar Co-ordinates –Change of variables in double integrals -change of order of integration.

**Unit– 2: Multipleintegrals-II**

Triple integral -region of integration -change of variables -Plane areas by double integrals -
Surface area by double integral -Volume as a double integral, volume as a triple integral.

**Unit – 3: Vector differentiation**

Vector differentiation –ordinary – derivatives of vectors – Differentiability –Gradient –Divergence -
Curl operators – Formulae involving the separators.

**Unit – 4: Vector integration**

1. Line Integrals with examples - Surface Integral with examples – Volume integral with examples.

**Unit – 5: Vector integration applications**

1. Gauss theorem and applications of Gauss theorem - Green's theorem in plane and
Applications of Green's theorem - Stokes's theorem and applications of Stokes theorem.

**II. Reference Books:**

Text Book

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

ReferenceBooks

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

**Semester – V End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-Major XIII & Minor VI : Vector Calculus & Problem solving Sessions**

| **Unit** | **TOPIC** | **E.Q** | **Marks allotted to the Unit** |
|---|---|---|---|
| I | Multiple Integrals-I | 2 | 12 |
| II | Multiple Integrals-II | 2 | 12 |
| III | Vector differentiation | 1 | 06 |
| IV | Vector integration | 2 | 12 |
| V | Vector integration applications | 1 | 06 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVT. COLLEGE (AUTONOMOUS), KAKINADA**

**III year B.Sc., Degree Examinations - V Semester**

**Mathematics Course-Major XIII & Minor VI : Vector Calculus & Problem solving Sessions**

**(w.e.f. 2023-24 Admitted Batch)**

**Practical Model Paper (w.e.f. 2025-2026)**

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**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – IV.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | | | | | |
|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program&Semester**<br>III B.Sc. Mathematics Major (V Sem) | | | |
| CourseCode<br>**MAT- 503 T** | **TITLEOFTHECOURSE**<br>**Advanced Numerical Methods & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on Integration | 3 | - | - | 3 |

Course Objectives:

This course will cover the particular mathematical functions that have more or less established names and notations due to their importance in mathematical analysis, functional analysis, geometry, physics, or other applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Find derivatives using various difference formulae |
| CO2 | Understand the process of Numerical Integration |
| CO3 | Solve Simultaneous Linear systems of Equations |
| CO4 | Understand Iterative methods |
| CO 5 | Find Numerical Solution of Ordinary Differential Equations |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**Syllabus:**

**Unit – 1: 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– 2: 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.

**Unit – 3: Solution of Simultaneous Linear systems of Equations – I**

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

**Unit – 4: Solution of Simultaneous Linear systems of Equations – II**

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

**Unit – 5: 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.

**Additional Inputs:**

Boole's Rule

**II. Reference Books:**

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.

**III. Co-Curricular Activities:**

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

BLUE PRINT FOR QUESTION PAPER PATTERN,

Paper –Major XIV : **Advanced Numerical Methods & Problem Solving Sessions**

| UNIT | TOPIC | S.A.Q | E.Q | Marks Allotted |
|---|---|---|---|---|
| I | Numerical Differentiation. | 02 | 01 | 20 |
| II | Numerical Integration | 01 | 02 | 25 |
| III | Solution of Simultaneous Linear systems of Equations – I | 01 | 01 | 15 |
| IV | Solution of Simultaneous Linear systems of Equations – II | 01 | 01 | 15 |
| V | Numerical Solution of Ordinary Differential Equations | 02 | 01 | 15 |
| Total | | 07 | 06 | 95 |

S.A.Q. = Short answer questions (5 marks)
E.Q . = Essay questions ( 10 marks)

Short answer questions : 4 x 5 M = 20
Essay questions : 3 x 10 M = 30

Total Marks : = 50

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**Pithapur Rajah's Government College (Autonomous), Kakinada**

**III Year B.Sc., Degree Examinations - V Semester**

**Mathematics Course: Major XIV : Advanced Numerical Methods & Problem solving sessions**

**(Model Paper w.e.f. 2025-26)**

……………………………………………………………………………………………………..

**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer Any Three Questions, Selecting At Least One Question From Each Part**

**Part – A** **3 X 10 = 30**

1.Essay question from Unit - I.

2. Essay question from Unit – II

3. Essay question from Unit - II.

Part – B

4.Esay question from Unit - III .

5.Essay question from Unit - IV.

6.Essay question from Unit - V .

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M** **7.**

Short answer question from Unit - I.

8.Short answer question from Unit - I .

