

Salesian College (Autonomous) Sonada \& Siliguri

## Curriculum Document

under
National Education Policy (NEP) 2020 Curriculum
Framework
for
Departments of Mathematics
and
Statistics (Minor)
$\qquad$

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2023-2024
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Approved by: Subhajit Paul, Chairperson, BoS of Mathematics \& Statistics.
Date: $\qquad$

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## PREAMBLE

This culminated document contains the complete curriculum framework with course objectives \& outcomes and assessment rubrics for the first two semesters designed by the Dept of Mathematics for its students of four-year undergraduate programmes (FYUGP) with Honours in Mathematics as the single Major and Statistics as one of the Minor subjects. This design aligns with the layout suggested by the UGC as cited in [1] and the regulations of Salesian College (Autonomous), Sonada \& Siliguri.

### 1.1 Vision \& Mission Statements

Vision: The Department of Mathematics, Salesian College envisages empowering the students with the ability to think critically and rationally along the lines of the robustness of Mathematical logic and to prepare them for the quest for higher knowledge and experiences in the fields of both Academia and Industry with a mindset to collaborate with interdisciplinary fields for a holistic betterment of the society.

Mission: To exercise relevant pedagogies to provide in-depth analysis and the sense of appreciation of Mathematical concepts while fostering scientific temper and encouraging rational thinking.

### 1.2 Graduate Attributes

### 1.2.1 Generic outcomes

1. Complex problem-solving: The graduates should be able to demonstrate the capability to solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations.
2. Critical thinking: The graduates should be able to demonstrate the capability to

- apply analytic thought to a body of knowledge, including the analysis and evaluation of policies, and practices, as well as evidence, arguments, claims, beliefs, and the reliability and relevance of evidence,
- identify relevant assumptions or implications; and formulate coherent arguments,
- identify logical flaws and holes in the arguments of others,
- analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples.

3. Creativity: The graduates should be able to demonstrate the ability to

- create, perform, or think in different and diverse ways about the same objects or scenarios,
- deal with problems and situations that do not have simple solutions,
- innovate and perform tasks in a better manner,
- view a problem or a situation from multiple perspectives,
- think 'out of the box' and generate solutions to complex problems in unfamiliar contexts,
- adopt innovative, imaginative, lateral thinking, interpersonal skills and emotional intelligence.

4. Communication Skills: The graduates should be able to demonstrate the skills that enable them to

- listen carefully, read texts and research papers analytically and present complex information in a clear and concise manner to different groups/audiences,
- express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media,
- confidently share views and express herself/himself,
- construct logical arguments using correct technical language related to a field of learning, work/vocation, or an area of professional practice, and convey ideas, thoughts, and arguments using language that is respectful and sensitive to gender and other minority groups.

5. Analytical reasoning/thinking: The graduates should be able to demonstrate the capability to

- evaluate the reliability and relevance of evidence;
- identify logical flaws in the arguments of others;
- analyse and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and address opposing viewpoints.

6. Research-related skills: The graduates should be able to demonstrate

- a keen sense of observation, inquiry, and capability for asking relevant/appropriate questions,
- the ability to problematize, synthesize, and articulate issues and design research proposals,
- the ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships,
- the capacity to develop appropriate methodology and tools for data collection,
- the appropriate use of statistical and other analytical tools and techniques,
- the ability to plan, execute and report the results of an experiment or investigation,
- the ability to acquire the understanding of basic research ethics and skills in practising/doing ethics in the field/personal research work, regardless of the funding authority or field of study.

7. Coordination/Collaboration: The graduates should be able to demonstrate the ability to

- work effectively and respectfully with diverse teams,
- facilitate cooperative or coordinated effort on the part of a group,
- act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.

8. Leadership qualities: The graduates should be able to demonstrate the capability for

- mapping out the tasks of a team or an organization and setting direction.
- formulating an inspiring vision and building a team that can help achieve the vision, motivating and inspiring team members to engage with that vision.
- using management skills to guide people to the right destination.

9. Lifelong learning of skills: The graduates should be able to demonstrate the ability to

- acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through selfpaced and self- directed learning aimed at personal development, meeting economic, social, and cultural objectives, and adapting to changing trades and demands of the workplace, including adapting to the changes in work processes in the context of the fourth industrial revolution, through knowledge/ skill development/reskilling,
- work independently, identify appropriate resources required for further learning,
- acquire organizational skills and time management to set self-defined goals and targets with timelines.
- inculcate a healthy attitude to be a lifelong learner.

10. Digital and technological skills: The graduates should be able to demonstrate the capability to

- use ICT in a variety of learning and work situations,
- access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.

11. Multicultural competence and inclusive spirit: The graduates should be able to demonstrate

- the acquisition of knowledge of the values and beliefs of multiple cultures and a global perspective to honour diversity,
- capability to effectively engage in a multicultural group/society and interact respectfully with diverse groups,
- capability to lead a diverse team to accomplish common group tasks and goals.
- gender sensitivity and adopting a gender-neutral approach, as also empathy for the less advantaged and the differently-abled including those with learning disabilities.

12. Value inculcation: The graduates should be able to demonstrate the acquisition of knowledge and attitude that are required to

- embrace and practice constitutional, humanistic, ethical, and moral values in life, including universal human values of truth, righteous conduct, peace, love, non violence, scientific temper, citizenship values,
- practice responsible global citizenship required for responding to contemporary global challenges, enabling learners to become aware of and understand global issues and to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies,
- formulate a position/argument about an ethical issue from multiple perspectives,
- identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights,
- recognise environmental and sustainability issues, and participate in actions to promote sustainable development.
- adopt an objective, unbiased, and truthful actions in all aspects of work,
- instil integrity and identify ethical issues related to work, and follow ethical practices.

13. Autonomy, responsibility, and accountability: The graduates should be able to demonstrate the ability to

- apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification,
- work independently, identify appropriate resources required for a project, and manage a project through to completion,
- exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces.

14. Environmental awareness and action: The graduates should be able to demonstrate the acquisition of and ability to apply the knowledge, skills, attitudes, and values required to take appropriate actions for

- mitigating the effects of environmental degradation, climate change, and pollution,
- effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.

15. Community engagement and service: The graduates should be able to demonstrate the capability to participate in community-engaged services/activities for promoting the well- being of society.
16. Empathy: The graduates should be able to demonstrate the ability to identify with or understand the perspective, experiences, or points of view of another individual or group, and to identify and understand other people's emotions.

### 1.2.2 Programme specific outcomes

After completion of the 4 year programme with Honours in Mathematics, a student should be able to
(a) demonstrate fundamental systematic knowledge of mathematics and its applications in engineering, science, technology and mathematical sciences;
(b) demonstrate educational skills in areas of analysis, geometry, algebra, mechanics, differential equations, etc;
(c) apply knowledge, understanding, and skills to identify the difficult/ unsolved problems in mathematics and to collect the required information in possible range of sources and try to analyse and evaluate these problems using appropriate methodologies;
(d) fulfil learning requirements in mathematics, drawing from a range of contemporary research works and their applications in diverse areas of mathematical sciences;
(e) apply disciplinary knowledge and skills in mathematics in newer domains and uncharted areas;
(f) identify challenging problems in mathematics and obtain well-defined solutions;
(g) exhibit subject-specific transferable knowledge in mathematics relevant to job trends and employment opportunities.

