SALESIAN COLLEGE
(AUTONOMOUS) | SONADA SILIGURI

Curriculum Document

under

National Education Policy (NEP) 2020 Curriculum Framework

for

Departments of Mathematics

and

Statistics (Minor)

Semesters: I – IV

Regulation Year: 2023

Approved by: _____
(Subhajit Paul, Chairperson, BoS of Mathematics & Statistics.)

Date: _____

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CHAPTER
ONE

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 published in the document "Curriculum and Credit Framework for Undergraduate Programmes" in 2022[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,

[1] available at https://www.ugc.gov.in/pdfnews/7193743_FYUGP.pdf.

- 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 self-paced 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	**# Courses**	**Credit/ course**	**Total 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	**53**		**168**

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 & Two-dimensional Geometry	4
	23MATMAJ102	ODE I and Application of Calculus	4
II	23MATMAJ103	Real Analysis I	4
	23MATMAJ104	Abstract Algebra I	4
III	23MATMAJ201	Linear Algebra I	4
	23MATMAJ202	Real Analysis II	4
IV	23MATMAJ203	Abstract Algebra II	4
	23MATMAJ204	Real Analysis III	4
	23MATMAJ205	ODE II and Three-dimensional Geometry	4
V	23MATMAJ301	Numerical Analysis	4
	23MATMAJ302	Multivariate Calculus	4
	23MATMAJ303	Probability Theory	4
	23MATMAJ304	Operations Research	4
VI	23MATMAJ305	Integral Calculus	4
	23MATMAJ306	Complex Analysis	4
	23MATMAJ307	Abstract Algebra III	4
VII	23MATMAJ401	Partial Differential Equations	4
	23MATMAJ402	Metric Spaces	4
	23MATMAJ403	Linear Algebra II	4
	23MATMAJ404	Number Theory *or* Vector Analysis	4
VIII	23MATMAJ405	General Topology	4
	23MATMAJ406	Measure Theory	4
	23MATMAJ407	Differential Geometry *or* Integral Transform	4
	23MATMAJ408	Functional Analysis *or* Graph Theory	4
		Minor Courses	
I	23MATMIN101	Linear Algebra and Differential Equations	4
	23STAMIN101	Statistical Methods	4
III	23MATMIN201	Discrete Mathematics	4

Sem	Course code	Course title	Credits
	23STAMIN201	Fundamentals of Probability	4
V	23MATMIN301	Numerical Analysis *or* Advanced Calculus	4
	23STAMIN301		4
VII	23MATMIN401	Optimisation Techniques *or* Algebra	4
	23STAMIN401		4
Skill Enhancement Courses (SEC)			
I	23MATSEC101	Typesetting in LaTeX	3
II	23MATSEC102	Graph Theory	3
III	23MATSEC201	Mathematical Modelling	3
Value Added Courses (VAC)			
I	23MATVAC101	Introduction to Number Systems	1
II	23MATVAC102	Prerequisites to Linear Algebra	1
III	23MATVAC201	Graphing using GeoGebra	1
IV	23MATVAC202	Poster Presentation	1
V	23MATVAC301	Problem solving techniques	1
VI	23MATVAC302	Students' Seminar	1
Multi-disciplinary Courses (MDC)			
I	23MATMDC101	Basic Mathematics	3
II	23MATMDC102	Mathematics for Competitive Examinations	3

1.3.2 Course matrix for Mathematics Major students (Sem I – IV)

Course code	Type	Course title	Credits (L+T+P)[2]	Classes/ week
Semester I				
23MATMAJ101	Major	Classical Algebra & 2-D Geometry	$4+0+0$	4
23MATMAJ102	Major	ODE I & Application of Calculus	$4+0+0$	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

[2] **L:** Lecture, **T:** Tutorial, **P:** Practical / Field work.

Course code	Type	Course title	Credits (L+T+P)	Classes/ week
23ENGAEC101	AEC	Compulsory English I	$2+0+0$	2
23***MDC101	MDC	Multi-disciplinary course	$3+0+0$	3
23SCSVED101	VAC	Value Education	$1+0+0$	1
		Total	22	26
Semester II				
23MATMAJ103	Major	Real Analysis I	$4+0+0$	4
23MATMAJ104	Major	Abstract Algebra I	$4+0+0$	4
23CSCMIN101	Minor	C Programming	$3+0+1$	5
23MATSEC102	SEC	Graph Theory	$3+0+0$	3
23MATVAC102	VAC	Prerequisites to Linear Algebra	$0+0+1$	2
23ENGAEC102	AEC	Compulsory English II	$2+0+0$	2
23***MDC101	MDC	Multi-disciplinary course	$3+0+0$	3
23SCSVED102	VAC	Value Education	$1+0+0$	1
		Total	22	24
Semester III				
23MATMAJ201	Major	Linear Algebra I	$4+0+0$	4
23MATMAJ202	Major	Real Analysis II	$4+0+0$	4
23STAMIN201	Minor	Fundamentals of Probability	$3+0+1$	5
23MATSEC201	SEC	Mathematical Modelling	$3+0+0$	3
23MATVAC201	VAC	Graphing using GeoGebra	$0+0+1$	2
23ENGAEC201	AEC	Environmental Sciences I	$2+0+0$	2
23***MDC201	MDC	Multi-disciplinary course	$3+0+0$	3
23SCSVED201	VAC	Value Education	$1+0+0$	1
		Total	22	24
Semester IV				
23MATMAJ203	Major	Abstract Algebra II	$4+0+0$	4
23MATMAJ204	Major	Real Analysis III	$4+0+0$	4
23MATMAJ205	Major	ODE II and 3-D Geometry	$4+0+0$	4
23CSCMIN201	Minor	Digital Electronics	$4+0+0$	4
23MATVAC201	VAC	Poster presentation	$0+0+1$	2

Course code	Type	Course title	Credits (L+T+P)	Classes/ week
23ENGAEC201	AEC	Environmental Sciences I	$2+0+0$	2
23SCSVED201	VAC	Value Education	$1+0+0$	1
		Total	20	21

CHAPTER

TWO

SYLLABI FOR MAJOR COURSES

2.1 23MATMAJ101: Classical Algebra & Two-dimensional Geometry

2.1.1 Course description

Course code:	**23MATMAJ101**			
Course category:	**Major**			
Title of the course:	**Classical Algebra & Two-dimensional Geometry**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I	**4**	**4**	**60**	**2023**

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**
Objectives mapped: **MAJ101-Ob1** and **MAJ101-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: MAJ101-CO1 Understanding: MAJ101-CO2 Applying: MAJ101-CO1 and MAJ101-CO2	
INEQUALITIES: AM $\geq$ GM $\geq$ HM; Theorem of weighted means. Statements only and applications of m^{th} power theorem, Cauchy-Schwartz inequality, Holder's inequality, Minkowski's inequality. COMPLEX NUMBERS: Polar representation. De Moivre's theorem for rational indices and its applications. Trigonometric, logarithm, exponential and hyperbolic functions of complex variable.		

Unit: 2	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ101-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MAJ101-CO3 and MAJ101-CO4 Understanding: MAJ101-CO3 and MAJ101-CO4 Applying: 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
Objectives mapped: **MAJ101-Ob4**	**Cognitive levels achieved through outcomes:** Remembering: MAJ101-CO5 Understanding: MAJ101-CO5 Applying: MAJ101-CO5	
2-DIMENSIONAL GEOMETRY: Transformation of axes. Pair of straight lines. Reduction of general equation of second degree into canonical forms. Tangents and normals. Pole and polars. Polar equations.		

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 & 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. $10 \times 2 = 20$.

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

2.2.1 Course description

	Course code:	**23MATMAJ102**		
	Course category:	**Major**		
	Title of the course:	**Ordinary Differential Equations I and Applications of Calculus**		
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I	**4**	**4**	**60**	**2023**

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: **MAJ102-Ob1** and **MAJ102-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: MAJ102-CO1 Understanding: MAJ102-CO1 and MAJ102-CO4 Applying: MAJ102-CO2 to MAJ102-CO4	
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: **MAJ102-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: MAJ102-CO4 Understanding: MAJ102-CO3	
General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.		

