Department of Mathematics

Birla Institute of Technology Mesra, Ranchi

Minutes of Board of Studies Meeting held on 1.7.2025

A meeting of the Board of Studies of the Department of Mathematics was held on **1.7.2025 2025** at **3:30 PM** in hybrid mode to finalize the Course Structure and Syllabi (First Year Mathematics Subjects) for the newly introduced **B.Sc. (Honours) – Mathematics and Computing programme at the Off-Campus Centre, Deoghar.**

Name and Signature of BOS members

INTERNAL MEMBERS		
S.No.	**Name of Member**	**Signature**
1	HOD/In-charge	
2	Dr. Saral Kumar Jain	
3	Dr. S. Padhi	
4	Dr. S. Chakraborty	Approved on Email (Email attached) 9/7/25
5	Dr. Prabal Datta	
6	Dr. Prabjot Kaur	
7	Dr. Randhir Singh	
8	Dr. S.D. Jabeen	
9	Dr. Payel Das	
10	Dr. A. P. Ghorai (In-charge Deoghar Campus) - Nominated by the Director, Deoghar	Approved on Email (Email attached) 9/7/25
11	Dr. Abhijit Mustafi, Professor, Department of CSE	8/7/25
12	Dr. Manish Pandey, Assistant Professor, CQEDS	
13	Sanchit Sanyam IMH/10013/22 - Student Representative	Sanchit Sanyam
14	Abhinandan Kumar IMH/10008/21- Student Representative	Abhinandan

EXTERNAL MEMBERS (any two)		
S.No.	**Name of Member**	**Signature**
1	Dr. Snehashish Chakraborty Professor HAG & Dean Academic, Department of Mathematics, National Institute of Technology Rourkela, Sundargarh, Odisha - 769008	–
2	Dr. Satyajit Roy Professor, Department of Mathematics, Indian Institute of Technology Madras, Chennai, Tamilnadu-600036	Approved on Email (Email attached) Vanda 9/7/22 Suggestions incorporated
3	Dr. P. K. Mishra Professor, Department of Computer Science, Banaras Hindu University, Varanasi, Uttar Pradesh-221005	Approved on Email (Email attached) Vanda 9/7/22
4	Dr. Bapan Ghosh Associate Professor, Department of Mathematics, Indian Institute of Technology Indore, Simrol, Khandwa Road, Indore, Madhya Pradesh - 453 552	Approved on Email (Email attached) Vanda 9/7/22
5	Dr. Jitendra Kumar Professor, Department of Mathematics, Indian Institute of Technology Ropar, Rupnagar, Punjab-140001	–
6	Ms. Vaishnudebi Dutta PhD Student, School of Engineering Mathematics and Technology, University of Bristol, Bristol, United Kingdom	Approved on email (Email attached) Vanda 9/7/22
7	Mr. Subhomoy Haldar Senior Software Developer, Component Sense (Remote), Edinburgh, Scotland, United Kingdom	Approved on email (Email attached) Vanda 9/7/22 Suggestions incorporated
8	Mr. Kanak Raj Applied Research Scientist, Thomson Reuters Lab., Bangalore, India	–

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2025)

Bachelor of Science (Honors) in Mathematics and Computing

DEPARTMENT
of
MATHEMATICS,
BIT Mesra, Off-Campus Deoghar.

INSTITUTE VISION

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

INSTITUTE MISSION

- To educate students at Undergraduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

DEPARTMENT VISION

- To become a globally recognized centre of excellence in teaching and research, producing excellent academicians, professionals and innovators who can positively contribute towards the society.

DEPARTMENT MISSION

- Imparting strong fundamental concepts to students in the field of Mathematical Sciences and motivate them towards innovative and emerging areas of research.
- Creation of compatible environment and provide sufficient research facilities for undertaking quality research to achieve global recognition.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To impart conceptual knowledge of Mathematical Sciences for formulating and analyzing the real-world problems with futuristic approach
2. To equip the students sufficiently in both analytical and computational skills in Mathematical Sciences.
3. To impart research-based knowledge and research methods for analysis and interpretation of data with valid conclusions.
4. To demonstrate knowledge and understanding of sciences and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
5. To develop a competitive attitude for building a strong academic - industrial collaboration, with a focus on continuous learning skills.
6. To nurture and nourish strong communication and interpersonal skills for working in a team with high moral and ethical values.

PROGRAMME OUTCOMES (POs)

A graduate of this program is expected to:

1 gain sound knowledge on fundamental principles and concepts of Mathematics and computing with their applications related to Industrial, Engineering, Biological and Ecological problems.

2 exhibit in depth the analytical and critical thinking to identify, formulate and solve real world problems of science and engineering.

3 be proficient in arriving at innovative solution to a problem with due considerations to society and environment.

4 be capable of undertaking suitable experiments/research methods while solving the real-life problem and would arrive at valid conclusions based on appropriate interpretations of data and experimental results.

5 exhibit understanding of societal and environmental issues (health, legal, safety, cultural etc) relevant to professional practice and demonstrate through actions, the need for sustainable development

6 be committed to professional ethics, responsibilities and economic, environmental, societal and political norms.

7 demonstrate appropriate inter-personal skills to function effectively as an individual, as a member or as a leader of a team and in a multi-disciplinary setting.

8 develop written and oral communications skills in order to effectively communicate design, analysis and research results.

9 be able to acquire competent positions in industry and academia as well.

10 be able to acquire lifelong learning and continuous professional development.

11 be conscious of financial aspects of all professional activities and shall be able to undertake projects with appropriate management control and control on cost and time.

12 recognize the need for continuous learning and will prepare himself/ herself appropriately for his/her all-round development throughout the professional career.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Apply in-depth knowledge gained during the B. Sc. Mathematics and Computing program in analyzing and interpreting real life problems for providing the optimal and achievable solutions.
2. Demonstrate combined knowledge of mathematics and computing to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.
3. Capable of using his/her knowledge of mathematical sciences in higher studies of interdisciplinary nature.