9. Short answer question from Unit – II.

10. Short answer question from Unit – III.

11. Short answer question from Unit - IV.

12. Short answer question from unit – V.

13. Short answer question from Unit – V.

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**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**DEPARTMENT OF MATHEMATICS**
**Question Bank for**
**PAPER–MAJOR XIV : ADVANCED NUMERICAL METHODS**

## Short Answer Questions

### Unit-I

1. Find the first order derivative of √x at x = 15 from the following .

| x | 15 | 17 | 19 | 21 | 23 | 25 |
|---|---|---|---|---|---|---|
| f(x) | 3.8773 | 4.123 | 4.359 | 4.583 | 4.796 | 5.000 |

2. Find $f^1(1)$ for $f(x) = \frac{1}{1+x^2}$ using the following table .

| x | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 |
|---|---|---|---|---|---|
| f(x) | 0.5000 | 0.4524 | 0.4098 | 0.3717 | 0.3378 |

3. Find $f^1(1.5)$ from the following table .

| x | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 |
|---|---|---|---|---|---|
| f(x) | 0.3989 | 0.3521 | 0.2420 | 0.1245 | 0.0540 |

4. Find $f^1(2.5)$ from the following table .

| x | 1.5 | 1.9 | 2.5 | 3.2 | 4.3 | 5.9 |
|---|---|---|---|---|---|---|
| f(x) | 3.375 | 6.059 | 13.625 | 29.368 | 73.907 | 196.579 |

5. Find $f^1(5)$ from the following table .

| x | 1 | 2 | 4 | 8 | 10 |
|---|---|---|---|---|---|
| f(x) | 0 | 1 | 5 | 21 | 27 |

### Unit – II

6. Evaluate $\int_0^1 (4x - 3x^2)\, dx$ taking 10 intervals by Trapezoidal rule.
7. Calculate the approximate value of $\int_{-3}^{3} x^4 dx$ by using Trapezoidal Rule.
8. Evaluate $I = \int_0^1 \frac{dx}{1+x}$ correct to three decimal places by Trapezoidal rule with h = 0.25
9. Evaluate the integral $\int_1^2 \sqrt{(1 - \frac{1}{x})}\, dx$ by Simpson's 1/3 rule with five ordinates.
10. Use Euler – Maclaurin's formula to prove that $\sum_1^n x^2 = \frac{n(n+1)(2n+1)}{6}$.

**Unit – III**

11. Solve the following equations by matrix inversion method.
    $3x + y + 2z = 3$, $2x – 3y – z = -3$, $x + 2y + z = 4$.
12. Solve the system of equations $2x + y + Z = 10$, $3x + 2y + 3z = 18$, $x + 4y + 9z = 16$ by Gauss Elimination method.
13. Solve the equations $x + 2y + z = 3$, $2x + 3y + 3z = 10$, $3x – y + 2z = 13$ by Gauss Elimination method.

**Unit – IV**

14. Solve the equations $10x – y + z = 12$, $x – 10y + z = 12$, $x + y -10z = 12$ by Gauss – Jacobi method.
15. Solve the equations $10x + 2y + z = 9$, $x + 10y – z = -22$, $-2x + 3y + 10z = 22$ by Gauss – Jacobi method.
16. Solve the equations $5x + 2y + z = 12$, $x + 4y + 2z = 15$, $x + 2y + 5z = 20$ by Gauss – Seidel method.

**Unit – V**

17. Solve the differential equations $\frac{dy}{dx} = x + y$ , with $y(0) = 1$ , $x \in [0,1]$ by Taylor series expansion to obtain y for $x = 0.1$ .
18. Using the Taylor's series for y(x) , find y(0.1) correct to four decimal places if y(x) satisfies $y^1 = x – y^2$ , $y_0 = 1$ where $x_0 = 0$ .
19. Solve $\frac{dy}{dx} = 1 + y^2$ , $y(0) = 0$ by Picard's method .
20. Given $\frac{dy}{dx} = y + x^3$ , $y(0) = 1$ , compute y(0.02) by Euler's method taking $h = 0.01$ .

**Essay Questions**

**Unit – I**

1. Using the following table , compute $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at $x = 1$ .

| x | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| y | 1 | 8 | 27 | 64 | 125 | 216 |

2. Using the following table , compute $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at $x = 1.2$ .

| x | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 |
|---|---|---|---|---|---|---|---|
| y | 2.7183 | 3.3201 | 4.0552 | 4.9530 | 6.0496 | 7.3891 | 9.0250 |

3. Using the following table , compute $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at $x = 2.2$ .

| x | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 |
|---|---|---|---|---|---|---|---|
| f(x) | 2.7183 | 3.3201 | 4.0552 | 4.9530 | 6.0496 | 7.3891 | 9.0250 |

4. Find $f^1(0.6)$ and $f^{11}(0.6)$ from the following table .

| x | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
|---|---|---|---|---|---|
| f(x) | 1.5836 | 1.7974 | 2.0442 | 2.3275 | 2.6510 |

**UNIT - II**

5. State and prove Simpson's 1/3 rule .
6. Evaluate $\int_0^6 \frac{dx}{1+x^2}$ by using Simpson's 1/3 rule .
7. State and prove Simpson's 3/8 rule .
8. Evaluate $\int_0^1 \frac{dx}{1+x^2}$ by using Simpson's 1/3 and 3/8 rule . Hence obtain the approximate value of $\pi$ in each case .
9. Evaluate $\int_3^7 x^2 logx\, dx$ by using Simpson's 3/8 rule. Take h = 1
10. Integrate numerically $\int_4^{5.2} logx\, dx$ by Weddle's rule .

**Unit – III**

11. Solve the equations 3x + 2y + 4z = 7, 2x + y + z = 7, x + 3y + 5z = 2 by Matrix inversion method.
12. Solve the equations 5x – y – 2z = 142, x – 3y – z = - 31, 2x – y – 3z = 5 by Gauss elimination method.
13. Solve the equations 5x + 2y + z = 12, x + 4y + 2z = 15, x + 2y + 5z = 20 by Gauss – Jordan method.
14. Solve the equations 2x + y + z = 10, 3x + 2y + 3z = 18, x + 4y + 9z = 16 by Gauss – Jordan method.