Unit: 3	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ102-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MAJ102-CO5 Understanding: MAJ102-CO5 Applying: MAJ102-CO5 and MAJ102-CO6	

Application of Differential Calculus: Successive differentiation, Leibnitz theorem. Curvature, convexity and concavity. Asymptotes. Envelope & evolutes. Nature of a singular point. Curve tracing.

Unit: 4	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ102-Ob4**	**Cognitive levels achieved through outcomes:** Remembering: MAJ102-CO7 Understanding: MAJ102-CO7 Applying: MAJ102-CO7	
Application of Integral Calculus: Derivations and illustrations of reduction formulæ of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \sec^n x\,dx$, $\int \tan^n x\,dx$, $\int (\log x)^n\,dx$, $\int \sin nx \cos mx\,dx$ 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. $10 \times 2 = 20$.

2.3 23MATMAJ103: Real Analysis I

2.3.1 Course description

Course code:	**23MATMAJ103**
Course category:	**Major**
Title of the course:	**Real Analysis I**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
II	**4**	**4**	**60**	**2023**

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
Objectives mapped: **MAJ103-Ob1**	**Cognitive levels achieved through outcomes:** Remembering: MAJ103-CO1 and MAJ103-CO2 Understanding: MAJ103-CO1 and MAJ103-CO2 Applying: MAJ103-CO1 and MAJ103-CO2	
REVIEW OF THE SET OF REAL NUMBERS: Algebraic, Order and Completeness axioms. Archimedean property. Density property of rational numbers. Nested interval theorem. Decimal representation of real numbers. Cardinality of sets. Uncountability of $\mathbb{R}$.		

Unit: 2	Credits: 1	Lecture hours: 15
Objectives mapped: **MAJ103-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: MAJ103-CO3 Understanding: MAJ103-CO3 Applying: MAJ103-CO3	
SUBSETS OF $\mathbb{R}$: Interior points, Open sets, Closed sets, Limit points, Derived sets, Bolzano-Weierstrass' theorem, Closure of a Set.		

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

Unit: 4	Credits: 1	Lecture hours: 15
Objectives mapped: **MAJ103-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MAJ103-CO4 Understanding: MAJ103-CO4 Applying: MAJ103-CO4	
INFINITE SERIES OF REAL NUMBERS: Convergence and divergence, Cauchy criterion. Tests for convergence (statements only): Comparison test (first and second kind), Ratio test, Root test, Condensation test, Raabe's test, Logarithmic test, Gauss's test. Alternating series, Leibniz test, absolute and conditional convergence, Riemann's rearrangement theorem (statement only). (Only) Applications of Abel's test and Dirichlet's test.		

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. $10 \times 2 = 20$.

2.4 23MATMAJ104: Abstract Algebra I

2.4.1 Course description

	Course code:	**23MATMAJ104**		
	Course category:	**Major**		
	Title of the course:	**Abstract Algebra I**		
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
II	**4**	**4**	**60**	**2023**

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 non-empty 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 group.

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: **MAJ104-Ob1**	**Cognitive levels achieved through outcomes:** Remembering: MAJ104-CO1 Understanding: MAJ104-CO1 and MAJ104-CO2 Applying: MAJ104-CO1 and MAJ104-CO2	

Groupoid, semigroup, monoid, groups, commutative groups; Elementary properties of groups: finite semigroup with cancellation properties is a group, semigroup containing unique solution of $ax = b$ and $xa = b$ 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^{th} roots of unity, Dihedral group, quaternion group (through matrices) etc.

Unit: 2	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ104-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: MAJ104-CO3 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**
Objectives mapped: **MAJ104-Ob3** and **MAJ104-Ob4**	**Cognitive levels achieved through outcomes:** Remembering: MAJ104-CO4 and MAJ104-CO5 Understanding: MAJ104-CO4 and MAJ104-CO5 Applying: MAJ104-CO4 and MAJ104-CO5	
Order of an element and a group; Generators, cyclic group and its properties, necessary and sufficient condition; Cosets, properties of cosets, Lagrange's theorem 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. $10 \times 2 = 20$.

2.5 23MATMAJ201: Linear Algebra I

2.5.1 Course description

Course code:	**23MATMAJ201**
Course category:	**Major**
Title of the course:	**Linear Algebra I**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
III	**4**	**4**	**60**	**2023**

Prerequisites

Before attending the course, students should be familiar with
- basic properties of addition and multiplication of real numbers, complex numbers, matrices, determinants;
- the course 23MATVAC102.

Objectives

At the end of the course, the students should be able to

MAJ201-Ob1 Define and understand vector space and related concepts.

MAJ201-Ob2 Understand Cayley-Hamilton theorem and compute eigenvalues and eigenvectors.

MAJ201-Ob3 Apply elementary operations to find the rank of a matrix.

MAJ201-Ob4 Analyse properties of a linear transformation and establish its properties.

MAJ201-Ob5 Find the change of basis matrix.

Corresponding outcomes

The outcomes corresponding to the learning objective **MAJ201-Ob1**, are

MAJ201-CO1: Define vector space, subspace, basis, linear transformation,

MAJ201-CO2: State and prove various related theorems.

The outcome corresponding to the learning objective **MAJ201-Ob2**, is

MAJ201-CO3: Prove Cayley-Hamilton theorem and compute eigenvalues and eigenvectors.

The outcomes corresponding to the learning objective **MAJ201-Ob3**, are

MAJ201-CO4: Apply elementary operations to find the rank of a matrix.

MAJ201-CO5: Analyse and solve a system of linear equations using rank of the coefficient matrix.

The outcomes corresponding to the learning objective **MAJ201-Ob4**, are

MAJ201-CO6: Prove various related theorems.

MAJ201-CO7: Find the matrix of a linear transformation and determine properties of the same in terms of the matrix.

The outcome corresponding to the learning objective **MAJ201-Ob5**, is

MAJ201-CO8: Find the change of basis matrix.

Content

Unit: 1	**Credits: 2**	**Lecture hours: 30**
Objectives mapped: **MAJ201-Ob1**	**Cognitive levels achieved through outcomes:** Remembering: MAJ201-CO1 Understanding: MAJ201-CO1 and MAJ201-CO2	
Vector spaces, subspaces, algebra of subspaces, quotient spaces. Linear combination of vectors, linear span, linear independence, basis and dimension. Deletion, Existence, Extension and Replacement theorems for basis of finite dimensional vector spaces. Ordered basis, coordinatisation of vectors.		

Unit: 2	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ201-Ob2** and **MAJ201-Ob3**	**Cognitive levels achieved through outcomes:** Understanding: MAJ201-CO2 Applying: MAJ201-CO3 Analysing: MAJ201-CO4	

Rank of a matrix, row and column rank. Determination of rank using elementary operations, echelon matrices, normal form. System of linear equations: homogeneous system, non-homogeneous system. Characteristics polynomial, characteristics equation. Eigenvalues and eigenvectors of a matrix. Cayley-Hamilton Theorem.

Unit: 3	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ201-Ob4** and **MAJ201-Ob5**	**Cognitive levels achieved through outcomes:** Understanding: MAJ201-CO6 and MAJ201-CO8 Evaluating: MAJ201-CO7	
Linear transformations (LT): null space, range space, rank and nullity of a LT, Rank-Nullity theorem. Matrix representation of a LT relative to ordered bases. Algebra of LTs, correspondence between LTs and matrices. Properties of LTs in terms of matrices. Change of coordinate matrix.		

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. Hoffman, K and Kunze, R, A, *Linear Algebra*, Prentice Hall of India Pvt Ltd.

Reference books

1. Friedberg, S H, Insel, A J, and Spence, L A, *Linear Algebra*, 4th Ed, Prentice Hall of India Pvt Ltd, 2004.
2. Lang, S, *Introduction to Linear Algebra*, 2nd Ed, Springer, 2005.
3. Strang, G, *Linear Algebra and its Applications*, Thomson, 2007.
4. Kumaresan, S, *Linear Algebra – A Geometric Approach*, Prentice Hall of India, 1999.
5. Lay, D C, *Linear Algebra and its Applications*, 3rd Ed, Pearson Education Asia, Indian Reprint, 2007.