### 1.3 Programme Structure

The honours programme in Mathematics at Salesian College (Autonomous) Siliguri spans across eight semesters over four years. Following table shows the total number of courses to be taken by a student in this entire period of study.

| Course type | $\#$ <br> Courses | Credit/ <br> course | Total <br> credits |
| :--- | :---: | :---: | :---: |
| Major courses | 24 | 4 | 96 |
| Minor courses | 8 | 4 | 32 |
| Multidisciplinary courses | 3 | 3 | 9 |
| Skill enhancement courses | 3 | 3 | 9 |
| Ability enhancement courses | 4 | 2 | 8 |
| Value added courses | 10 | 1 | 10 |
| Internship | 1 | 4 | 4 |
| Total | $\mathbf{5 3}$ |  | $\mathbf{1 6 8}$ |

Table 1.1: Cumulative course structure for Bachelor Degree programme with Honours with Major in Mathematics

### 1.3.1 Distribution of courses offered by Dept of Mathematics

| Sem | Course code | Course title | Credits |
| :---: | :---: | :---: | :---: |
| Major Courses |  |  |  |
| I | 23MATMAJ101 | Classical Algebra and Two-dimensional Geometry | 4 |
|  | 23MATMAJ102 | Ordinary Differential Equations I and Application of Calculus | 4 |
| II | 23MATMAJ103 | Real Analysis I | 4 |
|  | 23MATMAJ104 | Group Theory I | 4 |
| III | 23MATMAJ205 | Linear Algebra I | 4 |
|  | 23MATMAJ206 | Real Analysis II | 4 |
| IV | 23MATMAJ207 | Ring and Field Theory | 4 |
|  | 23MATMAJ208 | Real Analysis III | 4 |
|  | 23MATMAJ209 | Ordinary Differential Equations II and Three-dimensional Geometry | 4 |
| V | 23MATMAJ310 | Numerical Analysis | 4 |
|  | 23MATMAJ311 | Multivariate Calculus | 4 |
|  | 23MATMAJ312 | Probability Theory | 4 |
|  | 23MATMAJ313 | Operations Research | 4 |
| VI | 23MATMAJ314 | Integral Calculus | 4 |
|  | 23MATMAJ315 | Complex Analysis | 4 |
|  | 23MATMAJ316 | Group Theory II | 4 |
| VII | 23MATMAJ417 | Partial Differential Equations | 4 |
|  | 23MATMAJ418 | Metric Spaces | 4 |
|  | 23MATMAJ419 | Linear Algebra II | 4 |
|  | 23MATMAJ420 | Number Theory or Vector Analysis | 4 |
| VIII | 23MATMAJ421 | General Topology | 4 |
|  | 23MATMAJ422 | Measure Theory | 4 |
|  | 23MATMAJ423 | Differential Geometry or Integral Transform | 4 |
|  | 23MATMAJ424 | Functional Analysis or Graph Theory | 4 |
| Minor Courses |  |  |  |
| I | 23MATMIN101 | Linear Algebra and Differential Equations | 4 |
| III | 23MATMIN202 | Discrete Mathematics | 4 |


| Sem | Course code | Course title | Credits |
| :---: | :---: | :---: | :---: |
| V | 23MATMIN303 | Numerical Analysis or Advanced Calculus | 4 |
| VII | 23MATMIN404 | Optimisation Techniques or Algebra | 4 |
| Skill Enhancement Courses (SEC) |  |  |  |
| I | 23MATSEC101 | Typesetting in LATEX | 3 |
| II | 23MATSEC102 |  | 3 |
| III | 23MATSEC203 |  | 3 |
| Value Added Courses (VAC) |  |  |  |
| I | 23MATVAC101 | Introduction to Number Systems | 1 |
| II | 23MATVAC102 |  | 1 |
| III | 23MATVAC203 |  | 1 |
| IV | 23MATVAC204 |  | 1 |
| V | 23MATVAC305 |  | 1 |
| VI | 23MATVAC306 |  | 1 |
| Multi-disciplinary Courses (MDC) |  |  |  |
| I | 23MATMDC101 | Basic Mathematics | 3 |
| II | 23MATMDC102 | Mathematics for Competitive Examinations | 3 |

### 1.3.2 Semesters I \& II Course matrix for Mathematics Major students

| Course code | Type | Course title |  |  |  | Credits <br> $(\mathbf{L}+\mathbf{T}+\mathbf{P})^{1}$ | Classes/ <br> week |
| :---: | :---: | :--- | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |
| 23MATMAJ101 | Major | Classical Algebra and <br> Two-dimensional Geometry | $4+0+0$ | 4 |  |  |  |
| 23MATMAJ102 | Major | Differential Equations | $4+0+0$ | 4 |  |  |  |
| 23STAMIN101 | Minor | Statistical Methods | $3+0+1$ | 5 |  |  |  |
| 23MATSEC101 | SEC | Typesetting in LATEX | $1+0+2$ | 5 |  |  |  |
| 23MATVAC101 | VAC | Introduction to Number Systems | $0+0+1$ | 2 |  |  |  |
| 23ENGAEC101 | AEC | Compulsory English | $2+0+0$ | 2 |  |  |  |
| 23***MDC101 | MDC | Multi-disciplinary course | $3+0+0$ | 3 |  |  |  |

[^0]| Course code | Type | Course title | Credits <br> $(\mathbf{L}+\mathbf{T}+\mathbf{P})$ | Classes/ <br> week |
| :---: | :---: | :--- | :---: | :---: |
| 23SCSVED101 | VAC | Value Education | $1+0+0$ | 1 |
| Sotal |  |  |  |  |

## SYLLABI FOR MAJOR COURSES

### 2.1 23MATMAJ101: Classical Algebra and Two dimensional Geometry

### 2.1.1 Course description

| Course code: <br> Course category: <br> Title of the course: |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 23MATMAJ101 <br> Major <br> Classical Algebra and Two dimensional <br> Geometry |  |  |  |  |
| Semester | Credits | Lecture hours <br> in a week | Total lecture <br> hours | Regulation <br> year |
| $\mathbf{I}$ | $\mathbf{4}$ | $\mathbf{4}$ | $\mathbf{6 0}$ | $\mathbf{2 0 2 3}$ |

## Prerequisites

Before attending the course, students should be familiar with

- basic algebraic operations with real variables;
- binomial theorem with a positive integer index;
- solution of quadratic equations;
- evaluation of determinants up to order 3 .


## Objectives

At the end of the course, the students should be able to
MAJ101-Ob1 Familiarise themselves with estimation processes using inequalities.
MAJ101-Ob2 Develop an understanding of the argand plane and the complex numbers as vectors.

MAJ101-Ob3 Solve a polynomial equation up to degree 4 and investigate other equations of particular types.
MAJ101-Ob4 Develop an understanding of the conic sections.

## Corresponding outcomes

The outcome corresponding to the learning objective MAJ101-Ob1, is
MAJ101-CO1: Remember the important inequalities and apply the appropriate inequality for specific problems.

The outcome corresponding to the learning objective MAJ101-Ob2, is
MAJ101-CO2: Understand basic structure of Argand plane and perform algebra thereat.
The outcomes corresponding to the learning objective MAJ101-Ob3, are
MAJ101-CO3: Solve cubic, biquadratic, reciprocal and binomial equations, demonstrating proficiency in identifying and manipulating these specific equation types.

MAJ101-CO4: Locate positions of roots and exhibit relations of roots and coefficients.
The outcome corresponding to the learning objective MAJ101-Ob4, is
MAJ101-CO5: Analyse geometric objects, employ coordinate systems, derive equations, and apply geometric concepts to solve problems.