**Unit – IV**

15. Solve the equations 2x + 3y + z = 9, x + 2y + 3z = 6, 3x + y + 2z = 8 by LU decomposition method.
16. Solve the equations x + 2y + 3z = 14, 2x + 5y + 2z = 18, 3x + y + 5z = 20 by factorization method.
17. Solve the equations 10x + 2y + z = 9, 2x + 20y – 2z = -44, -2x + 3y + 10z = 22 by Gauss – Seidel method.
18. Solve the equations 10x + y = z = 12, 2x + 10y + z = 13, 2x + 2y + 10z = 14 by Gauss – Seidel method.

**Unit - V**

19. Determine the value of y when x = 0.1 given that y(0) = 1 and $y^1 = x^2 + y$ by Euler's modified method .
20. Find y(0.2) by using Euler's modified method for $\frac{dy}{dx} = log_{10}(x+y)$ with initial condition y = 1 for x = 0 .
21. Solve $\frac{dy}{dx} = xy$ using Runge – Kutta method for x = 0.2 given that y(0) = 1 taking h = 0.2
22. Given $\frac{dy}{dx} = y - x$ with y(0) = 2 find y(0.1) and y(0.2) correct to four decimal place by R – K method .

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| | | | | | |
|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program & Semester**<br>III B.Sc. Mathematics Major (V Sem) | | | |
| Course Code<br>**MAT-503 P** | **TITLEOFTHECOURSE**<br>**Advanced Numerical Methods & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:30(**Practicals**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on Integration | - | - | 2 | 1 |

**Syllabus:**

**Unit – 1: 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– 2: 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.

**Unit – 3: Solution of Simultaneous Linear systems of Equations – I**

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

**Unit – 4: Solution of Simultaneous Linear systems of Equations – II**

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

**Unit – 5: 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.

**II. Reference Books:**

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.

**Semester – V End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE- Major XIV : Advanced Numerical Methods & Problem solving sessions**

| Unit | TOPIC | E.Q | Marks allotted to the Unit |
|---|---|---|---|
| I | Numerical Differentiation. | 2 | 12 |
| II | Numerical Integration | 2 | 12 |
| III | Solution of Simultaneous Linear systems of Equations – I | 1 | 06 |
| IV | Solution of Simultaneous Linear systems of Equations – II | 1 | 06 |
| V | Numerical Solution of Ordinary Differential Equations | 2 | 12 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVT. COLLEGE (AUTONOMOUS), KAKINADA**

**III year B.Sc., Degree Examinations - V Semester**

**Mathematics Course- Major XIV : Advanced Numerical Methods & Problem solving sessions**

**(w.e.f. 2023-24 Admitted Batch)**

**Practical Model Paper (w.e.f. 2025-2026)**

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**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit - I.
2. Unit – I.
3. Unit - II.
4. Unit – II.

**SECTION – B**

5. Unit - III.
6. Unit - IV.
7. Unit – V.
8. Unit - V.

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

| | P.R.Government College (Autonomous) KAKINADA | Program&Semester<br>III B.Sc. Mathematics Major (V Sem) | | | |
|---|---|---|---|---|---|
| Course Code **MAT- 504 T** | **TITLE OF THE COURSE**<br>**Number Theory & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:60(**Theory**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on Integration | 3 | - | - | 3 |

Course Objectives:

This course will cover the particular mathematical functions that have more or less established names and notations due to their importance in mathematical analysis, functional analysis, geometry, physics, or other applications.

Course Outcomes:

| On Completion of the course, the students will be able to- | |
|---|---|
| CO1 | Understand the fundamental theorem of arithmetic |
| CO2 | Understand Mobius function, Euler quotient function, The Mangoldt function , Liouville's function, The divisor functions and the generalized convolutions. |
| CO3 | Understand Euler's summation formula, application to the distribution of lattice points and the applications to μ (n) and Λ (n) |
| CO4 | Understand the concepts of congruencies, residue classes and complete residues systems. |
| CO 5 | Comprehend the concept of quadratic residues mod p and quadratic non residues mod p. |

**Course with focus on employability/entrepreneurship /Skill Development modules**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Skill Development | | | Employability | | | Entrepreneurship | |

**Syllabus:**

**Unit – 1: 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– 2: Arithmetical Functions And Dirichlet Multiplication**

Introduction- The Mobius function $\mu(n)$ – The Euler quotient function $\phi(n)$ - A relation connecting $\varphi$ and $\mu$ - A product formula for $\phi(n)$ - 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 – 3: Averages Of Arithmetical Functions**

ntroduction- 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 $\phi$ (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 – 4: 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 – 5: 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.