2.5.2 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. $10 \times 2 = 20$.

2.5.3 Approval (23MATMAJ201)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Manoj Ray Bakshi	Subhajit Paul	Subhajit Paul

2.6 23MATMAJ202: Real Analysis II

2.6.1 Course description

Course code:	**23MATMAJ202**			
Course category:	**Major**			
Title of the course:	**Real Analysis II**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
III	**4**	**4**	**60**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- the definition of relations, mappings and related concepts.
- the course 23MATMAJ103.

Objectives

At the end of the course, the students should be able to

MAJ202-Ob1	Define and compute limit of a function.
MAJ202-Ob2	Identify the points of continuity and discontinuity of a function.
MAJ202-Ob3	Understand, prove and apply various properties of continuous functions.
MAJ202-Ob4	Understand the notion of differentiability of a function.
MAJ202-Ob5	Evaluate the Taylor series expansion of a given function.

Corresponding outcomes

The outcomes corresponding to the learning objective **MAJ202-Ob1**, are

MAJ202-CO1: Define both-sided and one-sided limits of a function.

MAJ202-CO2: Prove various theorems and apply them to find the limit of a function.

The outcome corresponding to the learning objective **MAJ202-Ob2**, are

MAJ202-CO3: Define a continuous function.

MAJ202-CO4: Apply various results to determine the continuity of a function.

The outcome corresponding to the learning objective **MAJ202-Ob3**, are

MAJ202-CO5: Understand, prove and apply various properties of continuous functions.

MAJ202-CO6: Uniformly continuous functions and compact sets.

The outcome corresponding to the learning objective **MAJ202-Ob4**, are

MAJ202-CO7: Determine whether a function is differentiable at a given point.

MAJ202-CO8: Prove and apply various related results.

The outcome corresponding to the learning objective **MAJ202-Ob5**, is

MAJ202-CO9: Evaluate the Taylor series expansion of a given function.

Content

Unit: 1	**Credits: 1**	**Lecture hours: 10**
Objectives mapped: **MAJ202-Ob1**	**Cognitive levels achieved through outcomes:** Remembering: MAJ202-CO1 Understanding: MAJ202-CO2 Applying: MAJ202-CO2	
LIMIT OF A FUNCTION: ϵ-δ definition, sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity.		

Unit: 2	**Credits: 1**	**Lecture hours: 25**
Objectives mapped: **MAJ202-Ob2** and **MAJ202-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MAJ202-CO3 Understanding: MAJ202-CO5 Applying: MAJ202-CO4 Analysing: MAJ202-CO6	
CONTINUITY: ϵ-δ definition, sequential criterion for continuity. Algebra of continuous functions. Continuous functions on an interval: Bolzano's theorem, intermediate value theorem, preservation of intervals theorem. Discontinuities, types of discontinuity. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem. Lipschitz condition. Compact sets: Open cover definition. Characterisations of compact sets, Heine-Borel theorem, sequential and Bolzano-Weierstrass compactness. Continuous functions on compact sets.		

Unit: 3	Credits: 1	Lecture hours: 15
Objectives mapped: **MAJ202-Ob4**	**Cognitive levels achieved through outcomes:** Understanding: MAJ202-CO7 Applying: MAJ202-CO7 Evaluating: MAJ202-CO8	
DIFFERENTIATION: Differentiability of a function at a point and in an interval, Carathéodory's theorem, algebra of differentiable functions. Intermediate value property of derivatives: Darboux's theorem. Relative extrema, absolute extremum theorem. Mean value theorems (MVT): Rolle's theorem, Lagrange's MVT, Cauchy's MVT. Applications of mean value theorem to inequalities and approximation of polynomials.		

Unit: 4	Credits: 1	Lecture hours: 10
Objectives mapped: **MAJ202-Ob5**	**Cognitive levels achieved through outcomes:** Analysing: MAJ202-CO8	
Taylor's theorem with Lagrange's form, Cauchy's form and general form of remainder. Taylor's series and Maclaurin's series expansions of various functions. Application of Taylor's theorem to inequalities.		

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.
3. Ghosh, R K, and Maity, K C, *An Introduction to Analysis, Differentail Calculus: Part I*, New Central Book Agency (P) Ltd.
4. Malik, S C, and Arora, S, *Mathematical Analysis*, New Age International 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.

2.6.2 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. $10 \times 2 = 20$.

2.6.3 Approval (23MATMAJ202)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Subhajit Paul	Subhajit Paul	Subhajit Paul

2.7 23MATMAJ203: Abstract Algebra II

2.7.1 Course description

Course code:	**23MATMAJ203**			
Course category:	**Major**			
Title of the course:	**Abstract Algebra II**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
IV	**4**	**4**	**60**	**2023**

Prerequisites

Before attending the course, students should be familiar with
- the course 23MATMAJ104.

Objectives

At the end of the course, the students should be able to

MAJ203-Ob1 Understand the relation between normal subgroups and group homomorphisms.

MAJ203-Ob2 Apply the fundamental concepts in ring theory such as of the ideals, quotient rings, integral domains, and fields in further branches of pure and applied Mathematics.

MAJ203-Ob3 Apply ring homomorphism and isomorphism theorems in the branch of modules, Galois Theory and field extensions.

Corresponding outcomes

The outcome corresponding to the learning objective **MAJ203-Ob1**, is

MAJ203-CO1: Identify and manipulate normal subgroups and corresponding group homomorphisms.

The outcome corresponding to the learning objective **MAJ203-Ob2**, is

MAJ203-CO2: Describe and analyse the fundamental concepts in ring theory such as of the ideals, quotient rings, integral domains, and fields.

The outcomes corresponding to the learning objective **MAJ203-Ob3**, are

MAJ203-CO3: Describe ring homomorphism, kernel and image of a homomorphism.

MAJ203-CO4: Demonstrate three ring isomorphism theorems with examples.

Content

Unit: 1	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ203-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: MAJ203-CO1 Analysing: MAJ203-CO1	
Normal subgroups. Quotient groups. Group homomorphisms. Isomorphism theorems.		

Unit: 2	**Credits: 2**	**Lecture hours: 30**
Objectives mapped: **MAJ203-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: MAJ203-CO2 Analysing: MAJ203-CO2	
Definition and examples of rings and fields. Properties of rings, subrings, integral domains and fields. Necessary and sufficient conditions for subrings and subfields. Characteristics of a ring. Ideal, ideal generated by a subset of a ring, operations on ideals, prime and maximal ideals. Quotient rings.		

Unit: 3	**Credits: 1**	**Lecture hours: 15**

Objectives mapped: **MAJ203-Ob2**	**Cognitive levels achieved through outcomes:** Understanding: MAJ203-CO3 Applying: MAJ203-CO4 Analysing: MAJ203-CO4
Ring homomorphisms: properties of ring homomorphisms. Isomorphism theorems I, II and III.	

Suggested readings

1. Mapa, S K, *Higher Algebra: Abstract and Linear*, Sarat Book House.
2. Fraleigh, J B, *A First Course in Abstract Algebra*, 7th Ed, Pearson, 2002.
3. Herstein, I N, *Topics in Algebra*, Wiley.
4. Dummit, D S and Foote, R M, *Abstract Algebra*, Wiley.

Reference books

1. Sen, M K, Ghosh, S, Mukhopadhyay P, Maity S, *Topics in Abstract Algebra*, 4th Ed, Universities Press.
2. Chakraborty, A, *Modern Algebra*, Levant Books.
3. Gallian, J A, *Contemporary Abstract Algebra*, Narosa Publishing House.
4. Artin, M, *Abstract Algebra*, Pearson.
5. Rotman, J J, *An Introduction to the Theory of Groups*, Springer Verlag.

2.7.2 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. $10 \times 2 = 20$.