## Content

| Unit: 1 | Credits: 1 | Lecture hours: 15 |
| :--- | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ101-Ob1 <br> and MAJ101-Ob2 | Remembering: $\quad$ MAJJ101-CO1 <br> Applying: $\quad$ MAJ101-CO1 and MAJ101-CO2 |
| InEQUALITIES: AM $\geq$ GM $\geq$ HM; Theorem of weighted means. Statements only <br> and applications of $m^{\text {th }}$ power theorem, Cauchy-Schwartz inequality, Holder's <br> inequality, Minkowski's inequality. |  |  |
| Complex nUMBERS: Polar representation. De Moivre's theorem for rational in- <br> dices and its applications. Trigonometric, logarithm, exponential and hyperbolic <br> functions of complex variable. |  |  |


| Unit: 2 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: |  |
| Objectives mapped: | Remembering: MAJ101-CO3 and MAJ101-CO4 |  |
| MAJ101-Ob3 | Understanding: MAJ101-CO3 and MAJ101-CO4 |  |
|  | Applying: $\quad$ MAJ101-CO3 and MAJ101-CO4 |  |

Theory of equations: Polynomials and their properties. Relation between roots and coefficients. Transformation of equations. Cubic and biquadratic equations. Cardan's and Ferrari's method. Solutions of reciprocal and binomial equations. Symmetric functions of roots. Location of roots.

| Unit: 3 | Credits: 2 | Lecture hours: 30 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ101-Ob4 | Remembering: MAJ101-CO5 <br> Understanding: MAJ101-CO5 <br> Applying: $\quad$ MAJ101-CO5 |

## Suggested readings

1. Mapa, S K, Higher Algebra: Classical, Sarat Book House.
2. Khan, R M, Algebra [Classical, Modern, Linear and Boolean], New Central Book Agency.
3. Chakravorty, J G, and Ghosh P R, Advanced Analytical Geometry, U N Dhur \& Sons Pvt Ltd.
4. Khan, R M, Analytical Geometry of Two and Three Dimensions and Vector Analysis, New Central Book Agency.

## Reference books

1. Andreescu, T, and Andrica, D, Complex Numbers from A to Z, Birkhäuser.
2. Burnside, W S, and Panton, A W, The Theory of Equations, Wentworth Press.
3. Bej, N K, and Mukherjee, A, Analytical Geometry Of Two $\mathcal{E}$ Three Dimensions (Advanced Level), Book \& Allied Pvt Ltd.

### 2.1.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 2.1.3 Approval (23MATMAJ101)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Bikiran Das | Subhajit Paul | Subhajit Paul |
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|  |  |  |
|  |  |  |

### 2.2 23MATMAJ102: Ordinary Differential Equations I and Applications of Calculus

### 2.2.1 Course description

| Course code: <br> Course category: <br> Title of the course: |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 23MATMAJ102 <br> Major <br> Ordinary Differential Equations I and <br> Applications of Calculus |  |  |  |  |
| Semester | Credits | Lecture hours <br> in a week | Total lecture <br> hours | Regulation <br> year |
| $\mathbf{I}$ | $\mathbf{4}$ | $\mathbf{4}$ | $\mathbf{6 0}$ | $\mathbf{2 0 2 3}$ |

## Prerequisites

Before attending the course, students should be familiar with

- computational processes in calculus like evaluating limits, investigating continuity, etc.;
- different differentiation techniques, including rules for differentiation, chain rule, product rule, and quotient rule;
- different techniques of integration, such as substitution, integration by parts, partial fractions, etc.


## Objectives

At the end of the course, the students should be able to
MAJ102-Ob1 Develop a solid understanding of the basic concepts related to ordinary differential equations (ODEs) including order, linearity, and solutions (particular solutions, general solutions, and initial value problems) and also learn to classify different types of ODEs based on their order, linearity, and degree.

MAJ102-Ob2 Learn various methods and techniques to solve different types of ODEs. These may include first order, second order linear, higher order, special types and system of ODEs.
MAJ102-Ob3 Investigate several properties of a curve and classify them.
MAJ102-Ob4 Calculate length of a curve, area bounded by a curve, and volume of a surface generated by a curve.

## Corresponding outcomes

The outcome corresponding to the learning objective MAJ102-Ob1 is
MAJ102-CO1: Identify different types of ODEs.
The outcomes corresponding to the learning objective MAJ102-Ob2, are
MAJ102-CO2: Solve first order ODEs utilising the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.
MAJ102-CO3: Compute exact solutions of solvable first order ODEs and linear ODEs of higher order using various methods.
MAJ102-CO4: Describe the concepts of general solution and particular integral of a linear ODE of an arbitrary order, and also to obtain them using prescribed methods.

The outcomes corresponding to the learning objective MAJ102-Ob3, are
MAJ102-CO5: Remember the formulæ of various attributes and trace a given curve by calculating them.
MAJ102-CO6: Calculate the higher order derivatives and limits of indeterminate forms.
The outcome corresponding to the learning objective MAJ102-Ob4, is
MAJ102-CO7: Calculate length of a curve, area bounded by a curve, and volume of a surface generated by a curve.

## Content

| Unit: 1 | Credits: 1 | Lecture hours: 15 |
| :---: | :---: | :---: |
| Objectives mapped: <br> MAJ102-Ob1 <br> and MAJ102-Ob2 | Cognitive levels achieved through outcomes: |  |
| Definition and examples of Ordinary Differential equations (ODEs). Formulation of ODE by eliminating parameters. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations. |  |  |


| Unit: 2 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :---: |
| Objectives mapped: | Cognitive levels achieved through outcomes: <br> MAJ102-Ob2 | Understanding: MAJ102-CO4 <br> Applying: $\quad$ MAJ102-CO3 |
| General solution of homogeneous equation of second order, principle of super posi- <br> tion for homogeneous equation, Wronskian: its properties and applications, Linear <br> homogeneous and non-homogeneous equations of higher order with constant coeffi- <br> cients, Euler's equation, method of undetermined coefficients, method of variation <br> of parameters. |  |  |


| Unit: 3 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ102-Ob3 | Remembering: MAJ102-CO5 <br>  Understanding: <br> Applying: MAJ102-CO5 <br> MAJ102-CO5 and MAJ102-CO6  |
| AppliCATION OF DIFFERENTIAL CALCULUS: <br> theorem. Curvature, convexity and concavity. |  |  |
| Natcessive differentiation, Leibnitz <br> Nature of a singular point. Curve tracing. |  |  |


| Unit: 4 | Credits: | Lecture hours: 15 |
| :---: | :---: | :---: |
| Objectives mapped: <br> MAJ102-Ob4 | Cognitive levels achieved through outcomes: |  |
| Application of Integral Calculus: Derivations and illustrations of reduction formulæ of the type $\int \sin ^{n} x d x, \int \cos ^{n} x d x, \sec ^{n} x d x, \int \tan ^{n} x d x, \int(\log x)^{n} d x$, $\int \sin n x \cos m x d x$ etc. Arc length of a curve, arc length of parametric curves, area enclosed by a curve, area between two curves, area and volume of revolution. |  |  |

## Suggested readings

1. Ghosh, R K, and Maity K C, An Introduction to Differential Equations, New Central Book Agency.
2. Raisinghania, M D, Ordinary and Partial Differential Equation, S Chand Publishing.
3. Ross, S L, Differential Equations, Wiley.
4. Ghosh, R K, and Maity, K C, An Introduction to Analysis: Differential Calculus: Part I, New Central Book Agency.
5. Ghosh, R K, and Maity, K C, An Introduction to Analysis: Integral Calculus, New Central Book Agency.

### 2.2.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 2.2.3 Approval (23MATMAJ102)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Debdut Sengupta | Subhajit Paul | Subhajit Paul |
|  |  |  |
|  |  |  |
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### 2.3 23MATMAJ103: Real Analysis I

### 2.3.1 Course description

| $\begin{array}{r}\text { Course code: } \\ \text { Course category: } \\ \text { Title of the course: }\end{array}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | \(\left.\begin{array}{l}23MATMAJ103 <br>

Major <br>
Real Analysis I\end{array}\right]\)

## Prerequisites

Before attending the course, students should be familiar with

- basic algebraic operations with real variables;
- special algebraic operations and functions like indices, logarithms, exponentiations, factorials, etc.;
- sets, relations and mappings;
- statements of common inequalities and manipulating them.