**II. Reference Books:**

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

**III. Co-Curricular Activities:**

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

BLUE PRINT FOR QUESTION PAPER PATTERN,

Paper –Major XV : Number Theory & Problem Solving Sessions

| UNIT | TOPIC | S.A.Q | E.Q | Marks Allotted |
|---|---|---|---|---|
| I | The Fundament Theorem of Arithmetic. | 01 | 01 | 15 |
| II | Arithmetical Functions And Dirichlet Multiplication | 02 | 01 | 20 |
| III | Averages Of Arithmetical Functions | 01 | 01 | 15 |
| IV | Congruences | 01 | 02 | 25 |
| V | Quadratic Residues and the Quadratic Reciprocity Law | 02 | 01 | 20 |
| Total | | 07 | 06 | 95 |

S.A.Q. = Short answer questions (5 marks)
E.Q . = Essay questions ( 10 marks)

Short answer questions : 4 x 5 M = 20
Essay questions : 3 x 10 M = 30

Total Marks : = 50

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**Pithapur Rajah's Government College (Autonomous), Kakinada**

**III Year B.Sc., Degree Examinations - V Semester**

**Mathematics Course: Major XV : Number Theory & Problem Solving Sessions**

**(Model Paper w.e.f. 2025-26)**

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**Time: 2Hrs** **Max. Marks: 50**

**SECTION-A**

**Answer Any Three Questions, Selecting At Least One Question From Each Part**

**Part – A** **3 X 10 = 30**

1.Essay question from Unit - I.

2. Essay question from Unit – II

3. Essay question from Unit - III.

Part – B

4.Esay question from Unit - IV .

5.Essay question from Unit - IV.

6.Essay question from Unit - V .

**SECTION-B**

**Answer any four questions** **4 X 5 M = 20 M**

7. Short answer question from Unit - I.
8. Short answer question from Unit - II.
9. Short answer question from Unit – II.
10. Short answer question from Unit – III.
11. Short answer question from Unit - IV.
12. Short answer question from unit – V.
13. Short answer question from Unit – V.

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**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**
**DEPARTMENT OF MATHEMATICS**
**Question Bank for**
**PAPER–MAJOR XV : NUMBER THEORY**

## Short Answer Questions

UNIT-1: FUNDAMENTAL THEOREM OF ARTHMETIC

1. If n is an even positive integer, prove that $2^{2n}$-1 is divisible by 15.

2. Find the gcd of 117,45.

3. If a=2210, b= 493 then find (a, b) and hence [a, b].

4. If p is a prime and a,b $\in Z$ , p|ab then Prove that p|a or p|b. .

5. Express 2025 as a product of prime numbers.

UNIT-II: ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION

1. If n$\geq 1$ prove that $\sum_{d/n} \mu(d) = \left[\frac{1}{n}\right] = \begin{cases} 1 if\ n = 1 \\ 0 if n > 1 \end{cases}$.

2. Find $\tau(50000)\ and\ \sigma(50000)$.

3. Find $\varphi(n)$ if n =5,6,8,12,15,35,60,72,100,256.

4. If (m, n) =1 then prove that $\varphi(n, m) = \varphi(n)\ \varphi(m)$.

5. Mobius function, Euler -Totient function, Mangoldt function.

6. For all f, prove that f*I=I*f = f.

UNIT-III: AVERAGE OF ARITHEMETICAL FUNCTIONS

1. Show that $\zeta(2) = \frac{\pi^2}{6}$.

2. Explain $\sum_{n=1}^{\infty} \frac{\mu(n)}{n^2} = \frac{6}{\pi^2} + O\left(\frac{1}{x}\right)$.

3. Prove that the Average Order of $\sigma_1(n) is \frac{1}{2}\ \zeta(2)$.

4. Define oh notation and asymptotic equality of functions.

UNIT-IV: CONGRUENCES

1. If a≡b (mod n) then Prove that ac ≡bc (mod n) for any c$> 0$.

2. Find the reminder obtained dividing the sum by 12 ,1! $+$ 2! $+ 3 + \cdots$ ... . .99! $+$ 100!.

3. If a$c$ ≡bc (mod n) then prove that a≡b (mod n| d) where d= gcd (c, n).

4. If (a,m) =1 then prove that $a^{\emptyset(m)}$ ≡1 (mod m).

5. Solve the congruence 5x ≡3 (mod 24).

UNIT-V: QUADRATIC RESIDUES AND THE RECIPROCITY LAW

1. Find the Legendre's symbol of $\left(\frac{77}{43}\right)$.

2. If p is odd prime then prove that $\left(\frac{2}{p}\right) = (-1)^{\frac{p^2-1}{8}}$.

3. Find the value of $\left(\frac{7}{11}\right), \left(\frac{22}{11}\right)$.

4. Find Jacobi symbol of $\left(\frac{109}{385}\right)$.

5. Find Jacobi symbol of $\left(\frac{5}{567}\right)$.

6. For a prime p = 11 find the quadratic residue (mod11).

ESSAY QUESTIONS

UNIT-1: FUNDAMENTAL THEOREM OF ARTHMETIC

1.State and prove Division Algorithm.

2. State and prove Euclidean Algorithm

3. State and prove the relation between L.C.M and G.C.D.

4. State and prove the Fundamental Theorem of Arithmetic

UNIT-II: ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION

1. If n≥ 1 prove that $\varphi(n) = \sum_{d/n} \mu\left(\frac{n}{d}\right) (OR) \frac{\varphi(n)}{n} = \sum_{d/n} \frac{\mu(d)}{d}$.