2.7.3 Approval (23MATMAJ203)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Debdut Sengupta	Subhajit Paul	Subhajit Paul

2.8 23MATMAJ204: Real Analysis III

2.8.1 Course description

Course code:	**23MATMAJ204**
Course category:	**Major**
Title of the course:	**Real Analysis III**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
IV	**4**	**4**	**60**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- the course 23MATMAJ202.

Objectives

At the end of the course,

MAJ204-Ob1 Students will be able to articulate the fundamental principles of Riemann integration and apply them to solve problems.

MAJ204-Ob2 Understanding of sequence and series concepts will enable students to analyse and manipulate functions, providing a strong foundation for advanced mathematical studies.

MAJ204-Ob3 Application of power series in problem-solving scenarios will enhance students' mathematical modeling skills and analytical thinking.

MAJ204-Ob4 Students will develop the ability to reason mathematically and construct logical arguments in the context of calculus concepts.

MAJ204-Ob5 Analyse mathematical structures and understanding the convergence and divergence of functions in various mathematical contexts.

Corresponding outcomes

The outcome corresponding to the learning objective **MAJ204-Ob1**, is

MAJ204-CO1: Articulate the fundamental principles of Riemann integration and apply them to solve problems.

The outcome corresponding to the learning objective **MAJ204-Ob2**, is

MAJ204-CO2: Analyse and manipulate functions, providing a strong foundation for advanced mathematical studies.

The outcome corresponding to the learning objective **MAJ204-Ob3**, is

MAJ204-CO3: Model a given problem in terms of sequences and series of functions and evaluate its various properties.

The outcome corresponding to the learning objective **MAJ204-Ob4**, is

MAJ204-CO4: Solve various problems in the context of Calculus concepts.

The outcome corresponding to the learning objective **MAJ204-Ob5**, is

MAJ204-CO5: Analyse mathematical structures and understanding the convergence and divergence of functions in various mathematical contexts.

Content

Unit: 1	**Credits: 2**	**Lecture hours: 30**
Objectives mapped: **MAJ204-Ob1** and **MAJ204-Ob2**	**Cognitive levels achieved through outcomes:** Understanding: MAJ204-CO1 Applying: MAJ204-CO2 Analysing: MAJ204-CO2	
RIEMANN INTEGRATION: Formulation of Riemann integration: partition, lower sum, upper sum, inequalities of lower sum and upper sum. Upper integral and lower integral. Darboux's definition of Riemann integration. Necessary and sufficient conditions for Riemann integration. Riemann sum, Riemann's definition of integration. Integrability of functions: continuous functions, functions with finitely many points of discontinuity, functions with infinitely many points of discontinuity. Riemann integrability of functions of the form: cf, $f \pm g$, fg, $\|f\|$, monotone functions. Intermediate value theorem for integrals; Fundamental theorem of Integral Calculus, Mean value theorems of Integral Calculus: First Mean value theorem, Second Mean value theorem, Bonnet's form & Weierstrass form (Statement only).		

Unit: 2	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ204-Ob3** and **MAJ204-Ob4**	**Cognitive levels achieved through outcomes:** Understanding: MAJ204-CO3 Applying: MAJ204-CO4 Evaluating: MAJ204-CO3	

SEQUENCE OF FUNCTIONS: Definition, pointwise and uniform convergence, limit function,Cauchy condition for uniform convergence, sup-norm test for uniform convergence, Dini's theorem. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. SERIES OF FUNCTIONS: Definition, pointwise and uniform convergence, sum function, Weierstrass M-test for uniform convergence. Theorems on continuity, derivability and integrability of the sum function of a series of functions, Abel's test and Dirichlet's test (statement only).

Unit: 3	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MAJ204-Ob4** and **MAJ204-Ob5**	**Cognitive levels achieved through outcomes:** Applying: MAJ204-CO5 Evaluating: MAJ204-CO4	
POWER SERIES: Definition, convergence, radius of convergence, interval of convergence, derivability and integration of sum function, term by term differentiation and integration, equality of power series, Abel's theorem and Weierstrass approximation theorem (statement only).		

Suggested readings

1. Ghosh, R K, and Maity, K C, *An Introduction to Analysis, Integral Calculus*, New Central Book Agency (P) Ltd.
2. Ghosh, R K, and Maity, K C, *An Introduction to Analysis, Differentail Calculus: Part II*, New Central Book Agency (P) Ltd.
3. Mapa, S K, *Introduction to Real Analysis*, Sarat Book Distributors.

Reference books

1. Bartle, R G, and Sherbert, D R, *Introduction to Real Analysis*, Wiley India Edition, Wiley India Pvt Ltd.
2. Narayan, S, and Mittal, P K, *Integral Calculus*, S Chand & Co Ltd.
3. Apostol, T M, *Calculus, Vol: I*, Willey student edition, Wiley India Pvt Ltd.
4. Ross, K A, *The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian Reprint, 2004.

2.8.2 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. $10 \times 2 = 20$.

2.8.3 Approval (23MATMAJ204)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Bikiran Das	Subhajit Paul	Subhajit Paul

2.9 23MATMAJ205: Ordinary Differential Equations II & Three-dimensional Geometry

2.9.1 Course description

Course code:	**23MATMAJ205**
Course category:	**Major**
Title of the course:	**Ordinary Differential Equations II & Three-dimensional Geometry**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
IV	**4**	**4**	**60**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- the course 23MATMAJ101.
- the course 23MATMAJ102.
- basic concepts of 3-D geometry, such as the equation of a plane, distance between points in 3D, and visualization of 3D objects.

Objectives

At the end of the course, the students should be able to

MAJ205-Ob1 Introduce the concept of power series solutions for solving ordinary differential equations, focusing on their convergence and applications.

MAJ205-Ob2 Introduce phase plane analysis as a method for visualizing and understanding the behaviour of solutions to first-order systems of ordinary differential equations.

MAJ205-Ob3 Study stability concepts in the context of phase plane analysis, identifying critical points and classifying them as stable, unstable, or semi-stable.

MAJ205-Ob4 Understand the geometrical terminologies and have a detailed idea of the planes, straight lines in 3D, Spheres, Cylindrical surfaces, Central Conicoids, Paraboloids, Plane sections of Conicoids along with the tangent and normal of the Conicoids.

MAJ205-Ob5 Develop an idea of classification of quadrics.

MAJ205-Ob6 Develop an idea of generating lines.

MAJ205-Ob7 Be familiar with the illustrations of graphing standard quadric surfaces like cones, Paraboloids, hyperboloids and ellipsoids.

Corresponding outcomes

The outcome corresponding to the learning objective **MAJ205-Ob1**, is

MAJ205-CO1: Apply power series method to find the solution of the ordinary differential equation understanding the convergence and divergence.

The outcome corresponding to the learning objective **MAJ205-Ob2**, is

MAJ205-CO2: Learn and apply phase plane analysis techniques to visualize and interpret solutions to first-order systems of differential equations.

The outcome corresponding to the learning objective **MAJ205-Ob3**, is

MAJ205-CO3: Analyse stability concepts in the context of phase plane analysis, identifying critical points and classifying them as stable, unstable, or semi-stable.

The outcomes corresponding to the learning objective **MAJ205-Ob4**, are

MAJ205-CO4: Acquire a level of proficiency in particular in using equation of plane in terms of its intercepts on axis and the equation of the planes through the given point length of the perpendicular from a given point to a given plane.

MAJ205-CO5: Explore the basic concept of the equation of a line, angle between the line and a plane, and the shortest distance between two lines.

MAJ205-CO6: Develop their knowledge and apply the skills in the study of the sphere.

The outcome corresponding to the learning objectives **MAJ205-Ob5** to **MAJ205-Ob7**, is

MAJ205-CO7: Gain a broader understanding on cones, Paraboloids, ellipsoids, hyperboloids and use the facts, formulas and techniques learned in this course to prove applications of those.