## Objectives

At the end of the course, the students should be able to
MAJ103-Ob1 Narrate the definition of real numbers and apply its intrinsic properties.
MAJ103-Ob2 Understand the topology of real numbers.
MAJ103-Ob3 Manipulate and investigate sequences and series of real numbers.

## Corresponding outcomes

The outcomes corresponding to the learning objective MAJ103-Ob1, are
MAJ103-CO1: Know the axiomatic construction of real numbers and apply Archimedean property to various sums.
MAJ103-CO2: Distinguish between countable and uncountable sets.
The outcome corresponding to the learning objective MAJ103-Ob2, is
MAJ103-CO3: Remember and use the results about open and closed sets, limit points, adherent points.

The outcomes corresponding to the learning objective MAJ103-Ob3, are
MAJ103-CO4: Know and investigate the definitions and key properties of sequences and series of real numbers and calculate their limits.
MAJ103-CO5: Explain the difference and relation between a Cauchy sequence and a convergent sequence.

## Content

| Unit: 1 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ103-Ob1 | Remembering: MAJ103-CO1 and MAJ103-CO2 <br>  <br>  <br> Understanding: MAJ103-CO1 and MAJ103-CO2 <br> Applying: $\quad$ MAJ103-CO1 and MAJ103-CO2 |
| Review OF THE SET OF REAL NUMBERS: Algebraic, Order and Completeness <br> axioms. Archimedean property. Density property of rational numbers. Nested <br> interval theorem. Decimal representation of real numbers. Cardinality of sets. <br> Uncountability of $\mathbb{R}$. |  |  |


| Unit: $\mathbf{2}$ | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ103-Ob2 | Remembering: MAJ103-CO3 |
|  | Understanding: MAJ103-CO3 |  |
|  | Applying: $\quad$ MAJ103-CO3 |  |


| Unit: 3 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ103-Ob3 | Remembering: MAJ103-CO4 |
|  | Understanding: MAJ103-CO4 and MAJ103-CO5 <br> Applying: $\quad$ MAJ103-CO4 and MAJ103-CO5 |  |
| SEQUENCES OF REAL NUMBERS: Bounded sequence. Convergent and limit of <br> a sequence. Limit theorems. Monotone sequences, monotone convergence theo- <br> rem. Subsequences, Bolzano-Weierstrass' theorem for sequences, limit superior and <br> limit inferior, monotone subsequence theorem (statement only). Cauchy sequence, <br> Cauchy's convergence criterion. |  |  |


| Unit: 4 | Credits: 1 | Lecture hours: 15 |
| :---: | :---: | :---: |


|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ103-Ob3 |
| :--- | :--- |
|  | Remembering: MAJ103-CO4 |
|  | Understanding: MAJ103-CO4 |
| Applying: $\quad$ MAJ103-CO4 |  |

## Suggested readings

1. Mapa, S K, Introduction to Real Analysis, Sarat Book House.
2. Bartle, R G, and Sherbert, D R, Introduction to Real Analysis, Wiley India Edition, Wiley India Pvt Ltd.

## Reference books

1. Goldberg, R R, Methods of Real Analysis, Oxford \& IBH Publishing.
2. Apostol, T M, Mathematical Analysis, Narosa Publications.
3. Rudin, W, Principles of Mathematical Analysis, Tata McGraw Hill Education.
4. Tao, T, Analysis I, TRIM Series, Hindustan Book Agency.
5. Lang, S, Undergraduate Analysis, Undergraduate Texts in Mathematics Series, Springer.
6. Abbott, S, Understanding Analysis, Undergraduate Texts in Mathematics Series, Springer.

### 2.3.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 2.3.3 Approval (23MATMAJ103)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Subhajit Paul | Subhajit Paul | Subhajit Paul |
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### 2.4 23MATMAJ104: Group Theory I

### 2.4.1 Course description

| $\begin{array}{c}\text { Course code: } \\ \text { Course category: } \\ \text { Title of the course: }\end{array}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 23MATMAJ104 |  |  |  |  |
| Major |  |  |  |  |
| Group Theory I |  |  |  |  |$]$

## Prerequisites

Before attending the course, students should be familiar with

- basic properties of addition and multiplication of real numbers, complex numbers, matrices,;
- basic congruence arithmetic;
- composition of functions.


## Objectives

At the end of the course, the students should be able to
MAJ104-Ob1 Describe and provide examples (with justifications) of groups from different domains of mathematics.
MAJ104-Ob2 Investigate whether a given subset of a group is a subgroup.
MAJ104-Ob3 Illustrate power of an element, order of an element and order of a group.
MAJ104-Ob4 Demonstrate a coset of a subgroup and prove Lagrange's theorem for a finite group.

## Corresponding outcomes

The outcomes corresponding to the learning objectives MAJ104-Ob1, are
MAJ104-CO1: Remember the postulates of a group and verify them for a given nonempty set with a binary composition.
MAJ104-CO2: Apply various results to construct a group from an algebraic structure satisfying an incomplete set of postulates.

The outcome corresponding to the learning objective MAJ104-Ob2, is
MAJ104-CO3: Prove the necessary and sufficient condition for a subset to be a subgroup, and apply it in various examples.

The outcome corresponding to the learning objective MAJ104-Ob3, is
MAJ104-CO4: Prove various results regarding order of an element and order of a grpup.
The outcome corresponding to the learning objective MAJ104-Ob4, is
MAJ104-CO5: State and prove Lagrange's theorem and apply it in various scenarios.
Content

| Unit: 1 | Credits: 2 | Lecture hours: 30 |
| :---: | :---: | :---: |
| Objectives mapped: <br> MAJ104-Ob1 | Cognitive levels achieved through outcomes: <br> $\begin{array}{ll}\text { Remembering: } & \text { MAJ104-CO1 } \\ \text { Understanding: } & \text { MAJ104-CO1 and MAJ104-CO2 } \\ \text { Applying: } & \text { MAJ104-CO1 and MAJ104-CO2 }\end{array}$ |  |
| Groupoid, semigroup, monoid, groups, commutative groups; Elementary properties of groups: finite semigroup with cancellation properties is a group, semigroup containing unique solution of $a x=b$ and $x a=b$ is a group. Particularly, $\mathbb{Z}_{n}$ group, $U_{n}$ group, Klein's 4 group, symmetric group $S_{n}$, alternating group $A_{n}$, matrix group $M_{n}(\mathbb{R})$, multiplicative group of $n^{\text {th }}$ roots of unity, Dihedral group, quaternion group (through matrices) etc. |  |  |


| Unit: $\mathbf{2}$ | Credits: $\mathbf{1}$ | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: |  |
| Objectives mapped: | Remembering: MAJ104-CO3 |  |
| MAJ104-Ob2 | Understanding: MAJ104-CO3 |  |
|  | Applying: | MAJ104-CO3 |

Subgroups and examples of subgroups; Necessary and sufficient conditions for a subset of a group to be a subgroup; Union and intersection of subgroups; Centralizer, normalizer, center of a group, product of two subgroups.

| Unit: 3 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MAJ104-Ob3 <br> and MAJ104-Ob4 | Remembering: MAJ104-CO4 and MAJ104-CO5 |
| Understanding: MAJ104-CO4 and MAJ104-CO5 <br> Applying: $\quad$ MAJ104-CO4 and MAJ104-CO5 |  |  |
| Order of an element and a group; Generators, cyclic group and its properties, <br> necessary and sufficient condition; Cosets, properties of cosets, Lagrange's theorem <br> and consequences including Fermat's Little theorem. |  |  |

## Suggested readings

1. Mapa, S K, Higher Algebra: Abstract and Linear, Sarat Book House.
2. Khan, R M, Algebra: Classical, Modern, Linear and Boolean, New Central Book Agency.
3. Herstein, I N, Topics in Algebra, Wiley.
4. Dummit, D S and Foote, R M, Abstract Algebra, Wiley.