Mapping of Pos and PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PO1	**3**	**3**	**3**	**2**	**2**	**0**
PO2	**3**	**3**	**3**	**2**	**2**	**0**
PO3	**2**	**2**	**2**	**2**	**2**	**2**
PO4	**2**	**2**	**3**	**2**	**2**	**2**
PO5	**1**	**1**	**1**	**3**	**3**	**3**
PO6	**1**	**1**	**1**	**3**	**3**	**3**
PO6	**1**	**1**	**1**	**3**	**3**	**3**
PO7	**1**	**1**	**2**	**3**	**3**	**3**
PO8	**2**	**2**	**2**	**3**	**3**	**3**
PO9	**2**	**2**	**2**	**3**	**3**	**3**
PO10	**2**	**2**	**2**	**3**	**3**	**3**
PO12	**2**	**2**	**2**	**3**	**3**	**3**
PSO1	**3**	**3**	**3**	**2**	**2**	**2**
PSO2	**3**	**3**	**3**	**2**	**2**	**2**
PSO3	**3**	**3**	**3**	**2**	**2**	**2**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

SOME IMPORTANT NOTES:

- The essential guidelines from UGC dated 07 Dec 2022 have been followed in the preparation of the course structure of this program.
- The NEP-2020 guidelines for awarding Certificate, Diploma, and Degree:
  - **I Year UG Certificate:** Students who opt to exit after completing the first year and have secured a minimum of 40 credits will be awarded a UG certificate provided they complete a 4-credit summer vocational program.
  - **II Year UG Diploma:** Students who opt to exit after completing the second year and have secured a minimum of 80 credits will be awarded the UG diploma provided they have completed a 4-credit summer vocational program.
  - **III Year UG Degree**: Students who opt to exit after 3-years will be awarded a B.Sc. Degree, provided they have earned a minimum of 120 credits as per Table- I.
  - **IV Year UG Degree (Honors):** A four-year B.Sc. (Honors) Degree will be awarded upon completion of a minimum of 160 credits as per Table-I.

Table -I: *Minimum Credit Requirements to Award UG Degree as per NEP guidelines*:

S.N.	Broad Category of Course	Minimum Credit Requirement	
		3-year UG	4-year UG
1.	Major (Core)	60	80
2.	Minor Stream	24	32
3.	Multidisciplinary (MDC)	09	09
4.	Ability Enhancement Courses (AEC)	08	08
5.	Skill Enhancement Courses (SEC)	09	09
6.	Value Added Courses (VAC)	06-08	06-08
7.	Summer Internship (SI) 02-04 02-04	02-04	02-04
8.	Research Project / Dissertation		12
	Total	120	160

Note: Honors students not undertaking research will do 3 courses for 12 credits in lieu of a research project / Dissertation.

PROGRAM COURSE STRUCTURE

Birla Institute of Technology, Mesra, Ranchi
Off- Campus, Deoghar
Course Structure for Bachelor of Science (Honors) in Mathematics and Computing
Based on NEP-2020, CBCS and OBE, Effective from MO_2025

Sr. No.	Semester of Study (Recommended)	Category of Course	Course Code	Subjects	Mode of Delivery & Credits *L-Lecture; T-Tutorial; P-Practical*			Total Credits
					L (*Periods / Week*)	**T** (*Periods / Week)*	**P** (*Periods / Week)*	C
	FIRST			**THEORY**				
1.1		**MAJOR**	MA25105	Calculus-I	3	1	0	4
1.2			MA25111	Ordinary Differential Equations	2	1	0	3
1.3			MA25117	Real Analysis & Matrix Theory	3	1	0	4
1.4		**MINOR**	CH24101	Chemistry	3	1	0	4
1.5			CE24101	Environmental Science	2	0	0	2
				LABORATORIES				
1.6		**MAJOR**	MA 25112	Computing Lab: Introduction to MATLAB	0	0	3	1.5
1.7		**MINOR**	CH 24102	Chemistry Lab	0	0	2	1
1.8		**AEC**	HU24131	Communication skill – I	0	0	3	1.5
1.9		VAC	MC 24 102/103	Choice of : NSS/ PT & Games	0	0	2	1
TOTAL (Theory + Labs)								**22**
	SECOND			THEORY				
1I.1		**MAJOR**	MA25113	Calculus-II	2	1	0	3
1I.2			MA25115	Complex Analysis	2	1	0	3
1I.3		**MINOR**	PH 24101	Physics	3	1	0	4
1I.4			MA 25119	Theory of Probability	3	1	0	4
1I.5		SEC	CS24101	Programming for problem solving	3	1	0	4
				LABORATORIES				
1I.6		**MINOR**	PH24102	Physics Lab	0	0	2	1
1I.7		SEC	CS24102	Programming for problem solving Lab	0	0	2	1
1I.8		VAC	MC 24 107/108	Choice of : NSS/ PT & Games	0	0	2	1
TOTAL (Theory + Labs)								**21**
GRAND TOTAL FOR FIRST YEAR								**43**
Vocational Courses for Exit after 1st Year								
Vocational Summer Training -1		Course Code		Course Name: Web Designing	1	0	6	**4**
Min. requirement for CERTIFICATE in Mathematics and Computing after First Year								**47**
	THIRD			THEORY				
III.1		MAJOR	MA25207	Abstract Algebra	3	0	0	3
III.2			MA25209	Partial Differential Equations	3	0	0	3
III.3			CS 24201	Data Structure and Algorithms	3	0	0	3
III.4		MINOR	MA 25211	Statistical Methods	3	0	0	3
III.5		SEC	MA 25213	Python Programming	3	0	0	3
III.6		VAC	MT24131	UHV-II: Understanding Harmony	3	0	0	3
				LABORATORIES				
III.7		**MAJOR**	CS 24202	Data Structure and Algorithms Lab	0	0	3	1.5