Content

Unit: 1	Credits: 2	Lecture hours: 30
Objectives mapped: **MAJ205-Ob1** to **MAJ205-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MAJ205-CO2 Understanding: MAJ205-CO1 Applying: MAJ205-CO1 to MAJ205-CO3	
Ordinary Differential Equations: Singularities and their classifications. Power series solution of a differential equation about an ordinary point, solution about a regular singular point. Equilibrium points, interpretation of the phase plane, critical points and paths of linear systems and non-linear systems.		

Unit: 2	Credits: 2	Lecture hours: 30
Objectives mapped: **MAJ205-Ob4** to **MAJ205-Ob7**	**Cognitive levels achieved through outcomes:** Remembering: MAJ205-CO4 to MAJ205-CO7 Understanding: MAJ205-CO4 to MAJ205-CO7 Applying: MAJ205-CO4 to MAJ205-CO7	
Three Dimensional Geometry: Introduction to coordinate system in three dimension. Straight line, Plane, Spheres, Cylindrical surfaces, Central Conicoids, Paraboloids, Plane sections of Conicoids, Generating lines, Classification of quadrics.		

Suggested readings

1. Chakravorty, J G, and Ghosh, P R, *Advanced Analytical Geometry*, U N Dhur and Sons Pvt Ltd.
2. Khan, R M, *Analytical Geometry of Two and Three Dimensions and Vector Analysis*, New Central Book Agency.
3. Ghosh, R K and Maity, K C, *An Introduction to differential equations*, New Central Book Agency.
4. Raisinghania, M D, *Ordinary and Partial Differential Equations*, S Chand Publishing.
5. Ross, S L, *Differential Equations*, Wiley.

Reference books

1. Coddington, E A, *An Introduction to Ordinary Differential Equations*, Dover Books on Mathematics Series, Dover Publications Inc.
2. Bej, N K, and Mukherjee, A, *Analytical Geometry of Two & Three Dimensions (Advanced Level)*, Book & Allied Pvt Ltd.

2.9.2 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. $10 \times 2 = 20$.

2.9.3 Approval (23MATMAJ205)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Snigdha Roy	Subhajit Paul	Subhajit Paul

CHAPTER

THREE

SYLLABI FOR MATHEMATICS MINOR COURSES

3.1 23MATMIN101: Linear Algebra and Differential Equations

3.1.1 Course description

Course code:	**23MATMIN101**			
Course category:	**Major**			
Title of the course:	**Linear Algebra and Differential Equations**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I	**4**	**4**	**60**	**2023**

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**
Objectives mapped: **MIN101-Ob1** to **MIN101-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MIN101-CO1 and MIN101-CO2 Understanding: MIN101-CO1 and MIN101-CO2 Applying: MIN101-CO1 to MIN101-CO4	

Linear Algebra: Elementary operations, Row/column reduced echelon matrix, Rank of matrix, Normal forms, Inverse of a matrix.

Systems of linear equations: $AX = b$. Solutions, Consistency, Coefficient matrix. Homogeneous and non-homogeneous system of equations. Solutions using elementary operations.

Characteristic polynomial and Characteristic equation of a square matrix. Cayley-Hamilton theorem. Computations (only) of eigenvalues and eigenvectors.

Unit: 2	Credits: 2	Lecture hours: 30
Objectives mapped: **MIN101-Ob4** and **MIN101-Ob5**	**Cognitive levels achieved through outcomes:** Remembering: MIN101-CO5 and MIN101-CO6 Understanding: MIN101-CO5 and MIN101-CO6 Applying: MIN101-CO5 and MIN101-CO6	

Differential Equations: Examples and formulations. 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.

General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation 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. $10 \times 2 = 20$.

3.2 23MATMIN201: Discrete Mathematics

3.2.1 Course description

Course code:	**23MATMIN201**
Course category:	**Minor**
Title of the course:	**Discrete Mathematics**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
III	**4**	**4**	**60**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- concepts of sets, functions and relations,
- basic concepts of permutations and combinations.

Objectives

At the end of the course, the students should be able to

MIN201-Ob1 Describe the concepts of mathematical logic.

MIN201-Ob2 Illustrate the concepts of sets, relations, and functions.

MIN201-Ob3 Perform the operations associated with sets, functions, and relations.

MIN201-Ob4 Relate practical examples to the appropriate set, function, or relation model, and interpret the associated operations and terminology in context.

Corresponding outcomes

The outcome corresponding to the learning objective **MIN201-Ob1**, is

MIN201-CO1: Applying mathematical logic to solve problems.

The outcome corresponding to the learning objective **MIN201-Ob2**, is

MIN201-CO2: Understanding sets, relations, functions and discrete structures.

The outcome corresponding to the learning objectives **MIN201-Ob3** and **MIN201-Ob4**, is

MIN201-CO3: Using logical notations to define and reason about fundamental mathematical concepts such as sets relations and functions.

Content

Unit: 1	Credits: 2	Lecture hours: 30
Objectives mapped: **MIN201-Ob2** and **MIN201-Ob3**	**Cognitive levels achieved through outcomes:** Understanding: MIN201-CO2 Applying: MIN201-CO3	
Set theory, operations and algebra, switching circuits as an application. Relations and their properties, equivalence relations, partial order relations. Functions, domain, codomain, range, the properties of one-to-one and onto, composite and inverse functions.		

Unit: 2	Credits: 1	Lecture hours: 15
Objectives mapped: **MIN201-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: MIN201-CO1 Applying: MIN201-CO1	
Introduction to logic, quantifiers and conditional propositions. Truth tables. Tautology and contradiction.		

Unit: 3	Credits: 1	Lecture hours: 15
Objectives mapped: **MIN201-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: MIN201-CO1 Applying: MIN201-CO1	
Fundamental Counting Principles: Permutations, Derangements, Combinations, Permutations and Combinations with repetitions, Binomial theorem. Generalised Inclusion Exclusion Principle. Pigeonhole principle.		

Suggested readings

1. Veerarajan, T, *Discrete Mathematics, with Graph Theory and Combinatorics*, McGraw Hill Education.
2. Rosen, K H, *Discrete Mathematics and its Applications*, 7th Ed, McGraw Hill Education (India) Pvt Ltd.
3. Grimaldi, R P, *Discrete and Combinatorial Mathematics*, Pearson.
4. Malik, D S, and Sen, M K, *Discrete Mathematics*, Revised edition, Cengage Learning.
5. Liu, C L, and Mohapatra, D P, *Elements of Discrete Mathematics*, 4th Ed, McGraw Hill Education (India) Private Limited.

3.2.2 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. $10 \times 2 = 20$.

3.2.3 Approval (23MATMIN201)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Debdut Sengupta	Subhajit Paul	Subhajit Paul

CHAPTER

FOUR

SYLLABI FOR SKILL ENHANCEMENT COURSES

4.1 23MATSEC101: Typesetting in LaTeX

4.1.1 Course description

Course code:	**23MATSEC101**			
Course category:	**Skill Enhancement**			
Title of the course:	**Typesetting in LaTeX**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I	**1(L)+2(P) = 3**	**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 LaTeX document.

SEC101-Ob3 Draw basic diagrams using Ti*k*Z package.

SEC101-Ob4 Refer to different items within the document.

SEC101-Ob5 Generate a bibliography for a particular document.

Corresponding outcomes

The outcome corresponding to the learning objectives **SEC101-Ob1**, is

SEC101-CO1: Create a LaTeX 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 LaTeX 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: **SEC101-Ob1** and **SEC101-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: SEC101-CO1 and SEC101-CO2 Understanding: SEC101-CO1 and SEC101-CO2 Applying: SEC101-CO1 and SEC101-CO2	
What is LaTeX. Basics for document structuring, preamble preparation, saving a folder. LaTeX commands for font colour, font size, make title, begin document, new page, sectioning. `beamer` document class. Creating Tables, Inserting figures, enumeration list, itemized list, inserting equations.		