## Reference books

1. Chakraborty, A, Modern Algebra, Levant Books.
2. Gallian, J A, Contemporary Abstract Algebra, Narosa Publishing House.
3. Artin, M, Abstract Algebra, Pearson.
4. Rotman, J J, An Introduction to the Theory of Groups, Springer Verlag.

### 2.4.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 2.4.3 Approval (23MATMAJ104)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Snigdha Roy | Subhajit Paul | Subhajit Paul |
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## SYLLABI FOR MINOR COURSES

### 3.1 23MATMIN101: Linear Algebra and Differential Equations

### 3.1.1 Course description

| $\begin{array}{r}\text { Course code: } \\ \text { Course category: } \\ \text { Title of the course: }\end{array}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 23MATMIN101 |  |  |  |  |
| Minor |  |  |  |  |
| Linear Algebra and Differential Equations |  |  |  |  |$]$

## Prerequisites

Before attending the course, students should be familiar with

- basic algebraic manipulations with one or more real variables, matrices, determinants (up to order 3) etc.;
- computational processes in calculus like evaluating limits, investigating continuity, etc.;
- different differentiation techniques, including rules for differentiation, chain rule, product rule, and quotient rule;
- different techniques of integration, such as substitution, integration by parts, partial fractions, etc.


## Objectives

At the end of the course, the students should be able to
MIN101-Ob1 Identify an invertible matrix and compute the inverse using elementary operations.
MIN101-Ob2 Investigate a system of linear equations and find the solution(s).
MIN101-Ob3 Compute and analyse the eigenvalues and eigenvectors of a matrix.

MIN101-Ob4 Develop a solid understanding of the basic concepts related to ordinary differential equations (ODEs) including order, linearity, and solutions (particular solutions, general solutions, and initial value problems) and also learn to classify different types of ODEs based on their order, linearity, and degree.
MIN101-Ob5 Learn different techniques to solve first order and higher order ODEs.

## Corresponding outcomes

The outcome corresponding to the learning objective MIN101-Ob1, is
MIN101-CO1: Use elementary operations to compute rank of a matrix by reducing to echelon or normal forms.

The outcome corresponding to the learning objective MIN101-Ob2, is
MIN101-CO2: Identify a solvable system of linear equations and solve it.
The outcomes corresponding to the learning objective MIN101-Ob3, are
MIN101-CO3: Compute eigenvalues by solving the characteristic equation and find corresponding eigenvectors,
MIN101-CO4: Use Cayley-Hamilton theorem to find the inverse of a matrix.
The outcome corresponding to the learning objective MIN101-Ob4, is
MIN101-CO5: Identify different types of ODEs.
The outcome corresponding to the learning objective MIN101-Ob5, are
MIN101-CO6: Apply different techniques to solve first order and higher order ODEs.

## Content

| Unit: 1 | Credits: 2 | Lecture hours: 30 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MIN101-Ob1 <br> to MIN101-Ob3 | Understanding: <br> Applying: $\quad$ MIN101-CO1 and MIN101-CO2 <br> MIN101-CO1 to MIN101-CO4 |
| LINEAR ALGEBRA: Elementary operations, Row/column reduced echelon matrix, <br> Rank of matrix, Normal forms, Inverse of a matrix. |  |  |
| Systems of linear equations: AX $=b$. Solutions, Consistency, Coefficient matrix. <br> Homogeneous and non-homogeneous system of equations. Solutions using elemen- <br> tary operations. |  |  |
| Characteristic polynomial and Characteristic equation of a square matrix. Cayley- <br> Hamilton theorem. Computations (only) of eigenvalues and eigenvectors. |  |  |


| Unit: 2 | Credits: 2 | Lecture hours: 30 |
| :---: | :--- | :---: |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MIN101-Ob4 <br> and MIN101-Ob5 | Remembering: <br> Understanding: <br> Applying:$\quad$MIN101-CO5 and MIN101-CO6 |
| DIFFERENTIAL EQUATIONS: <br> explicit, implicit and singular solutions of a differential equation. Exact differential |  |  |
| equations and integrating factors, separable equations and equations reducible to <br> this form, linear equation and Bernoulli equations, special integrating factors and <br> transformations. |  |  |
| General solution of homogeneous equation of second order, principle of super posi- <br> tion for homogeneous equation, Wronskian: its properties and applications, Linear <br> homogeneous, and non-homogeneous equations of higher order with constant coeffi- <br> cients, Euler's equation, method of undetermined coefficients, method of variation <br> of parameters. |  |  |

## Suggested readings

1. Mapa, S K, Higher Algebra: Abstract and Linear, Levant Books.
2. Ghosh, R K, and Maity, K C, An Introduction to Differential Equations, New Central Book Agency.
3. Raisinghania, M D, Ordinary and Partial Differential Equation, S Chand Publishing.

## Reference books

1. Hoffman, K, and Kunze, R, Linear Algebra, Prentice Hall India Learning Private Limited.
2. Ross, S L, Differential Equations, Wiley.

### 3.1.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 3.1.3 Approval (23MATMIN101)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Snigdha Roy | Subhajit Paul | Subhajit Paul |
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## SYLLABI FOR SKILL ENHANCEMENT COURSES

### 4.1 23MATSEC101: Typesetting in $\mathrm{IAT}_{\mathrm{E}} \mathrm{X}$

### 4.1.1 Course description

| Course code: 2323MATSEC101 <br> Course category: Skill Enhancement <br> Title of the course: Typesetting in $\mathbf{L A T}_{\mathbf{E}} \mathbf{X}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Semester | Credits | Lecture hours in a week | Total lecture hours | Regulation year |
| I | $1(\mathrm{~L})+2(\mathrm{P})=$ | 5 | 75 | 2023 |

## Prerequisites

To attend this course, the students should have access to a computer with internet facility.

## Objectives

At the end of the course, the students should be able to
SEC101-Ob1 Use the preamble of the .tex file to define document class and layout options.

SEC101-Ob2 Include figures, tables, lists, and mathematical equations in a $\mathrm{LAT}_{\mathrm{E}} \mathrm{X}$ document.

SEC101-Ob3 Draw basic diagrams using TikZ package.
SEC101-Ob4 Refer to different items within the document.

[^1]
## Corresponding outcomes

The outcome corresponding to the learning objectives SEC101-Ob1, is
SEC101-CO1: Create a $\mathrm{LA}_{\mathrm{E}} \mathrm{X}$ document with chapters, sections, subsections, etc., and also to manage the paper size and margins.

The outcome corresponding to the learning objective SEC101-Ob2, is
SEC101-CO2: Include figures, tables, longtables, enumerated and itemized lists, and mathematical equations at desired positions in a $\mathrm{EAT}_{\mathrm{E}} \mathrm{X}$ document.

The outcome corresponding to the learning objective SEC101-Ob3, is
SEC101-CO3: Draw line joining two points, circle, ellipse, parabola, ellipse, and other plane geometry diagrams.

The outcome corresponding to the learning objective SEC101-Ob4, is
SEC101-CO4: Refer to different items within the document using hyperref, cleveref, varioref packages.

The outcome corresponding to the learning objective SEC101-Ob5, is
SEC101-CO5: Use BibTeX to maintain bibliographic information and to generate a bibliography for a particular document.

## Content

| Unit: 1 | Credits: 1 | Lecture hours: 25 |
| :---: | :---: | :---: |
| Objectives mapped: <br> SEC101-Ob1 <br> and SEC101-Ob2 | Cognitive levels achieved through outcomes: |  |
| What is $\mathrm{LAT}_{\mathrm{E}} \mathrm{X}$. Basics for document structuring, preamble preparation, saving a folder. $\mathrm{ET}_{\mathrm{E}} \mathrm{X}$ commands for font colour, font size, make title, begin document, new page, sectioning. beamer document class. <br> Creating Tables, Inserting figures, enumeration list, itemized list, inserting equations. |  |  |


| Unit: 2 | Credits: 1 | Lecture hours: 20 |
| :---: | :--- | :--- |
| Objectives mapped: | Cognitive levels achieved through outcomes: |  |
|  | Understanding: | SEC101-CO3 |
|  | Applying: $\quad$ SEC101-CO3 |  |

TikZ PACKAGE: Draw line joining two points, circle, ellipse, parabola, ellipse, and other plane geometry diagrams. Use of nodes.

| Unit: 3 | Credits: 1 | Lecture hours: 30 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: |  |
| Objectives mapped: | Understanding: | SEC101-CO4 and SEC101-CO5 |
| SEC101-Ob4 <br> and SEC101-Ob5 | Applying: $\quad$ SEC101-CO4 and SEC101-CO5 |  |
| REFERENCING: Use of hyperref, cleveref, and varioref packages. Inserting <br> references, Manual reference, Reference using BibTeX, citing reference. |  |  |

## Suggested readings

1. $\mathrm{LA}_{\mathrm{E}} \mathrm{X}$ for beginners Work book, $5^{\text {th }}$ edition, Document Reference: 3722-2014, March 2014.
2. Kopka, H, and Daly, P W, Guide to $\mathrm{LAT}_{\mathrm{E}} \mathrm{X}$, Addison-Wesley.

## Reference books

1. Griffits, D F, and Higham, D J, Learning $\mathrm{LAT}_{\mathrm{E}} \mathrm{X}$, Siam, Philadelphia.
2. Kottwitz, S, $\mathrm{LAT}_{\mathrm{E}} \mathrm{X}$ Beginner's Guide, Packt Publishing Ltd.

### 4.1.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, Practical. Rubrics are as follows:
(a) Lab report: 10 marks.
(b) Viva-voce: 10 marks.
(c) Prepare codes for two problems of 15 marks each, pulled from a pool of 10 questions.. $15 \times 2=30$.

### 4.1.3 Approval (23MATSEC101)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Subhajit Paul | Subhajit Paul | Subhajit Paul |
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## SYLLABI FOR MULTI-DISCIPLINARY COURSES

### 5.1 23MATMDC101: Basic Mathematics

### 5.1.1 Course description

| $\begin{array}{r}\text { Course code: } \\ \text { Course category: } \\ \text { Title of the course: }\end{array}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | \(\left.\begin{array}{l}23MATMDC101 <br>

Multi-disciplinary <br>
Basic Mathematics\end{array}\right]\)

## Prerequisites

Before attending the course, students should be familiar with

- fundamental arithmetic operations like addition, subtraction, multiplication and division.
- derived arithmetic operations like simplifications, squares, square roots, cube and cube roots;
- factorisation of polynomials.


## Objectives

At the end of the course, the students should be able to
MDC101-Ob1 Learn the relationship between logarithm and indices and perform basic calculations.
MDC101-Ob2 familiarise themselves with the binomial theorem, including the general formula for expanding the power of a binomial expression.

MDC101-Ob3 Develop the understanding of the fundamental concepts of matrices and determinants, including their definitions, properties, and basic operations among the students.

MDC101-Ob4 Learn various techniques for calculating derivatives, including the addition, product, quotient and chain rules.

MDC101-Ob5 Understand the various techniques for calculating integrals, including basic rules, substitution, integration by parts.
MDC101-Ob6 Calculate area under a curve.

## Corresponding outcomes

The outcome corresponding to the learning objective MDC101-Ob1, is
MDC101-CO1: Learn and apply the formulaæof logarithm and indices to solve various basic sums.

The outcome corresponding to the learning objective MDC101-Ob2, is
MDC101-CO2: Learn and apply binomial theorem to expand a polynomial to a given power.

The outcomes corresponding to the learning objective MDC101-Ob3, are
MDC101-CO3: Identify different types of matrices and perform algebra.
MDC101-CO4: Understand the processes to determine adjoint, determinant and inverse (when exists) of a square matrix.

The outcome corresponding to the learning objectives MDC101-Ob4, is
MDC101-CO5: Remember and apply various techniques for calculating derivatives, including the addition, product, quotient and chain rules.

The outcome corresponding to the learning objectives MDC101-Ob5, is
MDC101-CO6: Remember and apply various techniques for calculating integrals by several techniques such as methods of substitution, by parts, and partial fractions.

The outcome corresponding to the learning objectives MDC101-Ob6, is
MDC101-CO7: Apply the Fundamental theorem of Calculus to calculate the area under a curve.

## Content

| Unit: 1 | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: |  |
| Objectives mapped: | Remembering: MDC101-CO1 to MDC101-CO3 |  |
| MDC101-Ob1 <br> to MDC101-Ob3 | Understanding: MDC101-CO1 to MDC101-CO4 |  |
|  | Applying: | MDC101-CO1 to MDC101-CO4 |

Algebra: Definitions of indices and logarithms. Illustrations of basic relations and properties of indices and logarithms (integer and rational indices only).

Statement and proof of the binomial theorem for positive integral indices. Pascal's triangle, simple applications.

Concept, notation, order, equality of matrices. Types of matrices: zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operations on matrices: Addition and multiplication of matrices; multiplication with a scalar. Non-commutativity of multiplication and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Invertible matrices and proof of the uniqueness of inverse, if it exists; (all matrices will have real entries).

Determinant of a square matrix (up to $3 \times 3$ matrices), minors, co-factors, adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

| Unit: 2 | Credits: 2 | Lecture hours: 30 |
| :---: | :--- | :--- |
|  | $\begin{array}{l}\text { Cognitive levels achieved through outcomes: } \\ \text { Objectives mapped: } \\ \text { MDC101-Ob4 } \\ \text { to MDC101-Ob6 }\end{array}$ | $\begin{array}{l}\text { Remembering: MDC101-CO5 and MDC101-CO6 }\end{array}$ |
| Understanding: MDC101-CO5 and MDC101-CO6 |  |  |
| Applying: $\quad$ MDC101-CO5 to MDC101-CO7 |  |  |$]$| CALCULUS: Differentiation as the instantaneous rate of change. Derivative of |
| :--- |
| sum, difference, product and quotient of functions. Derivatives of polynomials, |
| logarithmic and exponential functions. Chain rule. |
| Integration as inverse process of differentiation. Integration of a variety of functions <br> by substitution, by partial fractions and by parts, Evaluation of simple integrals and <br> problems based on them. Statement (only) of Fundamental theorem of Calculus <br> and its application to find the area under a curve. |

## Suggested readings

1. Agarwal, R S, Senior Secondary Mathematics For Class 11, Bharti Bhawan.
2. Agarwal, R S, Senior Secondary Mathematics For Class 12, Bharti Bhawan.

## Reference books

1. Sharma, R D, Mathematics for Class 11 (Vols I \& II), Dhanpat Rai Publications (P) Ltd.
2. Sharma, R D, Mathematics for Class 12 (Vols I \& II), Dhanpat Rai Publications (P) Ltd.
3. Arihant All in One Mathematics CBSE Class 12, Modern Publication.

### 5.1.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 5.1.3 Approval (23MATMDC101)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Debdut Sengupta | Subhajit Paul | Subhajit Paul |
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### 5.2 23MATMDC102: Mathematics for Competitive Examinations

### 5.2.1 Course description

| $\begin{array}{r}\text { Course code: } \\ \text { Course category: } \\ \text { Title of the course: }\end{array}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | \(\left.\begin{array}{l}23MATMDC102 <br>

Multi-disciplinary <br>
Quantitative Aptitude\end{array}\right]\)

## Prerequisites

Before attending the course, students should be familiar with

- different types of number system;
- fundamental arithmetic operations like addition, subtraction, multiplication and division;
- Basic operations like simplifications, squares, square roots, cube and cube roots;
- Terms like time, speed, distance, profit, loss;
- Basic geometric shapes like triangle, quadrilateral, circles.


## Objectives

At the end of the course, the students should be able to
MDC102-Ob1 Develop a strong foundation in number systems and fundamental operations enabling students from various disciplines to enhance their mathematical reasoning, problem-solving skills.
MDC102-Ob2 Equip students with the necessary knowledge and techniques to solve a wide range of quantitative problems related to daily life, commonly encountered in competitive exams and real-world scenarios.

MDC102-Ob3 Foster critical thinking and logical reasoning skills by applying mathematical concepts to analyse and interpret numerical data.

## Corresponding outcomes

The outcomes corresponding to the learning objective MDC102-Ob1, are
MDC102-CO1: Remember and understand the different types of number system and the arithmetic operations on them.

MDC102-CO2: Develop an understanding of the processes to find the squares, square roots, cube, cube roots.

MDC102-CO3: Develop an understanding of permutation and combination and analyse them to solve simple problems.

The outcomes corresponding to the learning objective MDC102-Ob2, are
MDC102-CO4: Understand and analyse the concepts of Heights and Distances, Profit and Loss, Discount, Partnership Business, Mixture, Time and distance, Time \& Work, Percentage problems, Boats and Streams, Ratio \& Proportion, Pipes and Cistern, Problems on Trains, Simple and Compound Interest and use them in solving simple problems thereby enhance performance in competitive exams that include quantitative aptitude.

MDC102-CO5: Remember the different formulae to find the area and volume of simple geometric shapes and apply them in simple problems.

The outcome corresponding to the learning objective MDC102-Ob3, is

MDC102-CO6: Understand data interpretation and analyse complex data presented in various forms, such as tables, bar graphs, pie charts, and line graphs.

## Content

| Unit: $\mathbf{1}$ | Credits: 1 | Lecture hours: 15 |
| :---: | :--- | :--- |
|  | Cognitive levels achieved through outcomes: <br> Objectives mapped: <br> MDC102-Ob1 | Remembering: MDC102-CO1 |
|  | Understanding: MDC102-CO2 and MDC102-CO3 <br> Applying: $\quad$ MDC102-CO2 and MDC102-CO3 |  |
|  <br> cube roots. Permutations and Combinations. Decimals problems, fractions prob- <br> lems. Numbers and Ages. Surds and Indices. Averages, Odd man out \& Series. <br> Calendar. Clocks. |  |  |


| Unit: 2 | Credits: 2 | Lecture hours: 30 |
| :---: | :--- | :--- |
|  | $\begin{array}{l}\text { Cognitive levels achieved through outcomes: } \\ \text { Objectives mapped: } \\ \text { MDC102-Ob2 } \\ \text { and MDC102-Ob3 }\end{array}$ | $\begin{array}{l}\text { Remembering: } \quad \text { MDC102-CO5 }\end{array}$ |
| Understanding: $\quad$ MDC102-CO4 and MDC102-CO6 |  |  |
| Applyg: $\quad$ MDC102-CO4 to MDC102-CO6 |  |  |$]$| Heights and distances. Profit and loss. Discounts. Partnership business. Mixture. |
| :--- |
| Time and distance. Time \& work. Percentage problems. Boats and streams. <br> Ratio \& proportion. Pipes and cistern. Problems on trains. Simple and compound <br> interest. Volume \& surface areas. |
| Data interpretation, tabulation, bar graphs, pie charts, line graphs. |

## Suggested readings

1. Agarwal, R S, Quantitative Aptitude, S Chand.
2. Oswal Publishers, Quantitative Aptitude For Competitive Examinations : IBPS, SSC, SBI, RBI, AFCAT, CDS, UPSC, UPPSC, CAT, MAT, XAT, Railways, Oswal Printers \& Publishers Pvt Ltd.

## Reference books

1. Khattar, D, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Pearson.
2. FACE, Aptipedia: Aptitude Encyclopedia, Wiley.

### 5.2.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment: 50 marks, 2 hours. Marks distribution as follows:
(a) Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
(b) Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
(c) Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.

### 5.2.3 Approval (23MATMDC102)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Bikiran Das | Subhajit Paul | Subhajit Paul |
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## SYLLABI FOR VALUE ADDED COURSES

### 6.1 23MATVAC101: Introduction to Number Systems

### 6.1.1 Course description

| $\begin{array}{r}\text { Course code: } \\ \text { Course category: } \\ \text { Title of the course: }\end{array}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 23MATVAC101 |  |  |  |  |
| Value added |  |  |  |  |
| Introduction to Number Systems |  |  |  |  |$]$

## Prerequisites

Before attending the course, students should be familiar with

- basic arithmetic and algebraic calculations.


## Objectives

At the end of the course, the students should be able to
VAC101-Ob1 Present a problem oriented introductory knowledge of Number systems and its applications to binary arithmetic.
VAC101-Ob2 Focus on the study of Boolean algebra and its applications to logic gates.
VAC101-Ob3 Understand the concept of Sum of Products (S.O.P) and product of sums (P.O.S) and its applications to Karnaugh map.

## Corresponding outcomes

The outcome corresponding to the learning objective VAC101-Ob1, is
VAC101-CO1: Acquire basic knowledge of number systems and its applications to binary arithmetic.

The outcome corresponding to the learning objective VAC101-Ob2, is

VAC101-CO2: Employ Boolean algebra and its applications to logic gates.
The outcome corresponding to the learning objective VAC101-Ob3, is
VAC101-CO3: Understand the concept of Sum of Products (SOP) and product of sums (POS) and its applications to Karnaugh map.

## Content

| nit: | Credits: | ecture hours: 30 |
| :---: | :---: | :---: |
| VAC101-Ob1 to VAC101-Ob3 | Cognitive levels achieved through outcomes: |  |
| Introduction to conventional number systems: Base, place value, digits available for a particular base. Binary, octal, decimal, hexadecimal number systems and conversions. Gray Code, Excess-3 code, code conversion. ASCII, EBCDIC codes and their conversions. Binary arithmetic and applications. Signed and unsigned binary numbers. 1's complement and 2's complement representation. Simple problems. <br> Boolean algebra and Logic gates: Basic logic circuits, logic gates, truth tables. Laws and properties of Boolean algebra. De Morgan's theorem and its applications. Min term, Max term with their applications. Conjunctive Normal Form (POS), Disjunctive Normal Form (SOP) and their inter-conversions. K-map and its applications. Simplifications of K-maps by Boolean theorems. |  |  |

## Suggested readings

1. Mano, M Morris, Digital Logic and Computer Design, Pearson Education.
2. Salivahanan, S and Arivazhagan, S, Digital Circuits And Design, Oxford University Press.

## Reference books

1. Roth, Charles H, Kinney, Larry L, and Raghunandan, G H, Fundamentals of Logic Design, Cengage India Private Limited.
2. Jain, R P, and Floyd, Thomas L, Digital Fundamentals, Pearson Education.

### 6.1.2 Assessment

1. Summative Assessment: 50 marks. Assignment based.

### 6.1.3 Approval

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Debdut Sengupta | Subhajit Paul | Subhajit Paul |
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## SYLLABI FOR STATISTICS MINOR COURSES

### 7.1 23STAMIN101: Statistical Methods

### 7.1.1 Course description

| Course code: 23STAMIN101 <br> Course category: Minor <br> Title of the course: Statistical Methods |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Semester | Credits | Lecture hours in a week | Total lecture hours | Regulation year |
| I / II | $3(\mathrm{~L})+1(\mathrm{P})=$ | 5 | 75 | 2023 |

## Prerequisites

Before attending the course, students should be familiar with

- basic arithmetic and algebraic calculations.
- coordinate geometry, concept of straight lines.


## Objectives

At the end of the course, the students should be able to
STAMIN101-Ob1 Demonstrate the history of statistics and present the data in various forms.

STAMIN101-Ob2 Understand and analyse the concepts of central tendency and dispersion.
STAMIN101-Ob3 Apply the concept of correlation and regression for relating two or more related variables.

STAMIN101-Ob4 Analyse data to measure association of attributes.

## Corresponding outcomes

The outcome corresponding to the learning objective STAMIN101-Ob1, is
STAMIN101-CO1: Demonstrate the history of statistics and present the data in various forms.

The outcome corresponding to the learning objective STAMIN101-Ob2, is
STAMIN101-CO2: Understand and analyse the concepts of central tendency and dispersion.

The outcome corresponding to the learning objective STAMIN101-Ob3, is
STAMIN101-CO3: Apply the concept of correlation and regression for relating two or more related variables.

The outcome corresponding to the learning objective STAMIN101-Ob4, is
STAMIN101-CO4: Analyse data to measure association of attributes.

## Content

| Unit: | Credits: | Lecture hours: 15 |
| :---: | :---: | :---: |
| Objectives mapped: STAMIN101-Ob1 | Cognitive levels achieved through outcomes: <br> Remembering: STAMIN101-CO1 <br> Understanding: STAMIN101-CO1 <br> Applying: STAMIN101-CO1 |  |
| Type of Data: Primary and secondary data, quantitative and qualitative data, nominal and ordinal data, cross section and time series data, discrete and continuous data. <br> Presentation of Data: Presentation by tables and by diagrams, construction of tables with one, two and three factors of classification, diagrammatic representations, frequency distributions for discrete and continuous data, representing distributions graphical by histogram and frequency polygon, stem \& leaf and boxplot; cumulative frequency distributions (inclusive and representation of a frequency conclusive method and Ogive. Stem-leaf and Box-plot diagrams. Horizontal and vertical bar charts. |  |  |


| Unit: 2 | Credits: 1 | Lecture hours: 15 |
| :--- | :--- | :--- |
|  | Cognitive levels achieved through outcomes: |  |
| Objectives mapped: | Remembering: $\quad$ STAMIN101-CO2 |  |
| STAMIN101-Ob2 | Understanding: | STAMIN101-CO2 |
|  | Applying: $\quad$ STAMIN101-CO2 |  |

Descriptive Statistics: Measure of central tendency; measures of dispersion, moments and quartiles, measure of skewness and kurtosis for both grouped and ungrouped data.

| Unit: 3 | Credits: 1 | Lecture hours: 20 |
| :---: | :---: | :---: |
| Objectives mapped: <br> STAMIN101-Ob3 | Cognitive levels achieved through outcomes: |  |
| Bivariate Analysis: Scatter diagram, regression, curve between two variables and concept of error in regression, principles of least squares; fitting of first, second and third degree. Concept of correlation coefficient and its properties. |  |  |


| Unit: 4 | Credits: 1 | Lecture hours: 25 |
| :---: | :---: | :---: |
| Objectives mapped: STAMIN101-Ob4 | Cognitive levels achieved through outcomes: |  |
| Analysis of Categorical Data: Fundamental set of frequencies, consistency of data; Measures of association and contingency-table; Association of attributes and various measurement of association; Analysis of data on two characters and three characters. |  |  |

## List of practicals

Following problems are to be done using calculators, or spreadsheet programme software.

1. Charts and diagrams.
2. Grouping of data.
3. Preparation of Histogram, frequency polygon and ogive from a set of given data.
4. Measure of central tendency, dispersion, moments, skewness and kurtosis of frequency distribution.
5. Calculation of correlation co-efficient from bivariate data. Interpretation of data and diagram.
6. Calculation of Spearman's rank correlation co-efficient from qualitative data.
7. Fitting of regression line by least square method.

## Suggested readings

1. Gun, A M, Gupta, M K and Dasgupta, B, Fundamentals of Statistics (Volume One), World Press Private Ltd.
2. Gupta, S C and Kapoor, V K, Fundamentals of Mathematical Statistics, S Chand \& Sons.
3. Bhattacharya, D and Roychowdhury, S, Statistics - Theory and Practice, U N Dhar Publications.
4. Mukherjee, A, Fundamental Treatise On Probability And Statistics, Shreetara Prakashani.
5. Kendall, M G and Stuart, A, Advanced Theory of Statistics, John Wiley \& Sons Inc.
6. Gupta, S C, Fundamentals of Statistics, Himalaya Publishing House.

### 7.1.2 Assessment

1. Formative Assessment: 50 marks, as per Assessment \& Evaluation Framework Document of Salesian College.
2. Summative Assessment:
(a) Theory examination: 50 marks, 2 hours; weighed down to $50 \%$ ( 25 marks). Marks distribution as follows:
i. Five questions of 2 marks each, out of eight questions. Remembering and Understanding levels of Revised Bloom's Taxonomy (RBT). $2 \times 5=10$.
ii. Four questions of 5 marks each, out of six questions. Analysis, and Applying levels of RBT. $5 \times 4=20$.
iii. Two questions of 10 marks each, out of four questions. Analysis, Application and Evaluation levels of RBT. $10 \times 2=20$.
(b) Practical examination: 50 marks; weighed down to $50 \%$ ( 25 marks). Marks distribution as follows:
i. Lab report: 10 marks.
ii. Viva-voce: 10 marks.
iii. Solve three questions for 10 marks each, chosen randomly from a pool of ten questions. $10 \times 3=30$.

### 7.1.3 Approval (STAMIN101)

| (Prepared by) <br> Course Faculty | (Checked and verified by) <br> Head of the Dept | (Approved by) <br> Dean |
| :---: | :---: | :---: |
| Manoj Ray Bakshi | Subhajit Paul | Subhajit Paul |
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## BIBLIOGRAPHY

[1] "Curriculum and Credit Framework for Undergraduate Programmes", University Grants Commission, New Delhi, 2022, URL: https://www.ugc.gov.in/pdfnews/ 7193743_FYUGP.pdf.

## APPROVAL BY BOS MEMBERS

| Subhajit Paul <br> Vice Chairperson, <br> BoS, Mathematics \& Statistics |  |
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| Bikiran Das Secretary, <br> BoS, Mathematics \& Statistics |  |
| Debdut Sengupta <br> Member, <br> BoS, Mathematics \& Statistics |  |
| Snigdha Roy Member, <br> BoS, Mathematics \& Statistics |  |
| Manoj Ray Baksi <br> Member, <br> BoS, Mathematics \& Statistics |  |
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[^0]:    ${ }^{1}$ L: Lecture, T: Tutorial, P: Practical / Field work.

[^1]:    SEC101-Ob5 Generate a bibliography for a particular document.