III.8		**MINOR**	MA25212	Statistical Lab	0	0	2	1
III.9		SEC	MA 25214	Python Programming Lab	0	0	2	1
III.10		VAC	MC 24 202/203	Choice of : NSS/ PT & Games	0	0	2	1
	TOTAL (Theory + Labs)							**22.5**
	FOURTH	THEORY						
IV.1		MAJOR	MA25215	Linear Algebra	3	0	0	3
IV.2			MA25217	DMS & GT	3	1	0	4
IV.3			CS 24211	Database Management System	3	0	0	3
IV.4			CS24213	Design and Analysis of Algorithm	3	0	0	3
IV.5		MINOR	MA25219	Statistical Inference and its Application	3	1	0	4
IV.6		AEC	PE XXX/ MO24201	Project Management/ MOOC-I-(Foreign Languages)	3	0	0	3
IV.7		VAC	HU24211	Indian Knowledge System	2	0	0	0
		LABORATORIES						
IV.8		MAJOR	CS 24212	Database Management System Lab.	0	0	3	1.5
IV.9		VAC	MC 24 207/208	Choice of : NSS/ PT & Games	0	0	2	1
	TOTAL (Theory + Labs)							**22.5**
	GRAND TOTAL FOR SECOND YEAR							**45**
	Vocational Courses for Exit after 2nd Year							
Vocational Summer Training -2		**Course Code XXX**		**Course Name: 3D Printing and Designing**	**1**	**0**	**6**	**4**
Minimum requirement for <u>DIPLOMA</u> in Mathematics and Computing (after Second Year)								**92**
	FIFTH	THEORY						
V.1		MAJOR	MA25301	Numerical Techniques	3	0	0	3
V.2			MA 25309	Integral Transforms and its Applications	3	0	0	3
V.3			CS 24303	Data Mining concepts and Techniques	3	0	0	3
V.4		MINOR	MA 25305	Statistical Quality Control and its Application	3	1	0	4
V.5		**MAJOR PE-1 (Any ONE from the list)**	MA25311/ MA25323/ AI24351/ CS24353	• Financial Mathematics • Applied Regression Analysis • Formal Language and Automata theory • Software Engineering	3	0	0	3
V.6		MDC	XX24XXX /MO25301	Open Elective - I / MOOC - II	3	0	0	3
		LABORATORIES						
V.7		MAJOR	MA25302	Numerical Techniques Lab	0	0	2	1
V.9		AEC	HU24133	Communication skill – II	0	0	3	1.5
	TOTAL (Theory + Labs)							**21.5**
	SIXTH	THEORY						
VI.1		MAJOR	MA25315	Optimization Techniques	3	0	0	3
VI.2			MA25325	Mathematics of Fuzzy Sets and Fuzzy Logic	3	0	0	3
VI.3			CS 24307	Artificial Intelligence	3	0	0	3
VI.4		**MAJOR PE-2 (Any one from the list)**	MA25313/ MA25317/ MA25319/ CS 24363/ CS 24367	• Integral equations and Green's Functions • Computational linear Algebra • Difference Equations and its Applications • Soft Computing • Computer Graphics	3	0	0	3

VI.5		MDC	XX24XXX /MO25303	Open Elective - II / MOOC - III	3	0	0	3
VI.6		**AEC**	MT24XXX	Organizational Behavior	2	0	0	2
		LABORATORIES						
VI.7		MAJOR	MA25316	Optimization Techniques Lab using MATLAB	0	0	3	1.5
VI.8			CS 24308	Artificial Intelligence Lab.	0	0	3	1.5
VI.9		VAC	MT24304	Constitution of India	2	0	0	0
TOTAL (Theory + Labs)								**20**
GRAND TOTAL FOR THIRD YEAR								**41.5**
Minimum requirement for <u>DEGREE</u> award of B.Sc. in Mathematics and Computing (after third year)								**129.5**
	SEVENTH	THEORY						
VII.1			MA25413	Number Theory and its Applications	3	0	0	3
VII.2			MA25415	Operation Research	3	0	0	3
VII.3		MAJOR	CS 24313	Machine Learning	3	0	0	3
VII.4		MINOR	MA25417	Stochastic Process and its applications	3	1	0	4
VII.5		**MAJOR PE-3 (Any one from the list)**	MA25407/ MA25409/ MA25411/ MA25421/ MA25423/ CS 24475/ CS 24471/	• Mathematical Modeling • Fuzzy Mathematical Programming • Theory of Elasticity • Mathematical Ecology • Mechanics • Cryptography and Network Security • Cloud Computing	3	0	0	3
VII.6		MDC	XX24XXX /MO25401	Open Elective - III / MOOC - IV	3	0	0	3
VII.7		**SI**	**MC25400**	**Summer Internship (Minimum 4 weeks/160 hrs)**	**0**	**0**	**0**	**4**
		LABORATORIES						
VII.8		**MAJOR**	CS 24314	Machine Learning Lab	0	0	3	1.5
VII.9		**Research Project**	MA25400	**Project-I**	0	0	4	2
TOTAL (Theory + Labs)								**26.5**
VIII.1	EIGHTH	**Research project/ Internship**	MA25450 MA25490	**Project-II / Internship**	0	0	0	10
VIII.2		MAJOR	MA25498	**Comprehensive Viva**	0	0	0	2
	TOTAL (Theory + Labs)							**12**
GRAND TOTAL FOR FOURTH YEAR								**38.5**
Minimum requirement for Degree award of B.Sc. Honours in Mathematics and Computing (after fourth year)								**168**