Unit: 2	**Credits: 1**	**Lecture hours: 20**
Objectives mapped: **SEC101-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: SEC101-CO3 Understanding: 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
Objectives mapped: **SEC101-Ob4** and **SEC101-Ob5**	**Cognitive levels achieved through outcomes:** Remembering: SEC101-CO4 and SEC101-CO5 Understanding: SEC101-CO4 and SEC101-CO5	
REFERENCING: Use of `hyperref`, `cleveref`, and `varioref` packages. Inserting references, Manual reference, Reference using `BibTeX`, citing reference.		

Suggested readings

1. LaTeX for beginners Work book, 5th edition, Document Reference: 3722-2014, March 2014.
2. Kopka, H, and Daly, P W, *Guide to* LaTeX, Addison-Wesley.

Reference books

1. Griffits, D F, and Higham, D J, *Learning* LaTeX, Siam, Philadelphia.
2. Kottwitz, S, LaTeX *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.. $15 \times 2 = 30$.

4.2 23MATSEC102: Graph Theory

4.2.1 Course description

Course code:	**23MATSEC102**			
Course category:	**Skill Enhancement**			
Title of the course:	**Graph Theory**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
II	**3**	**3**	**45**	**2023**

Objectives

At the end of the course, the students should be able to

SEC102-Ob1 Understand and apply the fundamental concepts in graph theory.

SEC102-Ob2 Apply graph theory based tools in solving practical problems.

Corresponding outcomes

The outcomes corresponding to the learning objective **SEC102-Ob1**, are

SEC102-CO1: Understanding relevance of graphs in different context, ranging from puzzles and games to social science/engineering/computer science.

SEC102-CO2: Solving real life problems based on graph theory.

The outcomes corresponding to the learning objective **SEC102-Ob2**, are

SEC102-CO3: Learning algorithms.

SEC102-CO4: knowing applications of Graph Theory.

Content

Unit: 1	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **SEC102-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: SEC102-CO1 Applying: SEC102-CO2	
Definition, examples and basic properties of graphs, directed graphs, pseudo graphs, complete graphs, bipartite graphs, isomorphism of graphs. Trees and forests, paths and cycles.		

Unit: 2	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **SEC102-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: SEC102-CO1 Applying: SEC102-CO2	
Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems. Hamiltonian cycles, theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph.		

Unit: 3	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **SEC102-Ob2**	**Cognitive levels achieved through outcomes:** Applying: SEC102-CO3 Analysing: SEC102-CO4	

Shortest path. Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm, Prim's algorithm. Connectivity, matching in bipartite graphs, matching in general graphs.

Suggested readings

1. Ghosh, D N, *Discrete Mathematics*, Academic Publishers.
2. Rosen, K H, *Discrete Mathematics and its Applications*, 7th Ed, McGraw Hill Education (India) Pvt Ltd.
3. Deo, N, *Graph Theory with applications to Engineering and Computer Science*, PHI Learning.
4. West, D B, *Introduction to Graph theory*, 2nd Ed, Pearson Education India.
5. Sharma, J K, *Discrete Mathematics*, 4th Ed, Laxmi Publications.

4.2.2 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. $10 \times 2 = 20$.

4.2.3 Approval (23MATSEC102)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Snigdha Roy	Subhajit Paul	Subhajit Paul

4.3 23MATSEC201: Mathematical Modelling

4.3.1 Course description

Course code:	**23MATSEC201**			
Course category:	**Skill Enhancement**			
Title of the course:	**Mathematical Modelling**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
III	**3**	**3**	**45**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- basic Calculus,
- the course 23MATMAJ102.

Objectives

At the end of the course, the students should be able to

SEC201-Ob1 Develop mathematical models to represent real-world phenomena across various domains such as Physics, Biology, Economics, Engineering, and Social sciences.

SEC201-Ob2 Enhance problem-solving skills by enabling students to translate real-world problems into mathematical formulations and vice versa, using appropriate modelling techniques.

SEC201-Ob3 Foster critical thinking skills by analysing the limitations, assumptions, and implications of mathematical models, and evaluating their effectiveness in addressing specific problems.

Corresponding outcomes

The outcome corresponding to the learning objective **SEC201-Ob1**, is

SEC201-CO1: Identifying real-world problems, define relevant variables, and formulate appropriate mathematical models to represent those problems.

The outcome corresponding to the learning objective **SEC201-Ob2**, is

SEC201-CO2: Analysing mathematical models using analytical techniques, numerical methods, and simulation to assess their accuracy, stability, and predictive capacity.

The outcome corresponding to the learning objective **SEC201-Ob3**, is

SEC201-CO3: Demonstrating critical thinking skills by questioning assumptions, exploring alternative modelling approaches, and adapting models to new situations or data.

Content

Unit: 1	Credits: 2	Lecture hours: 30
Objectives mapped: **SEC201-Ob1** and **SEC201-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: SEC201-CO1 and SEC201-CO2 Understanding: SEC201-CO2 Applying: SEC201-CO3	
Functions, modelling with linear and exponential functions. Average rate of change, linear functions with applications, Piecewise-linear functions with applications. Fitting linear models to data. Exponential growth functions with applications, Growth factors and rates, doubling time. Compound interest, Exponential decay functions with applications. Fitting exponential models to data, Decay factors and rates, Half-life. Modelling with logarithmic and polynomial functions, Logarithmic functions with applications, Fitting logarithmic models to data, Maxima and minima applications.		

Unit: 2	Credits: 1	Lecture hours: 15
Objectives mapped: **SEC201-Ob3**	**Cognitive levels achieved through outcomes:** Analysing: SEC201-CO3 Evaluating: SEC201-CO3	
Introduction to continuous time models, limitations and advantages of the discrete-time model, the need for continuous time models. Modelling the growth of microorganisms, chemostat. Stability and linearisation methods for system of ODEs.		

Suggested readings

1. Myint, T, and Debnath, L, *Linear Partial Differential Equation for Scientists and Engineers*, Springer, Indian reprint, 2008.
2. Kapoor, J N, *Mathematical Modelling*, New Age International Pvt Ltd Publishers, 2011.
3. Kamalanand, K, and Jawahar, P M, *Mathematical Modelling of Systems and Analysis*, PHI Learning Pvt Ltd, 2018.
4. Giordano, F R, Fox, W P, and Horton, S B, *A First Course in Mathematical Modelling*, Brooks/Cole Cengage Learning, USA, 2013.

4.3.2 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. $10 \times 2 = 20$.

4.3.3 Approval (23MATSEC201)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Snigdha Roy	Subhajit Paul	Subhajit Paul

CHAPTER

FIVE

SYLLABI FOR MULTI-DISCIPLINARY COURSES

5.1 23MATMDC101: Basic Mathematics

5.1.1 Course description

Course code:	**23MATMDC101**			
Course category:	**Multi-disciplinary**			
Title of the course:	**Basic Mathematics**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I / III	**3**	**3**	**45**	**2023**

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 formulæ of 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**
Objectives mapped: **MDC101-Ob1** to **MDC101-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MDC101-CO1 to MDC101-CO3 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 3×3 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**
Objectives mapped: **MDC101-Ob4** to **MDC101-Ob6**	**Cognitive levels achieved through outcomes:** Remembering: MDC101-CO5 and MDC101-CO6 Understanding: MDC101-CO5 and MDC101-CO6 Applying: 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 by substitution, by partial fractions and by parts, Evaluation of simple integrals and problems based on them. Statement (only) of Fundamental theorem of Calculus 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. $10 \times 2 = 20$.

5.2 23MATMDC102: Mathematics for Competitive Examinations

5.2.1 Course description

	Course code:	**23MATMDC102**		
	Course category:	**Multi-disciplinary**		
	Title of the course:	**Quantitative Aptitude**		
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
II	**3**	**3**	**45**	**2023**

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: 1	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **MDC102-Ob1**	**Cognitive levels achieved through outcomes:** Remembering: MDC102-CO1 Understanding: MDC102-CO2 and MDC102-CO3 Applying: MDC102-CO2 and MDC102-CO3	
Numbers, HCF & LCM of numbers. Decimal fractions. Simplifications. Square & cube roots. Permutations and Combinations. Decimals problems, fractions problems. Numbers and Ages. Surds and Indices. Averages, Odd man out & Series. Calendar. Clocks.		

Unit: 2	**Credits: 2**	**Lecture hours: 30**
Objectives mapped: **MDC102-Ob2** and **MDC102-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: MDC102-CO5 Understanding: MDC102-CO4 and MDC102-CO6 Applying: 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. Ratio & proportion. Pipes and cistern. Problems on trains. Simple and compound 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. $10 \times 2 = 20$.

CHAPTER

SIX

SYLLABI FOR VALUE ADDED COURSES

6.1 23MATVAC101: Introduction to Number Systems

6.1.1 Course description

Course code:	**23MATVAC101**			
Course category:	**Value added**			
Title of the course:	**Introduction to Number Systems**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I	**1**	**2**	**30**	**2023**

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

Unit: 1	**Credits: 1**	**Lecture hours: 30**
Objectives mapped: **VAC101-Ob1** to **VAC101-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: VAC101-CO1 and VAC101-CO2 Understanding: VAC101-CO1 to VAC101-CO3 Applying: VAC101-CO1 to VAC101-CO3	
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. 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.

6.1.2 Assessment

1. *Summative Assessment*: 50 marks. Assignment based.

6.2 23MATVAC102: Prerequisites to Linear Algebra

6.2.1 Course description

Course code:	**23MATVAC102**
Course category:	**Value Added**
Title of the course:	**Prerequisites to Linear Algebra**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
II	**1**	**2**	**30**	**2023**

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

VAC102-Ob1 Learn and manipulate different types of matrices in its general form.

VAC102-Ob2 Define determinants and manipulate them using various formulæ.

Corresponding outcomes

The outcomes corresponding to the learning objective **VAC102-Ob1**, are

VAC102-CO1: Multiply two compatible matrices.

VAC102-CO2: Compute transpose of a matrix.

VAC102-CO3: Identify symmetric, skew symmetric, nilpotent, idempotent matrices.

VAC102-CO4: Find inverse of a matrix using elementary transformations.

The outcomes corresponding to the learning objective **VAC102-Ob2**, are

VAC102-CO5: Define determinants using permutation definition.

VAC102-CO6: Compute determinants using various formulæ.

Content

Unit: 1	**Credits: 1**	**Lecture hours: 30**
Objectives mapped: **VAC102-Ob1** and **VAC102-Ob2**	**Cognitive levels achieved through outcomes:** Applying: VAC102-CO1 to VAC102-CO5	
MATRICES: Algebraic operations on matrices. Block multiplication of matrices. Transpose of a matrix. Symmetric and Skew-symmetric matrices. Types of matrices: orthogonal, idempotent, nilpotent matrix. Adjoint of a matrix, Inverse of a matrix, complex matrices. DETERMINANTS: Definition of determinant using permutations. Minors and Cofactors, complementary minor, multiplications of determinants, determinants of symmetric and skew-symmetric matrices, Cramer's Rule.		

Suggested readings

1. Mapa, S K, *Higher Algebra: Abstract and Linear*, Sarat Book House.

6.2.2 Assessment

1. *Summative Assessment*: 50 marks, Assignment based.

6.2.3 Approval (23MATVAC102)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Manoj Ray Bakshi	Subhajit Paul	Subhajit Paul

6.3 23MATVAC201: Graphing using GeoGebra

6.3.1 Course description

Course code:	**23MATVAC201**
Course category:	**Value Added**
Title of the course:	**Graphing using GeoGebra**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
III	**1**	**2**	**30**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- fundamental mathematical concepts, including algebra, geometry, and trigonometry;
- basic calculus concepts, including limits, derivatives, and integrals.
- basic computer literacy, including proficiency in using computer software and navigating interfaces.

Objectives

At the end of the course, the students should be able to

VAC201-Ob1 Learn and manipulate GeoGebra interface to create graphs of various functions.

VAC201-Ob2 Showcase the educational applications of GeoGebra in teaching and learning.

Corresponding outcomes

The outcomes corresponding to the learning objective **VAC201-Ob1** and **VAC201-Ob2**, are

VAC201-CO1: Students will proficiently navigate GeoGebra, utilising its basic tools for mathematical exploration.

VAC201-CO2: Dynamic geometry construction skills will allow students to visualise and manipulate geometric objects dynamically.

VAC201-CO3: The ability to connect algebraic and graphical representations will enable students to explore and analyse mathematical relationships effectively.

VAC201-CO4: Applying GeoGebra to investigate functions and calculus concepts dynamically, gaining insights into mathematical ideas.

VAC201-CO5: The creation of interactive demonstrations and simulations will allow students to communicate mathematical concepts effectively.

VAC201-CO6: The creation of custom tools and scripts in GeoGebra, tailoring the software to address specific mathematical problems.

VAC201-CO7: The course will demonstrate the diverse educational applications of GeoGebra in teaching and learning mathematics.

Content

Unit: 1	**Credits: 1**	**Lecture hours: 30**
Objectives mapped: **VAC201-Ob1** and **VAC201-Ob2**	**Cognitive levels achieved through outcomes:** Applying: VAC201-CO1 to VAC201-CO7	
Introduction to GeoGebra: Overview of GeoGebra interface: Introduction to GeoGebra software; navigation and basic tools. Dynamic geometry construction: Creating points, lines, and circles, exploring dynamic constructions with sliders. Algebraic and graphical representations: Inputting algebraic expressions and equations, connecting algebraic and graphical representations. Exploring functions in GeoGebra: Graphical analysis of functions, dynamic exploration of function transformations. Advanced Features and Customisations: Advanced dynamic geometry: Using advanced geometric tools, exploring 3D geometry in GeoGebra. Calculus concepts in GeoGebra: Investigating limits graphically, dynamic exploration of derivatives and integrals. Interactive demonstrations: Designing interactive demonstrations, showcasing GeoGebra applications in mathematics.		

Suggested readings

1. GeoGebra Tutorials by official GeoGebra website: Beginner Tutorials – GeoGebra at https://www.geogebra.org/m/ys2eur3x.
2. YouTube Khan Academy – GeoGebra at https://www.geogebra.org/m/rZHGCANX.
3. GeoGebra Tube at https://www.geogebra.org/?lang=en.

4. Coursera: GeoGebra Course at https://www.geogebra.org/m/kMm1U3DQ.

6.3.2 Assessment

1. *Summative Assessment*: 50 marks, Assignment based.

6.3.3 Approval (23MATVAC201)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Bikiran Das	Subhajit Paul	Subhajit Paul

6.4 23MATVAC202: Poster Presentation

6.4.1 Course description

Course code:	**23MATVAC202**
Course category:	**Value Added**
Title of the course:	**Poster Presentation**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
IV	**1**	**2**	**30**	**2023**

Prerequisites

Before attending the course, students should be familiar with
- basics of computer literacy.
- the course 23MATSEC101.

Objectives

At the end of the course, the students should be able to

VAC202-Ob1 Create and present a poster on a given topic.

Corresponding outcomes

The outcomes corresponding to the learning objective **VAC202-Ob1**, are

VAC202-CO1: Create a poster using a presentation software.

VAC202-CO2: Present the poster with vocal clarity and confidence.

VAC202-CO3: Answer questions from the audience.

Content

Unit: 1	Credits: 1	Lecture hours: 30
Objectives mapped: **VAC202-Ob1**	**Cognitive levels achieved through outcomes:** Applying: VAC202-CO1 to VAC202-CO3	
PRESENTATION SOFTWARE MS POWERPOINT OR EQUIVALENT: Creating a poster using available templates. PRESENTATION SOFTWARE LaTeX: Creating a poster using `tikzposter` or `beamerposter` document classes. Language and vocabulary for presenting the poster: outline, summary, background, problem, materials, methods, and processes. Explaining and discussing data in the form of figures and tables. Understanding and answering questions from the audience.		

Suggested readings

1. `tikzposter` and `beamerposter` tutorials at https://www.overleaf.com/learn/latex/Posters.
2. PowerPoint tutorials at https://youtube.com/playlist?list=PLpQQipWcxwt_KvhjMTsADzon_GY_vBGRL&si=vJFk0C2XPq0XCTAU.
3. Anthony, L, *Presenting Research in Science and Engineering*, 2nd Ed, DTP Publishing, Tokyo, Japan, 2010.

6.4.2 Assessment

1. *Summative Assessment*: 50 marks, Assignment based.

6.4.3 Approval (23MATVAC202)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Snigdha Roy	Subhajit Paul	Subhajit Paul

CHAPTER

SEVEN

SYLLABI FOR STATISTICS MINOR COURSES

7.1 23STAMIN101: Statistical Methods

7.1.1 Course description

Course code:	**23STAMIN101**			
Course category:	**Minor**			
Title of the course:	**Statistical Methods**			
Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
I / II	**3(L)+1(P) = 4**	**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: 1	**Credits: 1**	**Lecture hours: 15**
Objectives mapped: **STAMIN101-Ob1**	**Cognitive levels achieved through outcomes:** Remembering: STAMIN101-CO1 Understanding: STAMIN101-CO1 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. 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 box-plot; 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**
Objectives mapped: **STAMIN101-Ob2**	**Cognitive levels achieved through outcomes:** Remembering: STAMIN101-CO2 Understanding: STAMIN101-CO2 Applying: 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: **STAMIN101-Ob3**	**Cognitive levels achieved through outcomes:** Remembering: STAMIN101-CO3 Understanding: STAMIN101-CO3 Applying: STAMIN101-CO3	
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:** Remembering: STAMIN101-CO4 Understanding: STAMIN101-CO4 Applying: STAMIN101-CO4	
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. $10 \times 3 = 30$.

7.2 23STAMIN201: Fundamentals of Probability

7.2.1 Course description

Course code:	**23STAMIN201**
Course category:	**Minor**
Title of the course:	**Fundamentals of Probability**

Semester	*Credits*	*Lecture hours in a week*	*Total lecture hours*	*Regulation year*
III / IV	**3(L)+1(P) = 4**	**5**	**75**	**2023**

Prerequisites

Before attending the course, students should be familiar with

- basic arithmetic and algebraic calculations.
- coordinate geometry, concept of straight lines.
- basic calculus.
- the course 23STAMIN101.

Objectives

At the end of the course, the students should be able to

STAMIN201-Ob1 Understand the preliminary ideas of probability.

STAMIN201-Ob2 Have the concept of random variables.

STAMIN201-Ob3 Manipulate different standard probability distributions of both discrete and continuous types.

STAMIN201-Ob4 Manipulate two dimensional random variables.

STAMIN201-Ob5 Have an idea about the mathematical expectation of random variables along with bivariate random variables.

Corresponding outcomes

The outcomes corresponding to the learning objective **STAMIN201-Ob1**, are

STAMIN201-CO1: Learn and understand the differences among different definitions of probability and apply various results therein.

STAMIN201-CO2: Demonstrate the use of Bayes' theorem in decision making.

The outcome corresponding to the learning objectives **STAMIN201-Ob2** and **STAMIN201-Ob3**, is

STAMIN201-CO3: Distinguish between a discrete and a continuous random variable.

The outcome corresponding to the learning objective **STAMIN201-Ob4**, is

STAMIN201-CO4: Demonstrate the concept of joint, marginal and conditional probability distributions and the bivariate transformations.

The outcome corresponding to the learning objective **STAMIN201-Ob5**, is

STAMIN201-CO5: State and prove various properties of expectation, variance and covariance.

Content

Unit: 1	**Credits: 1**	**Lecture hours: 10**
Objectives mapped: **STAMIN201-Ob1**	**Cognitive levels achieved through outcomes:** Understanding: STAMIN201-CO1 Applying: STAMIN201-CO2	

Concept of deterministic and non-deterministic experiments. Sample space, events. Definitions of Probability: classical, statistical, and axiomatic. Conditional Probability, independent events. Laws of addition and multiplication. Theorem of total probability, Bayes' theorem and its applications.

Unit: 2	**Credits: 1**	**Lecture hours: 25**
Objectives mapped: **STAMIN201-Ob2**, **STAMIN201-Ob3** and **STAMIN201-Ob5**	**Cognitive levels achieved through outcomes:** Understanding: STAMIN201-CO3 Applying: STAMIN201-CO5	
Random variables. Probability distributions: probability density and probability mass functions, cumulative distribution functions. Mathematical expectation in one and two dimensional distribution with its related results. Moments generating and characteristic functions, Cauchy-Schwartz inequality. Standard discrete probability distributions: Uniform, Geometric, Binomial, Poisson, and Hyper-geometric. Standard continuous probability distributions: Uniform, Gamma, Beta, Exponential and Normal. Transformation of random variables.		

Unit: 3	**Credits: 1**	**Lecture hours: 10**
Objectives mapped: **STAMIN201-Ob4**	**Cognitive levels achieved through outcomes:** Understanding: STAMIN201-CO4 Applying: STAMIN201-CO4	
Two dimensional Random variables and bi-variate distributions. Marginal and conditional distributions, independence of variables. Bivariate transformations with illustrations.		

List of practicals (Credit: 1)

Following problems are to be done using calculators.

1. Application problems based on binomial distribution.
2. Application problems based on Poisson distribution.
3. Problems based on area property of normal distribution.
4. Fitting of binomial distributions for given n.
5. Fitting of Poisson distributions.
6. Fitting of normal distribution when parameters are not given.
7. Approximation of hypergeometric distribution by binomial distribution.
8. Approximation of binomial distribution by Poisson distribution.
9. Approximation of Poisson distribution by Normal distribution.

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. Das, N G, *Statistical Methods*, Combined edition: volume 1 & 2, McGraw Hill Education.

4. Bhattacharya, D and Roychowdhury, S, *Statistics – Theory and Practice*, U N Dhar Publications.

5. Mukherjee, A, *Fundamental Treatise On Probability And Statistics*, Shreetara Prakashani.

6. Kendall, M G and Stuart, A, *Advanced Theory of Statistics*, John Wiley & Sons Inc.

7. Gupta, S C, *Fundamentals of Statistics*, Himalaya Publishing House.

7.2.2 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. $10 \times 3 = 30$.

7.2.3 Approval (23STAMIN201)

(Prepared by) **Course Faculty**	(Checked and verified by) **Head of the Dept**	(Approved by) **Dean**
Manoj Ray Bakshi	Subhajit Paul	Subhajit Paul

APPROVAL BY BOS MEMBERS

The above syllabi are discussed thoroughly and found to be fit for the students in Semesters I – IV (Regulation year: 2023) in Mathematics Major, Mathematics Minor and Statistics Minor (as applicable) studying in Salesian College (Autonomous) Siliguri.

Subhajit Paul Vice Chairperson, BoS, Mathematics & Statistics	
Bikiran Das Secretary, BoS, Mathematics & Statistics	
Debdut Sengupta Member, BoS, Mathematics & Statistics	
Snigdha Roy Member, BoS, Mathematics & Statistics	
Manoj Ray Baksi Member, BoS, Mathematics & Statistics	
Dr Atasi Deb Roy Asso Prof, Dept of Mathematics, University of Calcutta; External Expert, BoS, Mathematics & Statistics	

Prof Kajal Kumar Mondal Dept of Mathematics, Coochbehar P B University; External Expert, BoS, Mathematics & Statistics	
Prof Arindam Sengupta Dept of Statistics, University of Calcutta; External Expert, BoS, Mathematics & Statistics	
Dr Bibaswan Dey Asst Prof, Dept of Mathematics, University of North Bengal (NBU); Nominated by Vice Chancellor (NBU), BoS, Mathematics & Statistics	
Anuj Kumar Bhagat Senior Research Fellow, Dept of Mathematics, IIT Delhi; Alumni Representative, BoS, Mathematics & Statistics	
Divyata Chhetri Deputy Manager, Retail Assets – Home Loans, HDFC Bank, Industry Representative, BoS, Mathematics & Statistics	