2. If F(n) = $\sum_{d/n} f(d)$ *then* $f(n) = \sum_{d/n} \mu(d) F\left(\frac{n}{d}\right) = \sum_{d/n} \mu(\frac{d}{d}) F(d)$.

3. If n≥ 1 prove that $\varphi(n) = n \prod_{p/n} (1 - \frac{1}{p})$.

4. If n≥ 1 prove that $\sum_{d/n} \varphi(d) = n$.

UNIT-III: AVERAGE OF ARITHEMETICAL FUNCTIONS

1. For any x > 1 Prove that $\sum_{n \le x} \varphi(d) = \frac{3}{\pi^2} x^2 + O(x \log x)$.

2. For any x≥ 1 Prove that
$\sum_{n \le x} d(n) = x \log x + (2c - 1)x + O(\sqrt{x})$, *where c is Euler's constant.*

3. For any x≥ 1 Prove that $\sum_{n \le x} \frac{1}{n} = \log x + c + O\left(\frac{1}{x}\right)$.

4. For any x≥ 1 Prove that $\sum_{n \le x} \sigma(n) = \frac{1}{12} \pi^2 x^2 + O(x \log x)$.

UNIT-IV: CONGRUENCES

1.The linear congruence a$x$ ≡b (mod n) has solution iff d|b where d= gcd (a, n).

2.What is the reminder when $2^{20}$ is divisible by 41.

3. If(a, m) =1 the solution (unique mod m) of linear congruence a$x$ ≡b (mod m) is given

by x ≡b$a^{\emptyset(m)-1}$ (mod m).

4. State and prove the Lagranges theorem.

5. State and prove Chinese Reminder Theorem.

6. For any prime p, prove that all the coefficients of polynomial f(x)=(x-1) (x-2) …….$x^{p-1}+1$ are divisible by p.

UNIT-V: QUADRATIC RESIDUES AND THE RECIPROCITY LAW

1. If p is an odd prime and (a, p) =1then prove that a is a quadratic residue of p

Iff $a^{\frac{p-1}{2}} \equiv 1(mod p)$.

2. If p is an odd prime then prove that $\left(\frac{-1}{p}\right) = \begin{cases} 1\ if p \equiv 1(mod 4) \\ -1 if p \equiv 3(mod 4). \end{cases}$

3. State and prove Gauss Lemma.

4. If P and Q are odd positive integers with (P,Q)=1 then prove that

$$\left(\frac{P}{Q}\right)\left(\frac{Q}{p}\right) = (-1)^{\frac{P-1}{2}}(-1)^{\frac{p-1}{2}}.$$

| | | | | | |
|---|---|---|---|---|---|
| | **P.R.Government College (Autonomous)**<br>**KAKINADA** | **Program & Semester**<br><br>III B.Sc. Mathematics Major (V Sem) | | | |
| CourseCode<br>**MAT-504 P** | **TITLEOFTHECOURSE**<br>**Number Theory & Problem Solving Sessions** | | | | |
| Teaching | HoursAllocated:30(**Practicals**) | L | T | P | C |
| Pre-requisites: | Basic Mathematics Knowledge on Integration | - | - | 2 | 1 |

**Syllabus:**

**Unit – 1: 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– 2: Arithmetical Functions And Dirichlet Multiplication**

Introduction- The Mobius function $\mu(n)$ – The Euler quotient function $\phi(n)$ - A relation connecting $\varphi$ and $\mu$ - A product formula for $\phi(n)$ - 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 – 3: Averages Of Arithmetical Functions**

ntroduction- 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 $\phi(n)$- 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 – 4: 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 – 5: 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.

**II. Reference Books:**

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

**Semester – V End Practical Examinations**

**Scheme of Valuation for Practical's**

**Time : 2 Hours** **Max.Marks : 50**

- **Record - 10 Marks**
- **Viva voce - 10 Marks**
- **Test - 30 Marks**
- **Answer any 5questions. At least 2 questions from each section. Each question carries 6 marks.**

**BLUE PRINT FOR PRACTICAL PAPER PATTERN**

**COURSE-Major XV : Number Theory & Problem Solving Sessions**

| **Unit** | **TOPIC** | **E.Q** | **Marks allotted to the Unit** |
|---|---|---|---|
| I | The Fundament Theorem of Arithmetic. | 2 | 12 |
| II | Arithmetical Functions And Dirichlet Multiplication | 1 | 12 |
| III | Averages Of Arithmetical Functions | 1 | 06 |
| IV | Congruences | 2 | 06 |
| V | Quadratic Residues and the Quadratic Reciprocity Law | 2 | 12 |
| | **Total** | 08 | 48 |

**PITHAPUR RAJAH'S GOVT. COLLEGE (AUTONOMOUS), KAKINADA**

**III year B.Sc., Degree Examinations - V Semester**

**Mathematics Course-Major XV : Number Theory & Problem Solving Sessions**

**(w.e.f. 2023-24 Admitted Batch)**

**Practical Model Paper (w.e.f. 2025-2026)**

…………………………………………………………………………………………………………

**Time: 2Hrs** **Max. Marks: 50M**

**Answer any 5questions. At least 2 questions from each section.** **5 x 6 = 30 Marks**

**SECTION - A**

1. Unit – I
2. Unit – I
3. Unit – II
4. Unit - III

**SECTION – B**

5. Unit – IV
6. Unit – IV
7. Unit – V
8. Unit – V

- **Record - 10 Marks**
- **Viva voce - 10 Marks**

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**Massive Open Online Course (MOOCS) CERTIFICATE COURSE**

**Additional Credits: Achieved Credits**

**Guidelines of this course:**

After completion of the course the student is able to get 2 additional credits through the examination cell under the following conditions.

- Completed the course through the online platforms Swayam, UGC, CEC, NPTEL, AICTE, NCERT, etc.
- Course related to any Mathematical subject or interdisciplinary with mathematics one of the subject.
- Course contains at least a minimum of 4 weeks.
- Course completion certificate must be submitted to the Examination cell through the department.

**For more details about online courses go through the following links:**

- http://www.apcce.gov.in/SwC
- https://swayam.gov.in/
- http://free.aicte-india.org/
- https://ugcmoocs.inflibnet.ac.in/
- https://swayam.gov.in/nc_details/CEC
- https://swayam.gov.in/nc_details/NCERT

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A),KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**CERTIFICATE COURSE -2025-26**

**COURSE TITLE: MATHEMATICS IN INDIA(I Mathematics Major)**

**Total Hours – 30 hours /Additional Credits: 2**

## Course Objectives:

This course will introduce students to some of the fundamental contributions to mathematics made in India over the course of history and examine their scientific and pedagogical significance in the modern context.

## Learning Outcome:

The students will gain an understanding of the history and development of mathematics in India. They will learn some of the important mathematical results and techniques given by Indian mathematicians, study mathematical proofs in the Indian tradition, and appreciate the pedagogical significance of the Indian approach to mathematics.

## SYLLABUS

### Unit 1. Origins: Vedas and Śubasūtras :

- Place value system
- Conception of zero
- Origins of geometry

### Unit 2. Overview of important mathematical texts and the contributions of leading Indian mathematicians

- Āryabhaṭīya of Āryabhaṭa
- Brāhmasphuṭasiddhānta of Brahmagupta
- Līlāvatī and Bījagaṇita of Bhāskarācārya
- The Kerala school – Mādhava, Nīlakaṇṭha, Jyesṭhadeva, etc.

### Unit 3. Mathematical proofs, teacher-disciple lineages, and transmission of knowledge

- Mathematical proofs given by Bhāskara-I, Nīlakaṇṭha, Jyeṣṭhadeva, Munīśvara, etc.
- An overview of the major teacher-disciple mathematical lineages of India
- Transmission of mathematical knowledge between India and other civilizations

## References:


1. The Science of the Śulba, B. Datta, University of Calcutta, 1932
2. History of Hindu Mathematics: A Source Book, B. Datta and A. N. Singh, Asia Publishing House, 1962
3. Āryabhaṭīya of Āryabhaṭa, K. S. Shukla and K. V. Sarma, Indian National Science Academy, 1976
4. Geometry in Ancient and Medieval India, T. A. Sarasvati Amma, Motilal Banarasidass, 2007
5. Gaṇita-yukti-bhāṣā of Jyeṣṭhadeva, K. V. Sarma et. al., Hindustan Book Agency, 2008
6. Studies in Indian Mathematics and Astronomy: Selected Articles of Kripa Shankar Shukla, Kolachana et. al. (eds.), Culture and History of Mathematics 12, HBA, 2019
7. Līlāvatī of Bhāskarācārya, H. T. Colebrooke, ed. by H. C. Banerji, Kitab Mahal, 1967
8. Mathematics in India: From Vedic Period to Modern Times, M. D. Srinivas and K. Ramasubramanian and M. S. Sriram, NPTEL course

**BLUE PRINT**

**BLUE PRINT FOR CERTIFICATE COURSE**

**PAPER: MATHEMATICS IN INDIA**

| UNIT | TOPIC | M.C.Q | Marks allotted to the units |
|---|---|---|---|
| I | Unit 1.<br>Origins: Vedas and Śubasūtras : | 20 | 20 |
| II | Unit 2. Overview of important mathematical texts and the contributions of leading Indian mathematicians. | 20 | 20 |
| III | Unit 3. Mathematical proofs, teacher- disciple lineages, and transmission of knowledge | 10 | 10 |
| Total | | 50 | 50 |

QUESTION PAPER PATTERN:

M.C.Q = Multiple Choice Questions (1mark)

Multiple Choice Questions: 50 x1 = 50 M

Total = 50 M

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**CERTIFICATE COURSE - II**

**Paper** – ANCIENT INDIAN MATHEMATICS (II Mathematics Major)

**Total Hours – 30 hours /Additional Credits: 2**

**Course Objectives:**

1. To promote awareness and understanding among younger minds about contributions of Vedic mathematics and its genesis.
2. To bring forward the extraordinary work done by Indian Mathematicians in the fields such as Astronomy, Astrology, Geometry, Algebra, and Arithmetic etc. and to help the existing education system become in tune with the values of Vedic knowledge and acknowledge the contributions of Indian mathematicians.