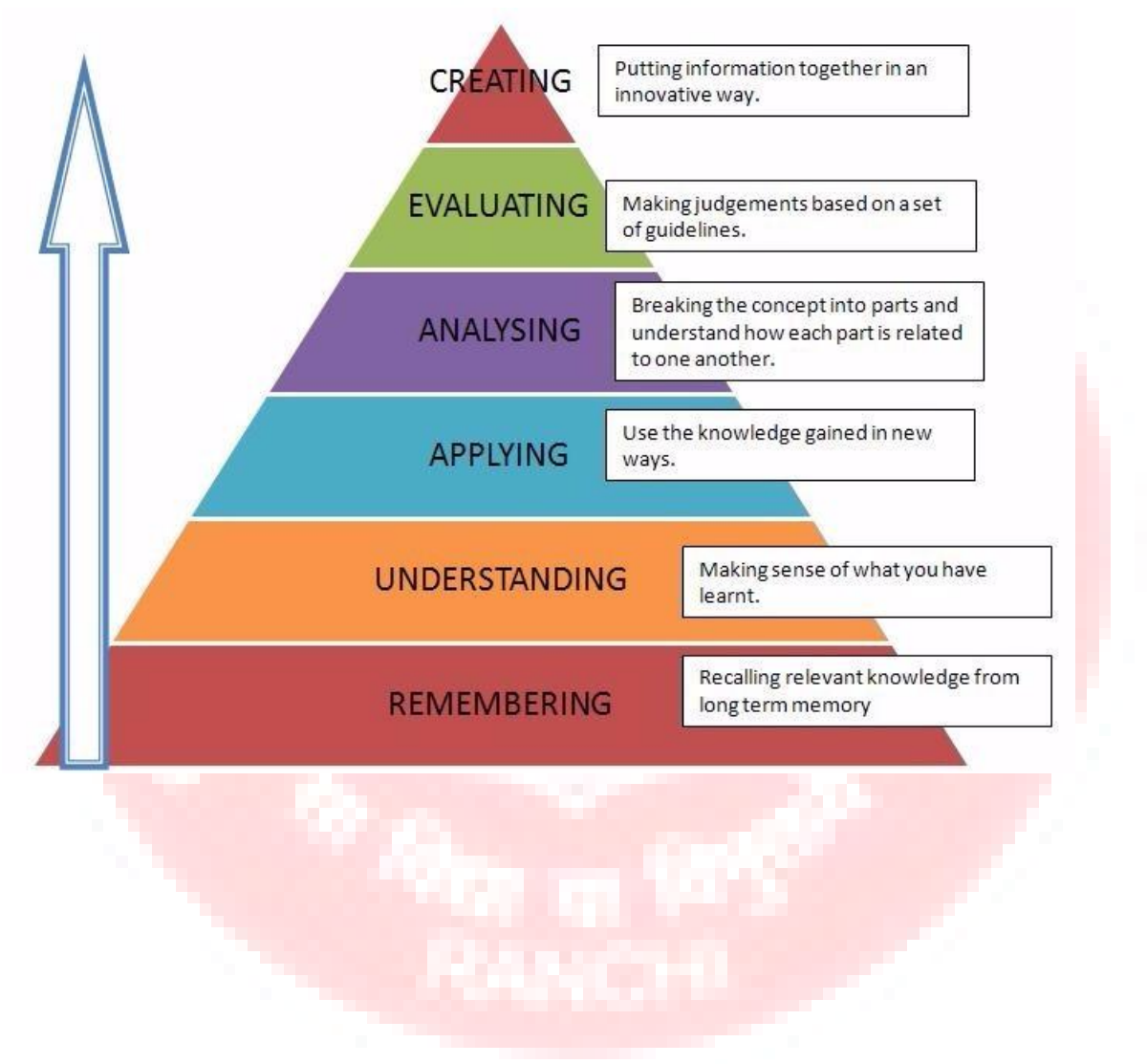
Table 2 : Recommended Scheme of Study

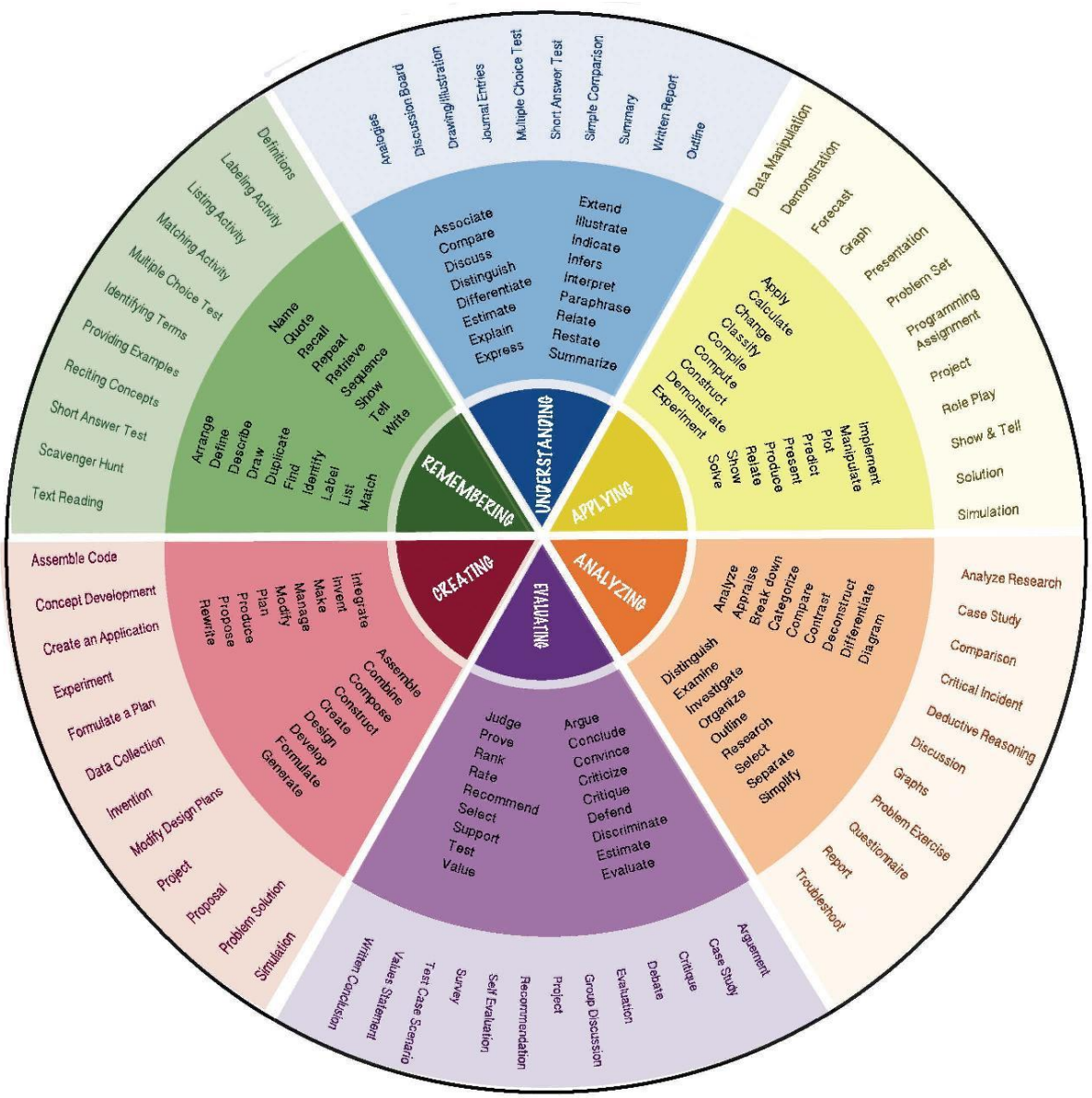
Details of Credit distribution for B Sc (Honors) in Mathematics and Computing

S.N.	Broad Category of Course	Credits Recommended	
		B Sc	B Sc (Honors)
1.	Major (Core)	71.5	87
2.	Minor Stream	28	32
3.	Multidisciplinary (MDC)	06	09
4.	Ability Enhancement Courses (AEC)	08	08
5.	Skill Enhancement Courses (SEC)	9	9
6.	Value Added Courses (VAC)	07	07
7.	Summer Internship (SI)	-	04
8.	Research Project / Dissertation	-	12
	Total	129.5	168

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble
The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.




REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING
Definitions
Labeling Activity
Listing Activity
Matching Activity
Multiple Choice Test
Identifying Terms
Providing Examples
Reciting Concepts
Short Answer Test
Scavenger Hunt
Text Reading
Name
Quote
Recall
Repeat
Retrieve
Sequence
Show
Tell
Write
Arrange
Define
Describe
Draw
Duplicate
Find
Identify
Label
List
Match
Analogies
Discussion Board
Drawing/Illustration
Journal Entries
Multiple Choice Test
Short Answer Test
Simple Comparison
Summary
Written Report
Outline
Associate
Compare
Discuss
Distinguish
Differentiate
Estimate
Explain
Express
Extend
Illustrate
Indicate
Infers
Interpret
Paraphrase
Relate
Restate
Summarize
Data Manipulation
Demonstration
Forecast
Graph
Presentation
Problem Set
Programming Assignment
Project
Role Play
Show & Tell
Solution
Simulation
Apply
Calculate
Change
Classify
Compile
Compute
Construct
Demonstrate
Experiment
Implement
Manipulate
Plot
Predict
Present
Produce
Relate
Show
Solve
Analyze Research
Case Study
Comparison
Critical Incident
Deductive Reasoning
Discussion
Graphs
Problem Exercise
Questionnaire
Report
Troubleshoot
Analyze
Appraise
Break down
Categorize
Compare
Contrast
Deconstruct
Differentiate
Diagram
Distinguish
Examine
Investigate
Organize
Outline
Research
Select
Separate
Simplify
Argument
Case Study
Critique
Debate
Evaluation
Group Discussion
Project
Recommendation
Self Evaluation
Survey
Test Case Scenario
Values Statement
Written Conclusion
Argue
Conclude
Convince
Criticize
Critique
Defend
Discriminate
Estimate
Evaluate
Judge
Prove
Rank
Rate
Recommend
Select
Support
Test
Value
Assemble Code
Concept Development
Create an Application
Experiment
Formulate a Plan
Data Collection
Invention
Modify Design Plans
Project
Proposal
Problem Solution
Simulation
Integrate
Invent
Make
Manage
Modify
Plan
Produce
Propose
Rewrite
Assemble
Combine
Compose
Construct
Create
Design
Develop
Formulate
Generate

COURSE INFORMATION SHEET

Course code: MA25105
Course title: Calculus-I
Pre-requisite(s): Basics of differential Calculus and integral Calculus
Co- requisite(s): Calculus-II
Credits: L:3 T:1 P:0 C:4
Class schedule per week: 3 lectures
Class: B. Sc.
Semester/level: I / 1
Branch: Mathematics and Computing
Name of the Faculty:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	know the behavior of functions studying different approach of derivatives for the function of single variable.
2.	understand the nature of the function in Cartesian and polar form and its behavior at infinity.
3.	get knowledge of functions of two or more variables, their differentiation, properties and applications as most of entities in the real world are dependent of several independent entities
4.	get knowledge of definite Integral, improper integrals and some special integrals such as Beta functions, Gamma Functions and Error functions.
5	apply the knowledge of the definite Integral to derive different important quantities as arc length, area, volume, work and moments.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	find the nth derivatives of the function, evaluate its indeterminate forms and way to expand a function in series form using Taylor's and Maclaurin's theorems. analytically and graphically understand the nature and forms of function
CO2	study behavior of a function at infinity, knowledge on curvature with its properties in both cartesian and polar form.
CO3	understand the fundamental concepts of functions with several variables, its derivatives in partial forms with other important related concepts, their applications in maxima - minima problems.
CO4	apply the principles of integral to solve a variety of practical problems in sciences and engineering.
CO5	enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of sciences and engineering.

MA25105 **CALCULUS-I** **3-1-0-4**

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I **Successive Differentiation and Mean Value Theorem:** Leibnitz Theorem, Generalized Mean Value Theorem, Taylor's and Maclaurin's Expansion of Functions of Single Variable**.** Increasing and decreasing functions. Concavity, Convexity and point of Inflection of a function. Extrema of a functions	**(10)**
Module – II **Analysis of functions:** Behavior of a function at infinity: Asymptotes. Orthogonal Intersection of Curves, Curvature and Radius of Curvature of a Curve in Cartesian, Parametric, Polar and Tangential Polar forms.	**(9)**
Module – III **Functions of several variables**: Limit and continuity, partial derivatives. Euler's theorem, Derivatives of composite and implicit functions, Total derivatives, Errors and Approximations, Jacobian's. Taylor's and Maclaurin's expansion of functions of several variables, Maxima and minima of functions of several variables, Lagrange's method of undetermined multipliers.	**(9)**
Module – IV **Definite Integral:** Reduction Formula, Differentiation under Integral Sign: Differentiation of Integrals with constant and variable limits, Leibnitz rule. **Improper integrals:** Convergence of improper integrals, Test of convergence, Beta and Gamma Functions and its Properties, Error function	**(9)**
Module – V **Application of Definite Integral:** Length of a Plane Curve, Area between Two Curves, Volume, Volume of Revolution, Area of Revolution, Work, and Moments	**(8)**

Text Books:

1. H Anton, I Brivens, S. Davis : Calculus, 10th Edition, John Wiley and sons, Singapore Pvt. Ltd., 2013.
2. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008.
3. M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling. Kindersley (India)Pvt. Ltd. (P Ed), Delhi, 2007.

Reference Books:

1. Apostol, Calculus Vol I and 11. 2nd Edition (reprint), John Wiley and sons, 2015.
2. Robert Wrede & Murray R. Spiegel, Advanced Calculus, 3rd Ed., Schaum's outline series, McGraw-Hill Companies, Inc.,2010.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Experimentally visualising the analytical concepts.
2. Difficult to produce extensive proves of the state-of-the-art definitions and theorems.

