Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI, NAVI MUMBAI
(Autonomous)
Department of Mathematics
M. Sc. Mathematics
(CBCS w.e.f. 2021-22)

Program Outcomes (POs)

Learners are able to:

PO-1	Disciplinary Knowledge and Skills	Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio-analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	Communication and Presentation Skills	Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	Creativity and Critical Judgement	Facilitate solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	Analytical Reasoning and Problem Solving	Build critical and analytical attitude in handling the problems and situations.
PO-5	Sense of Inquiry	Curiously raise relevant questions based on highly developed ideas, scientific theories and its applications including research.
PO-6	Use of Modern Tools	Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	Research Skills	Construct, collect, investigates, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	Application of Knowledge	Develop scientific outlook to create consciousness against the social myths and blind faith.
PO-9	Moral and Ethical Reasoning	Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	Leadership and Teamwork	Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.
PO-11	Environment and Sustainability	Create social awareness about environment and develop sustainability for betterment of future.

PO-12	Lifelong Learning	Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSO)

PSO1	Recalling the concepts of mathematics and applying them to the various courses like algebra, analysis, Differential equations, statistics, etc to form mathematical models.
PSO2	Apply Mathematics to interdisciplinary ways like statistician, mathematical finance, industry expertise and interpret quantitative ideas.
PSO3	Apply knowledge of Mathematics for research and engineering.

Choice Based Credit System (CBCS) Structure

Programme	SEM	Core Course (CC) (6 credits per course)	Discipline Specific Elective (DSE) (6 credits per course)	SEC (4 credits per course)
MSC-I Mathematics	I	Algebra-I Analysis-I Complex Analysis	Discrete Mathematics Or Elementary Probability Theory and Statistics	Introduction to R Programming-I
	II	Algebra-II Topology Research Methodology	Differential Equation Or Optimization Techniques	Introduction to R Programming-II
MSC-II Mathematics	III	Algebra-III Analysis-II Differential Geometry	Numerical Methods Or Graph Theory Or Design Theory	Integral Transform
	IV	Field Theory Functional Analysis Partial Differential Equations	Fourier Analysis Or Mathematical Modelling Or Calculus on Manifolds	Project

Note: 1. Blue Highlighted Topic / Course has focused on employability/ entrepreneurship/skill development
2. Yellow Highlighted Topic / Course is related to professional ethics, gender, human values, Environment & sustainability
3. Green Highlighted Topic / Course is related to local/national/regional & global development needs.

CO-PO Mapping Matrix

*In CO-PO Mapping Matrix: a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

PGMT101 - Algebra I

Course Outcomes: After successful completion of this course, students will be able to:
- **CO-1:** Define dual space and calculate the dual basis of a finite dimensional vector space.
- **CO-2:** Explain the relation between matrices representing a linear transformation and its transpose.
- **CO-3:** Explain different operators like normal, self-adjoint and symmetric operators.
- **CO4:** Compute the Eigenvalue and Eigenvectors and minimal polynomials of a matrix.
- **CO5:** Compute Jordan Canonical form of a matrix.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1. https://onlinecourses.nptel.ac.in/noc20_ma34/preview
2. https://onlinecourses.nptel.ac.in/noc19_ma23/preview
3. https://onlinecourses.nptel.ac.in/noc21_ma50/preview

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	1	-	-	-	-	-	-	-	-
CO2	1	1	-	1	-	-	-	-	-	-	-	-
CO3	2	1	-	1	-	-	-	-	-	-	-	-
CO4	3	-	-	2	-	-	-	-	-	-	-	-
CO5	1	-	-	2	-	-	-	-	-	-	-	-

PGMT102- Analysis I

Course Outcomes: After successful completion of this course, students will be able to:
- **CO-1:** Recall Inner product space, norm linear space and vector space.
- **CO-2:** Distinguish among open and closed sets on different topologies of $\mathbb{R}^n$.
- **CO-3:** Determine whether a function is Riemann integrable using definition and Riemann criteria.
- **CO4:** Demonstrate a working knowledge of Taylor's theorem, mean value inequality and mean value theorem.
- **CO5:** Find stationary points, saddle points, maxima and minima of a differentiable function by applying a second derivative test.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1) Basic Calculus-1 - Course https://onlinecourses.nptel.ac.in/noc20_ma34/preview
2) Basic real analysis - Course https://onlinecourses.nptel.ac.in/noc19_ma23/preview
3) Multivariable calculus - Course https://onlinecourses.nptel.ac.in/noc21_ma50/preview

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-		-	-	-	-	-	-	-	-
CO2	-	-	2	1	-	-	-	-	-	-	-	-
CO3	-	-	1	2	-	-	-	-	-	-	-	-
CO4	1	-	-	2	1	-	-	-	-	-	-	-
CO5	2	-	-	2	2	-	-	-	-	-	-	-

PGMT103 - Complex Analysis

Course Outcomes: After successful completion of this course, students will be able to:

CO-1 : Represent complex numbers algebraically and geometrically.

CO-2 : Define and analyze limits, continuity for complex functions as well as consequences of continuity.

CO-3 : Apply the Cauchy-Riemann equations and results on harmonic and entire functions including the fundamental theorem of algebra.

CO-4 : Analyze sequences and series of analytic functions and types of convergence.

CO-5 : Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions.

CO-6 : Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, problem Solving)

Links: SWAYAM / MOOCS:
1. NOC:Complex Analysis https://nptel.ac.in/courses/111/106/111106141/
2. Complex Analysis https://nptel.ac.in/courses/111/107/111107056/
3. Advanced Complex Analysis https://nptel.ac.in/courses/111/106/111106084/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-		-	-	-	-	-	-	-	-

CO												
CO2	1	-	-	2	-	-	-	-	-	-	-	-
CO3	1	-	2	3	1	-	-	-	-	-	-	-
CO4	2	-	-	2	-	-	-	-	-	-	-	-
CO5	1	-	2	1	1	-	-	-	-	-	-	-
CO6	1	1	2	-	-	-	-	-	-	-	-	-

PGMT104A - Discrete Mathematics

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Solve discrete mathematics problems that involve computing permutations and combinations of a set.

CO-2: Explain Polya's theory of counting, Orbit stabilizer theorem, Burnside lemma and its applications, applications of Polya's formula.

CO-3: Apply the knowledge of Number theory to attain specific maturity.

CO4: Apply fundamental enumeration principles to solve appropriate problems.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:

Mathematics - Discrete Mathematics   https://nptel.ac.in/courses/111/107/111107058/
Mathematics - Number Theory https://nptel.ac.in/courses/111/103/111103020/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	-	-	-	-	-	-	-	-
CO2	1	1	-	1	-	-	-	-	-	-	-	-
CO3	2	-	-	2	-	-	-	-	-	-	-	-
CO4	1	-	1	3	-	-	-	-	-	-	-	-

PGMT104B - ELEMENTARY PROBABILITY THEORY AND STATISTICS

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Define the principle concepts about probability.

CO-2: Express the concept of probability with the concept of random variable and the probability distributions.

CO-3: Calculate the expected value and the moments.

CO4: Derive the probability density function of transformation of random variables.

CO5: Find basic theoretical and applied principles of statistics.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	1	-	1	-	-	-	-	-	-	-	-
CO3	1	-	2	2	-	-	-	-	-	-	-	-
CO4	1	-	1	3	-	-	-	-	-	-	-	-
CO5	1	-	2	2	-	-	-	-	-	-	-	-

PGMT105: INTRODUCTION TO R PROGRAMMING -I

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Study of fundamentals of R.

CO-2: Use different functions, variables and operators in R

CO-3: Write and execute programming in R by using loop and string

CO-4: Analysed and visualized mathematical statistical functions using R.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	1	-	1	-	-	-	-	-	-
CO2	2	-	-	1	-	2	-	-	-	-	-	-
CO3	2	1	1	-	-	1	-	-	-	-	-	-
CO4	1	-	-	2	-	-	-	1	-	-	-	-

SEMESTER II

PGMT201 - ALGEBRA II

Course Outcomes: After successful completion of this course, students will be able to:

CO-1 : Understand the concept of group homomorphism, isomorphism and automorphism and apply it for constructing groups.

CO-2 : Analyze Class equation, Sylow's theorems and apply them for describing structures of finite groups.

CO-3 : Demonstrate the knowledge of Rings, ideals of Rings and Quotient rings, Polynomial ring over field and its extension.

CO-4 : Learn Fundamental theorem of algebra, Burnside theorem and Kronecker's theorem and solve the problems.

CO-5 : Derive and apply Gauss Lemma, and Eisenstein criterion for irreducibility of Polynomials.

CO-6 : Demonstrate Field extensions and characterization of finite fields.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1. NOC:Algebra II https://nptel.ac.in/courses/111/106/111106151/
2. Basic Algebraic Geometry https://nptel.ac.in/courses/111/106/111106097/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	3	1	-	-	-	-	-	-	-
CO2	2	-	1	2	-	-	-	-	-	-	-	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-
CO4	3	-	2	-	-	-	-	-	-	-	-	-
CO5	1	-	3	1	-	-	-	-	-	-	-	-
CO6	3	1	2	-	-	-	-	-	-	-	-	-

PGMT202– Topology

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Identify topologies and form a topological space using basis and sub-basis.

CO-2: Define connected space and find its components and path components of a topological space.

CO-3: Study of theorems on connectedness, compactness and completeness.

CO-4: State the first, second countability and separable axioms. List the results based on first and second countability.

CO-5: Apply metric space concept to compactness and completeness.

ICT Tools Used: Videos, PPT, Pen-Tablet

Links: SWAYAM / MOOCS:
1. https://nptel.ac.in/courses/111/106/111106054/#
2. https://nptel.ac.in/courses/111/106/111106053/#

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	1	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	1	1	-	-	-	-
CO4	3	-	2	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-

PGMT203– RESEARCH METHODOLOGY

Course Outcomes: After successful completion of this course, students will be able to:
CO-1: Understand fundamental concept of research and define appropriate hypothesis.
CO-2: Collect data and apply different methods for sampling data
CO-3: Analyse data and form report
CO-4: Understand Intellectual Property Rights, patenting and copy right to develop research skill
CO-5: Construct project research report

ICT Tools Used: Videos, PPT, Sampling Data Analysis

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1. https://nptel.ac.in/courses/121/106/121106007/
2. https://nptel.ac.in/courses/107/108/107108011/
3. https://nptel.ac.in/courses/127/105/127105008/
4. https://nptel.ac.in/courses/110/105/110105139/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	1	1	-	-	-	-	-	-
CO2	2	-	-	2	1	1	1	1	-	-	-	-
CO3	2	1	-	-	-	1	1	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	1	1	-	-	-	-	1

PGMT204A– Differential equations

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Apply Picard's method for finding solutions of first order differential equations.

CO-2: Expresses the existence and uniqueness results for an nth order linear Ordinary Differential Equations.

CO-3: Apply the method of 'variation of parameters' to find solution of higher order linear differential equations with variable coefficients.

CO-4: Define Fourier series and apply for periodic functions.

CO-5: Construct Fourier analysis of daily life periodic functions.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1. https://nptel.ac.in/courses/111/108/111108081/ .
2. https://nptel.ac.in/courses/111/106/111106046/
3. https://nptel.ac.in/courses/111/104/111104031/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	1	-	-	1	-	-	-	-
CO2	2	-	-	3	-	-	1	-	-	-	-	-
CO3	2	-	1	1	-	-	2	-	-	-	-	-
CO4	-	-	-	2	1	-	-	-	-	-	-	-
CO5	-	-	1	2	-	-	-	-	-	-	-	-

PGMT204B– Optimization Techniques

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Formulate linear programming problems to determine the feasible solutions.

CO-2: Explain first and second order conditions for local optima.

CO-3: Use various methods such as one-dimensional search method, Golden section search, Fibonacci search etc.

CO-4: Apply operation research to handle data in industry.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1. https://nptel.ac.in/courses/111/105/111105039/
2. https://nptel.ac.in/courses/111/102/111102012/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	c	-	-	-
CO2	3	-	1	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	2				1	-	-	-	-
CO5									-	-	-	-

PGMT204A– INTRODUCTION TO R PROGRAMMING-II

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Create different types of data frames in R

CO-2: Handel and analyse various files in R

CO-3: Analyse and visualize statistical functions using R.

CO-4: Apply R programming to machine learning and big data analysis.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1. https://nptel.ac.in/courses/111/104/111104100/
2. https://nptel.ac.in/courses/110/105/110105142/
3. https://nptel.ac.in/courses/111/104/111104120/
4. https://nptel.ac.in/courses/111/104/111104146/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	1	-	1	-		-	-	-	-
CO2	2	-	-	1	-	2	-	1	-	-	-	-
CO3	2	1	1	-	-	-	-	1	-	-	-	-
CO4	1	-	-	2	-	-	-	1	-	-	-	-

Scheme of Examination

      In each semester, the performance of the learners shall be evaluated into two parts. The learner's performance in each course shall be assessed by Continuous Internal Assessment **(CIE)** with 40 marks and conducting the **Semester End Examinations (SEE)** with 60 marks.

Continuous Internal Assessment of 40 marks:

Paper Code	CIE	Unit Tests/Seminar	Total
PGMT101 to PGMT104 and PGMT201 TO PGMT204	20 Marks	20 Marks	40 Marks
PGMT105 and PGMT205 (SEC)	Practical based on each unit		40 Marks

Project Work:
Evaluation of Project work: The evaluation of the Project submitted by a student shall be made by a Committee appointed by the Head of the Department of Mathematics of the college. The presentation of the project is to be made by the student in front of the committee appointed by the Head of the Department of Mathematics. This committee shall have two members, possibly with one external referee.

The Marks for the project are detailed below:
1. Monthly Project Report & Development: 30 Marks.
2. Power Point presentation: 10 Marks.
3. Viva- voce: 20 Marks.
4. Usage of modern tools/ technology: 10 Marks.
5. Innovativeness: 10 Marks.
6. Individual Contribution: 10 Marks.
7. Group activity: 10 Marks.

Semester End Examination of 60 marks:
(i) Duration: - Examination shall be of **Two and Half hours** duration.
(ii) Theory Question Paper Pattern: -
    1. There shall be five questions each of 12 marks.
    2. On each unit there will be one question and the fifth one will be based on entire syllabus.
    3. All questions shall be compulsory with internal choice within each question.
    4. Each question may be subdivided into sub-questions a, b, c, d and the allocation of marks depend on the weightage of the topic.
    5. Each question will be of 24 marks when marks of all the sub-questions are added (including the options) in that question.

Questions		Marks
Q 1	Based on Unit I	12
Q 2	Based on Unit II	12
Q 3	Based on Unit III	12
Q 4	Based on Unit IV	12
Q 5	Based on All Units (I to IV)	12
Total Marks		**60**