**Learning Outcome:**

Study of Indian Mathematics will reveal students how it is embedded in Indian art, architecture, music, and religious practices, fostering a deeper understanding and appreciation of Indian culture. It will help learners to utilize efficient methods of solving mathematical problems devised within the field and expose them to unique notations & techniques expanding their mathematical toolkit. It will be interesting for students to learn and apply the concepts in other fields such as astronomy, architecture, navigation, linguistics etc. The subject will also showcase the global influence of Indian mathematical contributions, broadens students' mathematical knowledge, enhance problem-solving skills, and in turn will provide a deeper appreciation for the beauty and diversity of mathematical thought. Thus, the scope of Indian mathematics is enormous and through proper training of teachers, the learning process for it will be effectively facilitated.

**SYLLABUS**

Unit - I

1. Introductory Overview
2. Geometry in Śulbasūtras
3. Development of the Place-value system
4. Āryabhaṭīya of

Āryabhaṭa Unit - II

5. Brahmasphuṭasiddhānta
6. Līlāvat
7. Kuṭṭaka: Solutions of indeterminate equations and continued fractions •

Unit - III

8. Kerala school of Mathematics
9. Development of Trigonometry and Spherical trigonometry for solving astronomical problems.
10. Notion of Proofs in Indian mathematics and conclusion.

**References:**

1. B. Datta and A. N. Singh, History of Hindu Mathematics, 2 Parts, Lahore, 1935, 1938; Reprint, Asia Publishing House,
2. Bombay 1962; Reprint, Bharatiya Kala Prakashan, Delhi 2004.
3. C. N. Srinivasiengar, History of Indian Mathematics, The World Press, Calcutta, 1967.
4. T. A. Saraswati Amma, Geometry in Ancient and Medieval India, Motilal Banarsidass, Varanasi, 1979.
5. S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, 3rd Ed. Bhavan's Gandhi Centre, Bangalore, 2004.
6. G. G. Emch, M. D. Srinivas and R. Sridharan, Eds., Contributions to the History of Mathematics in India, Hindustan Book Agency, Delhi, 2005.
7. C. S. Seshadri, Ed., Studies in History of Indian Mathematics, Hindustan Book Agency, Delhi, 2010.
8. G. G. Joseph, Indian Mathematics Engaging the World from Ancient to Modern Times, World Scientific, London, 2016.
9. P. P. Divakaran, The Mathematics of India Concepts Methods Connections, Hindustan Book Agency 2018. Rep Springer New York, 2018.
10. Gaṇitayuktibhāṣā (c.1530) of Jyeṣṭhadeva (in Malayalam), Ed. with Tr. by K. V. Sarma with Explanatory Notes by K.Ramasubramanian, M. D. Srinivas and M. S. Sriram, 2 Volumes, Hindustan Book Agency, Delhi, 2008

**BLUE PRINT FOR CERTIFICATE COURSE**

**PAPER:** ANCIENT INDIAN MATHEMATICS

| UNIT | TOPIC | M.C.Q | Marks allotted to the units |
|---|---|---|---|
| I | Unit 1. | 20 | 20 |
| II | Unit 2. | 15 | 15 |
| III | Unit 3. | 15 | 15 |
| Total | | 50 | 50 |

QUESTION PAPER PATTERN:

M.C.Q = Multiple Choice Questions (1mark)

Multiple Choice Questions: 50 x1 = 50 M

Total = 50 M

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**WORK LOAD FOR THE YEAR 2025-2026 (ODD SEMESTERS)**

Name of the Subject : Mathematics

Total No. of Hours : 153

No. of Permanent posts sanctioned : 05

No. of Permanent staff working : Nil

No. of Contract faculty : 05

No. of Part – Time Faculty : 01

| S. No | Name of the class | No. of Theory hours | No. of Practical Hours | No.of Batches | Total Practical Hours | Study Hour | Total hrs.(Theory + Practical+ Study Hour) |
|---|---|---|---|---|---|---|---|
| 1 | Major Course - I | 5 | 0 | 0 | 0 | - | 05 |
| 2 | Major Course - II | 5 | 0 | 0 | 0 | - | 05 |
| 4 | Major Course - V | 3 | 2 | 4 | 8 | - | 11 |
| 5 | Major Course – VI | 3 | 2 | 4 | 8 | - | 11 |
| 6 | Major Course – VII | 3 | 2 | 4 | 8 | - | 11 |
| 7 | Major Course - VIII | 3 | 2 | 4 | 8 | - | 11 |
| 8 | Minor Course – II (Stat) | 3 | 2 | 3 | 6 | - | 09 |
| 9 | Minor Course – II (Che) | 3 | 2 | 3 | 6 | - | 09 |
| 10 | Minor Course – II (DS) | 3 | 2 | 3 | 6 | - | 09 |
| 11 | Major Course - XII | 3 | 2 | 4 | 8 | - | 11 |
| 12 | Major Course – XIII | 3 | 2 | 4 | 8 | - | 11 |
| 13 | Major Course – XIV | 3 | 2 | 4 | 8 | - | 11 |
| 14 | Major Course - XV | 3 | 2 | 4 | 8 | - | 11 |
| 15 | Minor Course – V (Stat) | 3 | 2 | 2 | 4 | - | 7 |
| 16 | Minor Course – V (Che) | 3 | 2 | 2 | 4 | - | 7 |
| 17 | Minor Course – VI (Stat) | 3 | 2 | 2 | 4 | - | 7 |
| 18 | Minor Course – VI (Che) | 3 | 2 | 2 | 4 | - | 7 |
| **Total Work load for the subject Mathematics** | | | | | | | 153 |

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**DEPARTMENT OF MATHEMATICS**

**WORK LOAD FOR THE YEAR 2025-2026(EVEN SEMESTERS)**

Name of the Subject : Mathematics

Total No. of Hours : 103

No. of Permanent posts sanctioned : 05

No. of Permanent staff working : Nil

No. of Contract faculty : 05

No. of Part – Time Faculty :

| S. No | Name of the class | No. of Theory hours | No. of Practical Hours | No.of Batches | Total Practical Hours | Study Hour | Total hrs.(Theory + Practical+ Study Hour) |
|---|---|---|---|---|---|---|---|
| 1 | Major Course - III | 5 | 0 | 0 | 0 | - | 05 |
| 2 | Major Course - IV | 5 | 0 | 0 | 0 | - | 05 |
| 6 | Major Course - IX | 3 | 2 | 3 | 8 | - | 11 |
| 7 | Major Course – X | 3 | 2 | 4 | 8 | - | 11 |
| 8 | Major Course – XI | 3 | 2 | 4 | 8 | - | 11 |
| 9 | Minor Course – III (Stat) | 3 | 2 | 3 | 6 | - | 9 |
| 10 | Minor Course – III (Che) | 3 | 2 | 3 | 6 | - | 9 |
| 11 | Minor Course – III (DS) | 3 | 2 | 3 | 6 | - | 9 |
| 12 | Minor Course – IV (Stat) | 3 | 2 | 3 | 6 | - | 9 |
| 13 | Minor Course – IV (Che) | 3 | 2 | 3 | 6 | - | 9 |
| 14 | Minor Course – IV (DS) | 3 | 2 | 3 | 6 | - | 9 |
| 15 | Apprenticeship | 6 | - | - | - | - | 6 |
| **Total Work load for the subject Mathematics** | | | | | | | 103 |

PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA
KAKINADA 533 001-ANDHRA PRADESH
An outcome based, NAAC accredited, green autonomous institution
4th Cycle NAAC accreditations grade B++
(Affiliated to ADI KAVI NANNAYA UNIVERSITY, Rajamahendravarm.)

## ACADEMIC CELL

(Certificate to be issued by the UniversityNomine/Subject Expert/Member of BOS)

Department Name : MATHEMATICS

Name of the BOS Member : Y PADMAJA

(University Nominee /Subject Expert/ Industrialist / Member)

I certify that the syllabus submitted by the Mathematics Department is verified by me and I recommend the following suggestions:

1. To enhance work load from 3+2 hrs to 4+2 hrs (in theory + practicals) to give justice to all the papers.
2. Proposed to conduct International Seminar / workshop in Mathematics
3. Inculcate Mathematical mind set in the High School Students through extension activities
4. Establishment of Mathematical labs using open source softwares
5. To encourage the Students for higher education as Mathematics is the Queen of All Sciences

The syllabus is approved with the above suggested modification

Padmaja 7/8/25
Signature with Date

Note: BOS Members are requested to fill the above details with necessary suggestions and send back to the Head of the department along with the syllabus

PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA
KAKINADA 533 001-ANDHRA PRADESH
An outcome based, NAAC accredited, green autonomous institution
4th Cycle NAAC accreditations grade B++
(Affiliated to ADI KAVI NANNAYA UNIVERSITY, Rajamahendravarm.)

## ACADEMIC CELL

(Certificate to be issued by the UniversityNomine/Subject Expert/Member of BOS)

Department Name : MATHEMATICS

Name of the BOS Member : M. Madhavi

(University Nominee /Subject Expert/ Industrialist / Member)

I certify that the syllabus submitted by the Mathematics Department is verified by me and I recommend the following suggestions:

1. It is recommended to increase the Lecture hours for each Course.
2. Instead of problem solving sessions, introduce the mathematical software in opensource in practical session.
3. To enhance the mathematical skills among students & faculty requested to conduct workshops/seminars.
4. Introduce the best practice of the department.
5. —

The syllabus is approved with the above suggested modification

M. Madhavi 7/8/25
Signature with Date

Note: BOS Members are requested to fill the above details with necessary suggestions and send back to the Head of the department along with the syllabus

PITHAPUR RAJAH'S GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA
KAKINADA 533 001-ANDHRA PRADESH
An outcome based, NAAC accredited, green autonomous institution
4th Cycle NAAC accreditations grade B++
(Affiliated to ADI KAVI NANNAYA UNIVERSITY, Rajamahendravarm.)

## ACADEMIC CELL

(Certificate to be issued by the UniversityNomine/Subject Expert/Member of BOS)

Department Name : MATHEMATICS

Name of the BOS Member : P.S.R. SUBRAHMANYAM.

(University Nominee /Subject Expert/ Industrialist / Member)

I certify that the syllabus submitted by the Mathematics Department is verified by me and I recommend the following suggestions:

1. I discussed with University nominee
2. and subject expert and convinced by the ideas and suggestions made
3. by them in their report. Those
4. may be implemented as per
5. convenience.

The syllabus is approved with the above suggested modification

Signature with Date

PSR SUBRAHMANYAM

Note: BOS Members are requested to fill the above details with necessary suggestions and send back to the Head of the department along with the syllabus


Thank you