POS MET THROUGH GAPS IN THE SYLLABUS : NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Proofs of the said theorems
2. For students to come up with innovative ideas and carry out project works during the running semester is beyond syllabus
3. Industrial visits to train them of the challenges in the industry and support students to do Projects at industries

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN :NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz	10
Assessment/ quiz	10
Assignment	5

Continuous Internal Assessment	% Distribution
Quiz	10
Assessment/ quiz	10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures and Industrial visits
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7
CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: MA25111
Course title: Ordinary Differential Equations
Pre-requisite(s): Differentiation, Integration.
Co- requisite(s): Partial Differential Equations
Credits: L:2 T:1 P:0 C:3
Class schedule per week: 3 lectures
Class: B. Sc.
Semester/level: I / 1
Branch: Mathematics and Computing
Name of the Faculty:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	get knowledge of first order linear and nonlinear differential equations and their solutions, trajectories and its types, Lagrange's equation, Clairaut's equation, envelopes
2.	study the existence and uniqueness theorem, Wronskian and its properties, higher-order linear differential equations with constant coefficients, method of variation of parameter
3.	get knowledge of simultaneous linear differential equations with constant coefficients, second order linear differential equations with variable coefficients, series solution. Bessel's and Legendre's equations
4.	study the initial value problems, stability, Adjoint differential equations, Sturm-Liouville problem, Fourier series.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	identify, analyse and subsequently solve physical situations whose behaviour can be described by ordinary differential equations
CO2	competence in solving applied problems which are linear and nonlinear form
CO3	solve the problems choosing the most suitable method.
CO4	determine the solution of differential equations with initial and boundary value problems
CO5	enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of sciences and engineering.

MA25111 ORDINARY DIFFERENTIAL EQUATIONS 2-1-0-3

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I First order linear and nonlinear differential equations and their solutions, Trajectories (Orthogonal, oblique, polar and Cartesian coordinate). Equations of first order but not of first degree and singular solutions: equation solvable for x and y , Lagrange's equation, Clairaut's equation, singular solutions (Envelopes).	**(8)**
Module – II Wronskian and linear dependence of functions, Abel's formula. Higher-order linear differential equations with constant coefficients, C.F and P.I. Euler-Cauchy equations. Method specific to second ODE: Methods of undetermined coefficients, reduction of order and Method of variation of parameters	**(8)**
Module – III Simultaneous linear differential equations with constant coefficients, total differential equation and condition of integrability.	**(6)**
Module – IV Series solution around an ordinary point and a regular singular point, Power Series; the method of Frobenius. Bessel and Legendre equations	**(8)**
Module – V Initial value problems: Lipchitz condition, existence and uniqueness of solution of initial value problems for first order ODEs. Adjoint and Self-Adjoint differential equations, Sturm-Liouville problem.	**(8)**

Text Books:

1. A. K, Nandakumaran, P. S, Datti & R. K. George: Ordinary differential equations: Principles and applications. Cambridge University Press, 2017.
2. G.F. Simmons: Differential Equations with Applications and Historical Notes, McGraw-Hill
3. R. C. DiPrima and W. E. Boyce: Ordinary Differential Equations and Boundary Value Problems, Willey
4. Dennis G. Zill, Warren S. Wright: Advanced Engineering Mathematics, Jones and Bartlett Pubs.
5. Edwards & Penney: Differential Equations and Boundary value problems, Pearson Education
6. S. L. Ross: Differential Equations, Wiley

Reference books:

1. S.J. Farlow: An Introduction to Ordinary Differential Equations, PHI
2. M.D. Raisinghania: Ordinary and Partial Differential Equations, S. Chand & Co.
3. V. Sundarapandian: Ordinary and Partial Differential Equations, McGraw-Hill

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Experimentally visualising the analytical concepts.
2. Difficult to produce extensive proves of the state-of-the-art definitions and theorems.

POS MET THROUGH GAPS IN THE SYLLABUS :NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Proofs of the said theorems
2. For students to come up with innovative ideas and carry out project works during the running
3. semester is beyond syllabus
4. Industrial visits to train them of the challenges in the industry and support students to do Projects at industries

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN :NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz	10
Assessment/ quiz	10
Assignment	5

Continuous Internal Assessment	% Distribution
Quiz	10
Assessment/ quiz	10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

2. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures and Industrial visits
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7
CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: MA25117
Course title: Real Analysis and Matrix Theory
Pre-requisite(s): Basics of real number system, basics of algebra.
Co- requisite(s): Linear Algebra
Credits: L:3 T:1 P:0 C:4
Class schedule per week: 4 lectures
Class: B. Sc.
Semester/level: I / 1
Branch: Mathematics and Computing
Name of the Faculty:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	know the convergence and divergence criteria for sequence and series of Real Numbers
2.	understand the nature of convergence criteria for sequence and series of functions
3.	get knowledge of Riemann integration of real valued functions.
4.	know the rank of a matrix and apply it to solving system of linear equations.
5.	analyzing eigenvalues and associated eigenvectors of a matrix

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO 1	develop an understanding of limits in abstract way and how they are used in sequences, series, differentiation and integration.
CO 2	solve the problems of convergence and divergence of sequences and series of real number and real functions.
CO 3	Grasp the concepts of Riemann integration, including the Fundamental Theorem of Calculus and conditions for integrability.
CO 4	apply the matrix theory to study the properties of solutions of different algebraic systems.
CO 5	apply the matrix theory in different problems of computer graphics, electrical engineering, civil engineering, robotics and automation.

MA25117 REAL ANALYSIS AND MATRIX THEORY 3-1-0-4

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I Notion of limit point of a sequence; convergent, divergent and oscillating sequences; Cauchy sequence; subsequence and Bolzano-Weierstrass theorem (Statement only); Cauchy theorems on limit; Monotonic sequence and its convergence. Convergence of Series of real numbers. Test of positive term series; p-series test, comparison tests, Cauchy's root test, D' Alembert's ratio test, Raabe's test, Cauchy's Integral Test. Gauss's Ratio Test, Logarithmic and Higher Logarithmic Ratio Test, Absolute and conditional convergence, Leibnitz's Rule for Alternating series Test	**(10)**
Module – II Sequence of functions, uniform boundedness, pointwise and uniform convergence of sequence of functions, Series of functions, pointwise and uniform convergence of series of functions, Weierstrass-M Test.	**(7)**
Module – III Riemann integral, definition and existence of the integral, Upper and Lower Integrals, Darboux theorem, Properties of the integral, differentiation and integration, Fundamental theorem of integral calculus, Riemann integration of continuous and monotonic functions. Mean value theorems of integral calculus	**(10)**
Module – IV Matrix: Elementary operations, elementary matrices, inverse using elementary transformations, Rank of a matrix, row-reduced echelon form, normal form, Consistency of system of homogeneous and non-homogeneous linear equations using rank. Solution of system of linear equations using Gauss elimination, Gauss Jordan and LU decomposition methods.	**(10)**
Module – V Matrix Polynomial, Fundamental definition and properties of Eigenvalues and Eigenvectors; Cayley-Hamilton theorem and its applications. Similar and Diagonalizable matrices.	**(8)**

Text Books:

1. S.C. Malik, Principles of Real Analysis (Fourth Edition), New Age International publisher.
2. S. Lipschutz, M. L. Lipson: Schaum's Outline of Linear Algebra, Mcgraw-Hill.
3. David c. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Ed. Asia, Indian Reprint, 2007.

Reference Books:

1. Donald R. Sherbert and Robert G. Bartle, Introduction to Real Analysis.
2. S. K. Mapa, Introduction to Real Analysis (Revised 6^{th} edition), Sarat book distributers, 2011.
3. Higher Algebra Abstract and Linear, S K Mapa, Levant Publications.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Experimentally visualising the analytical concepts.
2. Difficult to produce extensive proves of the state-of-the-art definitions and theorems.

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Proofs of the said theorems
2. For students to come up with innovative ideas and carry out project works during the running semester is beyond syllabus
3. Industrial visits to train them of the challenges in the industry and support students to do Projects at industries

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz	10
Assessment/ quiz	10
Assignment	5

Continuous Internal Assessment	% Distribution
Quiz	10
Assessment/ quiz	10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

3. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures and Industrial visits
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7
CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: MA25112
Course title: Computing Lab (MAT LAB}
Pre-requisite(s):
Co- requisite(s):
Credits: L:0 T:0 P:3 C:1.5
Class schedule per week: 3 Sessional
Class: B. Sc.
Semester/level: I / 1
Branch: Mathematics and Computing
Name of the Faculty:

List of Problems:

1. **Problems related to basic arithmetic-------2 days**
2. **Problems related to array operations: Vectors and Matrices ------2days**
3. **Problems of calculating Eigen values and eigen vectors ------1 day**
4. **Problems related to elementary Statistical data. -------2 days**
5. **Problems related to the plotting of Statistical datas. -------2 days**
6. **Problems related to the 2D and 3D plotting-------2 days**
7. **Problems related to the solutions of system of linear equations-------2 days**
8. **Problems related to the ordinary differential equations -------2 days**

Text Books:

1. B.R. Hunt, R.L. Lipsman, J. M. Rosenberg,: A guide to MATLAB for Beginners and Experience Users, Cambridge University Press, 3rd Ed. 2014

Reference books:

1. Rudra Pratap: Getting started with MATLAB, Oxford University Press, 7th Ed. 2016.

COURSE INFORMATION SHEET

Course code: MA25113
Course title: Calculus-II
Pre-requisite(s): Calculus-I
Co- requisite(s):
Credits: L:2 T:1 P:0 C:3
Class schedule per week: 3 lectures
Class: B. Sc.
Semester/level: II / 1
Branch: Mathematics and Computing
Name of the Faculty:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	know the behavior of coordinate axes and coordinate plane and surfaces in 3-dimensional space.
2.	understand the mathematical tools needed in evaluating multiple integrals and their usage.
3.	get knowledge of vector differential calculus
4.	get knowledge of vector integral calculus.
5	apply the knowledge of vector valued functions in orthogonal curvilinear coordinate system

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1.	explain coordinate axes and coordinate plane and surfaces in 3-dimensional space.
CO2.	visualize and deal with problems consisting of surface area, volume of solids and derive different impotant quantities as Centre of Mass and Moments.
CO3.	explain the characteristics of scalar and vector valued functions and provide a physical interpretation of the gradient, divergence, curl and related concepts and also give an account of important vector field models of Nature.
CO4.	transform line integral to surface integral, surface to volume integral and vice versa using Green's theorem, Stoke's theorem and Gauss's divergence theorem and understand the concept of vector valued functions in orthogonal curvilinear coordinate system
CO5.	enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of sciences and engineering.

MA25113 **CALCULUS-II** **2-1-0-3**

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I Three-dimensional space: rectangular coordinate system in 3D space, Basic idea of Cylindrical and Spherical coordinate system, parametric equations of lines, planes, sphere and cylinder. Conicoid	**(6)**
Module – II Multiple Integral: Double and triple integrals, Iterated integrals and their connections, Change of order of integration, Change of variables in double and triple integrals, Application of Double and triple integrals to evaluate the area of plane and curved surface, volume of a solid, Center of Mass and Moment of Inertia.	**(10)**
Module – III Vector valued functions, unit tangent, normal and binormal vectors, curvature, torsion and TNB frame. Motion along the curves: Tangential and normal components of velocity and acceleration. Scalar and vector point functions, Gradient, Directional derivative, Divergence and curl, properties, second order derivatives, identities.	**(8)**
Module – IV Line integrals, vector field, work done, circulation, conservative field, potential function. Surface integral and volume integral, Green's theorem, Stoke's theorems and Gauss divergence theorem. Application of vector calculus in engineering problems.	**(8)**
Module – V Transformation of coordinates, orthogonal curvilinear coordinates, Gradient, divergence and curl in curvilinear co-ordinate systems, Special orthogonal curvilinear coordinate system	**(6)**

Text Books:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008.
3. H Anton, I Brivens, S. Davis: Calculus, 10th Edition, John Wiley and sons, Singapore Pte. Ltd., 2013

Reference Books:

1. M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. Murray R Spiegel: Vector Analysis, Metric Editions, Schaum's Outline series.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Experimentally visualising the analytical concepts.
2. Difficult to produce extensive proves of the state-of-the-art definitions and theorems.

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Proofs of the said theorems
2. For students to come up with innovative ideas and carry out project works during the running semester is beyond syllabus
3. Industrial visits to train them of the challenges in the industry and support students to do Projects at industries

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN :NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz	10
Assessment/ quiz	10
Assignment	5

Continuous Internal Assessment	% Distribution
Quiz	10
Assessment/ quiz	10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

4. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures and Industrial visits
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7
CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: MA25115
Course title: Complex Analysis
Pre-requisite(s): Complex Numbers, Basic Calculus.
Co- requisite(s): Linear Algebra
Credits: L:2 T:1 P:0 C:3
Class schedule per week: 3 lectures
Class: B. Sc.
Semester/level: II / 1
Branch: Mathematics and Computing
Name of the Faculty:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	understand the strength of being analytic for a complex variable function and different properties associated with analytic functions
2.	get knowledge of the integration of complex variable functions and different techniques to evaluate complex integrals
3.	get knowledge of the series of complex variable functions, criteria for their convergence and divergence
4.	get knowledge of the singularities of complex variable functions and methods to compute residues
5.	get knowledge of mapping of complex variable functions and its different types

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1.	demonstrate the remarkable properties of complex variable functions, which are not the features of their real analogues
CO2.	develop an understanding to prove the analytical results related to theory of complex variable functions
CO3.	conceptualize the differentiation and integration of complex variable functions
CO4.	acquire the skills to evaluate complicated real variable function properties in the light of complex variable theory
CO5.	apply the knowledge of complex variable theory in diverse fields related to mathematics

MA25115 **COMPLEX ANALYSIS** **2-1-0-3**

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I **Complex Differentiation:** Regions in the complex plane, function of a complex variable, Limit, continuity, differentiability of complex functions, analytic functions, Cauchy – Riemann equations in Cartesian and polar forms, harmonic functions, harmonic conjugates, Milne Thomson method.	**(8)**
Module – II **Complex Integration:** Integration of complex variable function along contour**,** line integral, properties of line integrals, Cauchy's theorem, Cauchy's Integral Formula, Cauchy's Integral formula for derivatives of analytic function, Cauchy's Inequality.	**(8)**
Module – III **Infinite Series and Singularities:** Power Series, convergence of power series, Taylor's series, Laurent Series. Zeros and singularities of analytic function, types of singularities, properties of singular points	**(6)**
Module – IV **Calculus of Residues:** Residues, computation of residues at pole, Cauchy – Residue theorem. Application of residue calculus in evaluation of improper real integrals of types $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and $\int_{-\infty}^{\infty} f(x)dx$.	**(8)**
Module – V **Conformal Mapping:** Mapping (or Transformation) of complex variable function, Conformal Mapping, Types of elementary transformations – translation, rotation, magnification, inversion, Bilinear transformation, properties of bilinear transformation	**(8)**

Text Books:

1. J.W. Brown and R.V. Churchill, Complex Variable and its Applications, Tata McGraw Hill, Pub., 7th Edition, 2014.
2. D.G. Zill and P.D. Shanahan, A First Course in Complex Analysis with Applications, Jones and Bartlett Publishers, 2003
3. H.S. Kasana, Complex Variables: Theory and Applications, PHI, Second Edition, 2005.

Reference Books:

1. E. M. Stein and R. Shakarchi, Complex Analysis, Princeton University Press, 2003.
2. S. Ponnusamy and H. Silverman, Complex Variables with Applications, Birkhauser, 2006.
3. M. R. Spiegel, S. Lipschutz, J.J. Schiller and D. Spellman, Complex Variables, Schuam Outlines, Tata McGraw Publications, 2nd Edition, 2009.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Experimentally visualising the analytical concepts.
2. Difficult to produce extensive proves of the state-of-the-art definitions and theorems.

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Proofs of the said theorems
2. For students to come up with innovative ideas and carry out project works during the running semester is beyond syllabus
3. Industrial visits to train them of the challenges in the industry and support students to do Projects at industries

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN :NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz	10
Assessment/ quiz	10
Assignment	5

Continuous Internal Assessment	% Distribution
Quiz	10
Assessment/ quiz	10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

5. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures and Industrial visits
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7
CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: MA25119
Course title: Theory of Probability
Pre-requisite(s): Basic Calculus.
Co- requisite(s):
Credits: L:3 T:1 P:0 C:4
Class schedule per week: 4 lectures
Class: B. Sc.
Semester/level: I / 1
Branch: Mathematics and Computing
Name of the Faculty:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	understand decision making under uncertainty.
2.	get knowledge of probability which is the fundamental to risk management.
3.	get knowledge of probability which is extensively used in statistical analysis of scientific research.
4.	get knowledge of probability which helps in predicting future trends based on past data and patterns

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1.	acquire the fundamentals of probability and demonstrate decision making under uncertainty.
CO2.	develop an understanding of discrete and continuous randomness.
CO3.	model random events which is essential in various fields where randomness plays a significant role.
CO4.	acquire the knowledge of probability which helps in predicting future trends based on past data and patterns
CO5.	apply the knowledge of convergence in probability.

MA25119 **THEORY OF PROBABILITY** **3-1-0-4**

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I **Definition of Probability:** Classical, Relative frequency and axiomatic definitions of probability, Addition rule and conditional probability, Independence of Events, Multiplication rule, Total probability, Bayes Theorem.	**(9)**
Module – II **Random Variables**: Random Variables: Discrete, continuous, and mixed random variables, probability mass functions, special distributions (Bernoulli, Binomial, Poisson's, Geometric), Cumulative Distribution Functions.	**(9)**
Module – III **Continuous Random Variables**: Probability Density Functions, Special Distributions (Uniform, Exponential, Normal), Expectation of a random variable, Variance of a random variable, Moment Generating Function, Functions of a random variable.	**(9)**
Module – IV **Joint Distributions**: Joint distributions of discrete random variables, linearity and monotonicity of expectations, independence, correlation, covariance, variance of a sum, distribution of sum of two independent random variables using moment generating functions	**(9)**
Module – V Convergence in Probability, Tail Bounds (Markov's Inequality, Chebyshev's, Weal Law of Large Numbers, Strong Law of large numbers, Central Limit Theorem)	**(9)**

Text Books:

1. Sheldon Ross, A First Course in Probability, 9th Edition, Pearson, 2013.
2. Dimitri P. Bertsekas and John N. Tsitsiklis, Introduction to Probability, 2nd Edition, 2008.
3. P. G. Hoel, S. C. Port and C. J. Stones: Introduction to Probability Theory
4. S. C. Gupta, V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 12th Ed. 2020.

References:

1. K. L. Chung: Elementary Probability Theory with Stochastic Processes.
2. W. Feller: Introduction to Probability: Theory and Applications - Vol. I and II
3. Walpole and Mayers: Probability & Statistics for Engineers

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Experimentally visualising the analytical concepts.
2. Difficult to produce extensive proves of the state-of-the-art definitions and theorems.

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Proofs of the said theorems
2. For students to come up with innovative ideas and carry out project works during the running semester is beyond syllabus
3. Industrial visits to train them of the challenges in the industry and support students to do Projects at industries

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN :NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz	10
Assessment/ quiz	10
Assignment	5

Continuous Internal Assessment	% Distribution
Quiz	10
Assessment/ quiz	10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

6. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures and Industrial visits
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7
CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO2	3	2	2	2	1	1	2	1	3	3	2	2	2	3	3
CO3	3	3	2	2	1	1	1	1	3	3	2	2	2	3	3
CO4	2	2	3	1	1	1	1	1	3	3	2	2	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
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CO2	CD1, CD2, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD7