

INDIRA GANDHI UNIVERSITY, MEERPUR, REWARI
(A State University Established under Haryana Act No.29 of 2013)
(Recognized u/s 12(B) & 2(f) of UGC Act, 1956)

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Syllabus and Scheme of Examination

(in accordance with National Educational Policy 2020)

for
Post Graduate Programme
in
Mathematics

Effective from Academic Year : **2026-2027**

Department of Mathematics

Faculty of Physical Sciences

Indira Gandhi University

Meerpur-Rewari (122502)

Haryana, India

Details of Approvals

Council/Board	Date	Remarks
Staff Council	04.08.2026	
Board of Studies	05.08.2026	
Faculty		
Academic Council		
Year of implementation	2026	


14.08.26

Chairperson

VISION AND MISSION OF THE UNIVERSITY

VISION

To be a globally renowned university, recognized for excellence in teaching, innovative research, and welfare of the society, imbibing the spirit of “*Vasudhaiv kutumbkam*”.

MISSION

- To introduce and implement innovation in teaching and learning process matching up the global standards to strengthen academic delivery through curriculum design, teaching pedagogy and usage of ICT.
- To develop a mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University.
- To offer academic programs at UG, PG, doctoral, Post-Doctoral levels which are learner-centric, industry focused, and adhere to outcome based international models.
- To create an ambiance that is conducive for undertaking sponsored research, innovation and consultancy services to a wide spectrum of societal and industrial requirements while encouraging interdisciplinary approach of learning, team work, and research.
- To establish state of art centres of excellence in frontier areas of research and design innovation through industry collaboration to innovate and incubate the products and services.
- To establish smart campus and promote e-governance activities in the university for the digitally empowered society and knowledge economy.
- To provide a hygienic, modern, environment friendly and vivacious campus attuned to the urgent needs of Green Technology.
- To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies.
- To make society self-reliant by organizing various programmes including literacy, gender sensitization, health awareness, and dissemination of information about livelihood generation.



VISION AND MISSION OF THE DEPARTMENT

Vision

To be an internationally recognized center for research and teaching in Mathematics, encouraging excellence, innovation, integrity, and values for society to produce global leaders for academics and industry by imparting multidisciplinary and contemporary mathematical education.

Mission

- To provide quality education and research in Mathematics through an updated curriculum and effective teaching-learning process.
- To impart innovative skills, teamwork, and ethical practices to the students to meet societal and industrial expectations.
- To provide learner-centric, industry-focused, and outcome-based academic programmes at different levels adhering to the international standards.
- To offer integrated M.Sc. (Mathematics) programme and M.Sc. Programme in Big Data Science.

ABOUT THE PROGRAMME

The Department of Mathematics offers a two-year, full-time Post Graduate Programme M.Sc. Mathematics comprising four semesters. The curriculum is designed in accordance with the principles of the National Education Policy (NEP) 2020, with a focus on outcome-based education, critical thinking, and research-oriented learning. It provides students with a strong foundation in pure and applied mathematics while nurturing analytical, computational, and problem-solving skills. In addition, the programme offers practical training in the use of relevant mathematical software, enabling students to apply theoretical knowledge to computational and research-oriented problems.

INTAKE IN THE PROGRAMME

The sanctioned intake for the M.Sc. Mathematics Programme is 50 .

MINIMUM ELIGIBILITY CRITERIA

B.A./B.Sc. (Hons.) in Mathematics, or a B.A./B.Sc. (Pass) with Mathematics as one of the subjects, with a minimum of 50% marks in aggregate (47.5% for SC/ST/Blind/Visually and Differently Abled candidates of Haryana only) in aggregate or any other examination recognized by Indira Gandhi University, Meerpur as equivalent thereto.

PASSING CRITERIA

The pass percentage will be 40% both for theory and practicum End-Term Examination. A student has to obtain minimum 40% marks in aggregate (sum of the Internal Assessment and End-Term Examination marks) and in End-Term Examination separately to qualify a course.



ELIGIBILITY FOR EXAMINATION

1. End-Term Examination shall be open to a regular student who:
 - a. has been on the rolls of the Department/College/Institute during the semester.
 - b. has passed the requisite qualifying examination, if s/he is a candidate for the first semester Examination.
 - c. has her/his examination form submitted on the university portal through the Chairperson/Principal/Director of the concerned Department/College/Institute.
 - d. has attended not less than 75% of the lectures. A deficiency may be condoned by the Chairperson/Principal/ Director of the Department/College/Institute in deserving cases up to 15%.
2. The condonation up to 15% shall also include loss of attendance due to participation in the cultural and sports assignments, etc. organized by the concerned agencies/branches/offices such as DYW, NSS, NCC, YRC, Sports etc. Provided further that, a student who participates in the Inter-University Tournaments or Inter University Youth Festivals or Republic Day Parade and any event as deemed fit by the concerned office, may be allowed additional condonation on this ground up to 10% in each course on a certificate from the Director, Sports; Director, Youth Welfare; Programme Coordinator, NSS/NCC as the case may be, subject to the condition that such a student shall not be allowed to appear in the examination if his/her attendance, after condonation on all counts, falls below 50%. The concerned office shall issue such certificates.

DURATION FOR PASSING THE PROGRAMME

A student can complete 2-year PG Programme in Mathematics within four years. A student, who fails to pass the whole examination(s) of the 2-year PG Programme within four years of admission but has passed all courses of first two semesters and also has completed the requisite internship of the programme, shall be awarded with Postgraduate Diploma on the basis of courses completed and credits earned, if otherwise eligible.



PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	To provide students with in-depth and advanced knowledge of core and applied areas of Mathematics.
PEO 2	To develop the ability to formulate new theoretical concepts and mathematical models applicable to real-world problems.
PEO 3	To foster innovative and independent thinking, preparing students to pursue high-level research in Mathematics and allied disciplines.
PEO 4	To develop proficiency in relevant mathematical and computational software for problem-solving and data analysis.
PEO 5	To prepare students for diverse career opportunities in academia, research, industry, banking, data science, and public sector roles.

PROGRAMME LEARNING OUTCOMES (PLOs)

PLO 1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PLO 2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PLO 3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PLO 4	Problem-Solving	Capability of applying knowledge to solve scientific and other problems
PLO 5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PLO 6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PLO 7	Modern Tool Usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PLO 8	Scientific temperament	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PLO 9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PLO 10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PLO 11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects



PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1	Have deep understanding and knowledge in the core areas of Mathematics and demonstrate understanding and application of the concepts/theories/principles/ methods/ techniques in different areas of pure and applied Mathematics.
PSO 2	Have capability to read and understand mathematical texts, demonstrate and communicate mathematical knowledge effectively and unambiguously through oral and/or written expressions and attain skills of computing/programming/using software tools/formulating models.
PSO 3	Attain abilities of critical thinking, logical reasoning, investigating problems, analysis, problem solving, application of mathematical methods/techniques, disciplinary knowledge so as to develop skills to solve mathematical problems having applications in other disciplines and/or in the real world.
PSO 4	Have strong foundation in basic and applied aspects of Mathematics so as to venture into research in different areas of mathematical sciences, jobs in scientific and various industrial sectors and/or teaching career in Mathematics.



Scheme of Examination	
Name of the Programme	M.Sc. Mathematics
Total number of Semesters	04
Total Marks	2700
Total Credits	108
Framework	2
Scheme	Q



Semester	Course Type	Course Code*	Nomenclature ofcourse	Theory (T)/ Practical (P)	Credits		Contact hoursper week L: Lecture P: Practical T: Tutorial To: Total				Internal Assessment Marks	End Term Examination Marks	Total Marks	Examination Hours
						To	L	T	P	To				
1	CC-1	26L6.0-MAT-101	Abstract Algebra	T	4	26	4	0	0	4	30	70	100	3
	CC-2	26L6.0-MAT-102	Mathematical Analysis	T	4		4	0	0	4	30	70	100	3
	CC-3	26L6.0-MAT-103	Ordinary Differential Equations	T	4		4	0	0	4	30	70	100	3
	CC-4	26L6.0-MAT-104	Complex Analysis	T	4		4	0	0	4	30	70	100	3
	CC-5	26L6.0-MAT-105	Mathematical Statistics	T	4		4	0	0	4	30	70	100	3
	PC-1	26L6.0-MAT-106	Programming with Python	P	4		0	0	8	8	30	70	100	3
	SEM	26L6.0-MAT-107	Seminar		2					2	0	50	50	1
2	CC-6	26L6.0-MAT-201	Field Extensions and Galois Theory	T	4	26	4	0	0	4	30	70	100	3
	CC-7	26L6.0-MAT-202	Measure and Integration Theory	T	4		4	0	0	4	30	70	100	3
	CC-8	26L6.0-MAT-203	Integral Equations and Calculus of Variations	T	4		4	0	0	4	30	70	100	3
	CC-9	26L6.0-MAT-204	General Topology	T	4		4	0	0	4	30	70	100	3
	CC-10	26L6.0-MAT-205	Operations Research Techniques	T	4		4	0	0	4	30	70	100	3
	PC-2	26L6.0-MAT-206	Typesetting in LaTeX	P	4		0	0	8	8	30	70	100	3
	CHM	26L6.0-CHM-201	Constitutional, Human and Moral Values and IPR	T	2		2	0	0	2	15	35	50	2
	Internship	26L6.0-MAT-INT	An internship course of 4 Credits of 4-6 weeks duration during summer vacation after 2 nd semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude.								50	50	100	



3	CC-11	26L6.5-MAT-301	Functional Analysis	T	4	26	4	0	0	4	30	70	100	3
	CC-12	26L6.5-MAT-302	Fluid Dynamics	T	4		4	0	0	4	30	70	100	3
	DEC-1 (Any one)	26L6.5-MAT-303	Advanced Topology	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-304	Partial Differential Equations	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-305	Mathematical Modeling	T	4		4	0	0	4	30	70	100	3
	DEC-2 (Any one)	26L6.5-MAT-306	Analytical Number Theory	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-307	Fuzzy Set Theory	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-308	Mechanics of Solids	T	4		4	0	0	4	30	70	100	3
	DEC-3 (Any one)	26L6.5-MAT-309	Discrete Mathematics	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-310	Advanced Complex Analysis	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-311	Computational Fluid Dynamics	T	4		4	0	0	4	30	70	100	3
	PC-3	26L6.5-MAT-312	MATLAB Programming	P	4		0	0	8	8	30	70	100	3
	OEC	26L6.5-OEC-MAT-301*	(*for the students of other than PG Programme in Mathematics) Students of PG Programme in Mathematics will choose the course from the pool of open elective courses provided by the university except the OEC offered by Department of Mathematics	T	2		2	0	0	2	15	35	50	2

4	CC-13	26L6.5-MAT-401	Viscous Fluid Dynamics	T	4	26	4	0	0	4	30	70	100	3
	CC-14	26L6.5-MAT-402	Inner Product Spaces and Measure Theory	T	4		4	0	0	4	30	70	100	3
	DEC-4 (Any one)	26L6.5-MAT-403	Algebraic Number Theory	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-404	Differential Geometry	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-405	Applied Solid Mechanics	T	4		4	0	0	4	30	70	100	3
	DEC-5 (Any one)	26L6.5-MAT-406	Theory of Linear Operators	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-407	Classical Mechanics	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-408	Fractional Calculus	T	4		4	0	0	4	30	70	100	3
	DEC-6 (Any one)	26L6.5-MAT-409	Graph Theory	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-410	Mathematics for Finance and Insurance	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-411	Bio-Fluid Dynamics	T	4		4	0	0	4	30	70	100	3
	PC-4	26L6.5-MAT-412	R Programming	P	4		0	0	8	8	30	70	100	3
EEC	26L6.5-MAT-413	Employability Skills in Mathematics	T	2	2	0	0	2	15	35	50	2		
Scheme of Semester IV when a student opts for Dissertation Work														
4	CC-13	26L6.5-MAT-401	Viscous Fluid Dynamics	T	4	26	4	0	0	4	30	70	100	3
	DEC-4 (Any one)	26L6.5-MAT-403	Algebraic Number Theory	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-404	Differential Geometry	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-405	Applied Solid Mechanics	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-406	Theory of Linear Operators	T	4		4	0	0	4	30	70	100	3
	DEC-5 (Any one)	26L6.5-MAT-407	Classical Mechanics	T	4		4	0	0	4	30	70	100	3
		26L6.5-MAT-408	Fractional Calculus	T	4		4	0	0	4	30	70	100	3
		EEC	26L6.5-MAT-413	Employability Skills in Mathematics	T		2	2	0	0	2	15	35	50
	Dissertation	26L6.5-MAT-414	Dissertation	D	12					12	0	300	300	

Semester	Core Courses (CC+DEC+PC)	Minor Courses (Seminar/Value Added Course/Open Elective Course/ Employability & Entrepreneurship Skills Course)	Total Number of Courses
1 st	06	01	07
2 nd	06	01	07
3 rd	06	01	07
4 th	06	01	07
Grand Total	24	04	28



Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	I		
Nature of Course	Theory		
Nomenclature of the Course	Abstract Algebra		
Course Code	26L6.0-MAT-101		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Algebra up to the level 299		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Learn about Sylow theorem's and apply Sylow's theorems to describe the structure of some finite groups	
	CLO ₂	Learn properties of solvable and nilpotent groups, analyze and illustrate examples of normal series, subnormal series and composition series	
	CLO ₃	Identify and construct examples of modules, and apply homomorphism theorems on the same. Study modules over principal ideal domain and its applications to finitely generated abelian groups	
	CLO ₄	Define and characterize Noetherian & Artinian modules and rings, and prove Hilbert basis theorem, Wedderburn-Artin theorem and Maschke theorem.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	p-groups, Sylow p-subgroups, Sylow theorems, Applications of Sylow theorems, Description of groups of order p^2 and pq , Survey of groups up to order 15.	CLO ₁	15
II	Normal and subnormal series, Solvable series, Derived series, Solvable groups, Solvability of S_n -the symmetric group of degree $n \geq 2$, Central series, Nilpotent groups and their properties, Upper and lower central series. Composition series, Zassenhaus lemma, Jordan-Holder theorem.	CLO ₂	15

III	Modules, Cyclic modules, Simple modules, Schur lemma, Free modules, Torsion modules, Torsion free modules, Fundamental structure theorem for finitely generated free modules, Modules over principal ideal domain and its applications to finitely generated abelian groups.	CLO ₃	15
IV	Noetherian and Artinian modules, Noetherian and Artinian rings, Nil and nilpotent ideals in Noetherian and Artinian rings, Hilbert basis theorem. HomR(R,R), Opposite rings, Wedderburn-Artin theorem, Maschke theorem.	CLO ₄	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Luther, I. S., & Passi, I. B. S. (2013). <i>Algebra: Vol. I. Groups</i> . Narosa Publishing House.			
2. Luther, I. S., & Passi, I. B. S. (2013). <i>Algebra: Vol. III. Modules</i> . Narosa Publishing House.			
3. Lanski, C. (2010). <i>Concepts in abstract algebra</i> . American Mathematical Society.			
4. Sahai, V., & Bist, V. (1999). <i>Algebra</i> . Narosa Publishing House.			
5. Malik, D. S., Mordeson, J. N., & Sen, M. K. (1997). <i>Fundamentals of abstract algebra</i> . McGraw-Hill.			
6. Bhattacharya, P. B., Jain, S. K., & Nagpaul, S. R. (1997). <i>Basic abstract algebra</i> (2nd ed.). Cambridge University Press.			
7. Musili, C. (1994). <i>Introduction to rings and modules</i> . Narosa Publishing House.			
8. Jacobson, N. (1985). <i>Basic algebra I</i> (2nd ed.). W. H. Freeman and Company.			
9. Jacobson, N. (1989). <i>Basic algebra II</i> (2nd ed.). W. H. Freeman and Company.			
10. Artin, M. (1991). <i>Algebra</i> . Prentice Hall of India.			
11. Macdonald, I. D. (1968). <i>The theory of groups</i> . Clarendon Press.			

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	—	2	—	—	2	—	—	3	2	2	2
CLO ₂	3	2	2	3	—	3	—	—	2	—	—	3	2	3	3
CLO ₃	3	3	2	3	—	3	—	—	2	—	—	3	3	2	2
CLO ₄	3	3	2	3	—	3	—	—	2	—	—	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	60
Skill Enhancement	60
Communication Development	60

Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	I		
Nature of Course	Theory		
Nomenclature of the Course	Mathematical Analysis		
Course Code	26L6.0-MAT-102		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course (if any)	Courses on Mathematical Analysis up to the 299 level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Understand the concept of Riemann-Stieltjes integral along its properties; integration of vector-valued functions with application to rectifiable curves.	
	CLO ₂	Understand and handle convergence of sequences and series of functions; demonstrate understanding of the statement and proof of Weierstrass approximation theorem.	
	CLO ₃	Understand the concepts of differentiability and continuity of functions of several variables and their relation to partial derivatives; apply the knowledge to prove inverse function theorem.	
	CLO ₄	Understand the concepts of Power series, Implicit functions, Lagrange method of multipliers, Jacobians and its properties: apply the knowledge to find stationary values of implicit functions.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		

Part B- Contents of the Course

Instructions for Paper- Setter:

The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.

Unit	Topics	CLO's Attempt	Contact Hours
I	Riemann-Stieltjes integral, Existence and properties, Integration and differentiation, The fundamental theorem of calculus. Integration of vector-valued functions, Rectifiable curves.	CLO ₁	15
II	Sequence and series of functions: Pointwise and uniform convergence, Cauchy criterion for uniform convergence, M_n -test for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform convergence and differentiation, Weierstrass approximation theorem.	CLO ₂	15
III	Functions of several variables, Linear Transformations, Euclidean space R^n , Derivatives in an open subset of R^n , Chain Rule, Partial derivatives, Continuously Differentiable Mappings, The inverse function theorem.	CLO ₃	15
IV	Power series, uniform convergence and uniqueness theorem, Abel's theorem, Tauber's theorem. Implicit functions, Stationary values of implicit functions, Lagrange multipliers method, Jacobian and its properties.	CLO ₄	15
Total Contact hours			60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz /class test etc.:	10		
• Mid-Term Exam:	15		



Part C-Learning Resources

Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):

1. Apostol, T. M. (2002). *Mathematical analysis* (2nd ed.). Narosa Publishing House.
2. Bartle, R. G. (2011). *The elements of real analysis*. John Wiley & Sons.
3. Goldberg, R. R. (2020). *Methods of real analysis*. Oxford & IBH Publishing.
4. Malik, S. C., & Arora, S. (2024). *Mathematical analysis*. New Age International Publishers.
5. Rudin, W. (2023). *Principles of mathematical analysis* (3rd ed.). McGraw-Hill.
6. Somasundaram, D., & Choudhary, B. (1997). *A first course in mathematical analysis*. Narosa Publishing House.

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	-	2	1	-	2	-	-	3	2	3	2
CLO ₂	3	3	2	3	-	3	1	-	2	-	-	3	2	3	3
CLO ₃	3	3	2	3	-	3	1	-	2	-	-	3	2	3	3
CLO ₄	3	2	2	3	-	2	1	-	2	-	-	3	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	30
Entrepreneurship	4
Skill Enhancement	24
Communication Development	3
Indian Knowledge System	2



Part A–Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	I		
Nature of Course/Course Composition	Theory		
Name of the Course	Ordinary Differential Equations		
Course Code	26L6.0-MAT-103		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Differential Equations and Real Analysis up to the 299 level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁ :	Know about existence, uniqueness and continuity of solutions of first order ODE's.	
	CLO ₂ :	Learn about linear systems, self-adjoint equations of second order and some basic results of Sturm theory.	
	CLO ₃ :	Learn about critical points of autonomous systems and their stability.	
	CLO ₄ :	Learn about critical points and paths of almost linear systems, existence and nonexistence of limit cycles, eigen values and eigen functions of Sturm-Liouville's problems.	
	Theory	Practical	Total
Credits	4	0	4
Teaching hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	03		
Part B-Contents of the Course			
<u>Instructions for Theory Paper-Setter</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Preliminaries, ε -approximate solution, Cauchy-Euler construction of an ε -approximate solution of an initial value problem, Equicontinuous family of functions, Ascoli-Arzelà Lemma, Cauchy-Peano existence theorem. Lipchitz condition, Picard-Lindelof existence and uniqueness theorem for differential equation $\frac{dy}{dt} = f(t,y)$, Solution of initial-value problems by Picard's method, Dependence of solutions on initial conditions.	CLO ₁	15

II	Linear systems, Matrix method for homogeneous first order system of linear differential equations, Basic theory of the homogeneous linear system, Fundamental set of solutions, Fundamental matrix of solutions, Wronskian of solutions, Abel-Liouville formula, Non-homogeneous linear system. Strum Theory: Self-adjoint equations of the second order, Some basic results of Sturm theory, Abel's formula, Strum Separation theorem, Strum's Fundamental comparison theorem. (Relevant topics from chapters 7 and 11 of book by Ross)	CLO ₂	15
III	Nonlinear differential systems, Phase plane, Path, Critical points, Autonomous systems, Isolated critical point, Path approaching a critical point, Path entering a critical point, Types of critical points - Center, Saddle points, Spiral points, Node points. Stability of critical points, Stable critical points, Asymptotically stable critical points, Unstable critical points, Critical points and paths of linear systems. (Relevant topics from chapter 13 of book by Ross).	CLO ₃	15
IV	Almost linear systems, Critical points and paths of almost linear systems, Nonlinear conservative dynamical systems, Dependence on a parameter, Liapunov's direct method. Limit Cycles and Periodic solutions: Limit cycles, Periodic solutions, Existence and nonexistence of limit cycles, Bendixson's nonexistence criterion, Poincare-Bendixson theorem (statement only), Index of a critical point. Strum-Liouville problems, Orthogonality of characteristic functions. (Relevant topics from chapters 12 and 13 of the book by Ross).	CLO ₄	15
Total		60	
Evaluation Methods			
Internal Assessment:30 Marks		End Term Examination: 70 Marks	
Class Participation:	5	Written Examination: 70	
Seminar/presentation/assignment/quiz/ class test etc.	10		
Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/Journals/e-resources/Learning Management System:

1. Boyce, W. E., & DiPrima, R. C. (1986). *Elementary differential equations and boundary value problems* (4th ed.). John Wiley & Sons.
2. Chicone, C. (2024). *Ordinary differential equations with applications* (3rd ed.). Springer.
3. Coddington, E. A., & Levinson, N. (2000). *Theory of ordinary differential equations*. Tata McGraw-Hill.
4. Ross, S. L. (1984). *Differential equations*. John Wiley & Sons.
5. Simon, G. F. (1993). *Differential equations*. Tata McGraw-Hill.

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLO _s	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	-	2	-	-	2	-	-	3	2	3	3
CLO ₂	3	2	1	3	-	3	-	-	2	-	-	3	2	3	3
CLO ₃	3	3	1	3	-	3	1	1	2	-	-	3	2	3	3
CLO ₄	3	3	1	3	-	3	1	1	2	-	-	3	2	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability/Entrepreneurship	60
Skill Enhancement	60
Communication Development	30



Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	I		
Nature of Course	Theory		
Nomenclature of the Course	Complex Analysis		
Course Code	26L6.0-MAT-104		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Real Analysis up to the 299 level		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Learn about basics of complex numbers, power series, complex valued functions and their properties.	
	CLO ₂	Study about complex integration, Cauchy integral formula, Poisson integral formula and inverse function theorem.	
	CLO ₃	Understand analytic functions, some fundamental results such as Cauchy integral formula, Poisson integral formula, Liouville theorem.	
	CLO ₄	Evaluate the complex integration with infinite limit, residues and Montel theorem, Riemann mapping theorem.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
Instructions for Paper- Setter:			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Functions of a complex variable, Continuity, Differentiability, Analytic functions and their properties, Cauchy-Riemann equations in Cartesian and polar coordinates. Power series, Radius of convergence, Differentiability of sum function of a power series, Branches of many valued functions with special reference to $\arg z$, $\text{Log } z$ and z^a .	CLO_1	15

II	Path in a region, Contour, Complex integration, Cauchy theorem, Cauchy integral formula, Extension of Cauchy integral formula for multiple connected domain, Poisson integral formula, Higher order derivatives, Complex integral as a function of its upper limit, Morera theorem, Cauchy inequality, Liouville theorem, Taylor theorem.	<i>CLO₂</i>	15
III	Zeros of an analytic function, Laurent series, Isolated singularities, Cassorati-Weierstrass theorem, Limit point of zeros and poles. Maximum modulus principle, Schwarz lemma, Meromorphic functions, Argument principle, Rouche theorem, Fundamental theorem of algebra, Inverse function theorem.	<i>CLO₃</i>	15
IV	Calculus of residues, Cauchy residue theorem, Evaluation of integrals of the types: $\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta$, $\int_{-\infty}^{\infty} f(x) dx, \int_0^{\infty} f(x) \sin mx dx, \int_0^{\infty} f(x) \cos mx dx$ Conformal mappings, Space of analytic functions and their completeness, Hurwitz theorem, Montel theorem, Riemann mapping theorem.	<i>CLO₄</i>	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Priestley, H. A. (1990). <i>Introduction to complex analysis</i> . Clarendon Press.			
2. Conway, J. B. (2002). <i>Functions of one complex variable I</i> (2nd ed.). Springer. <i>Note:</i> The Indian Student Edition was published by Narosa Publishing House.			
3. Churchill, R. V., & Brown, J. W. (2009). <i>Complex variables and applications</i> (8th ed.). McGraw-Hill Higher Education.			
4. Copson, E. T. (1972). <i>An introduction to the theory of functions of a complex variable</i> . Oxford University Press.			
5. Titchmarsh, E. C. (1939). <i>The theory of functions</i> (2nd ed.). Oxford University Press.			
6. Kasana, H. S. (2013). <i>Complex variables: Theory and applications</i> (2nd ed.). PHI Learning Private Limited.			
7. Zill, D. G., & Shanahan, P. D. (2010). <i>A first course in complex analysis with applications</i> (2nd ed.). Jones and Bartlett Publishers.			

**Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes
& Programme Specific Outcomes**

<i>CLOs</i>	<i>PLO₁</i>	<i>PLO₂</i>	<i>PLO₃</i>	<i>PLO₄</i>	<i>PLO₅</i>	<i>PLO₆</i>	<i>PLO₇</i>	<i>PLO₈</i>	<i>PLO₉</i>	<i>PLO₁₀</i>	<i>PLO₁₁</i>	<i>PSO₁</i>	<i>PSO₂</i>	<i>PSO₃</i>	<i>PSO₄</i>
<i>CLO₁</i>	3	1	1	2		1			2			3	2	2	1
<i>CLO₂</i>	3	2	1	3		2	1		2			3	2	3	2
<i>CLO₃</i>	3	2	2	3		3	2		2			3	3	3	2
<i>CLO₄</i>	3	3	2	3		3	2		2		1	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	60
Skill Enhancement	60
Communication Development	30



Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	I		
Nature of Course	Theory		
Nomenclature of the Course	Mathematical Statistics		
Course Code	26L6.0-MAT-105		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course			
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Know basics of probability.	
	CLO ₂	Understand discrete and continuous probability distributions.	
	CLO ₃	Learn joint probability distributions, random samples, point estimation and confidence intervals.	
	CLO ₄	Understand Hypotheses testing and inferences based on two samples.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Probability: Definition and various approaches of probability, Addition theorem, Boole's inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes' theorem and its applications.	CLO ₁	15
II	Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function, Concepts of bivariate random variable: joint, marginal and conditional distributions. Mathematical expectation: Definition and its properties, Variance, Covariance, Moment generating function-Definitions and their properties.	CLO ₂	15

III	Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties. Continuous distributions: Uniform, Exponential and Normal distributions with their properties.	<i>CLO₃</i>	15
IV	Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors. Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions.	<i>CLO₄</i>	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
Instructions			
1. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). <i>Introduction to the theory of statistics</i> (3rd ed.). McGraw-Hill.			
2. Gupta, S. C., & Kapoor, V. K. (2020). <i>Fundamentals of mathematical statistics</i> (12th ed.). Sultan Chand & Sons.			
3. Freund, J. E. (1992). <i>Mathematical statistics</i> (5th ed.). Prentice Hall.			
4. Spiegel, M. R., Schiller, J., & Srinivasan, R. A. (2012). <i>Probability and statistics</i> (4th ed.). McGraw-Hill Education.			
5. Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2015). <i>Probability and statistical inference</i> (9th ed.). Pearson.			

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

<i>CLOs</i>	<i>PLO₁</i>	<i>PLO₂</i>	<i>PLO₃</i>	<i>PLO₄</i>	<i>PLO₅</i>	<i>PLO₆</i>	<i>PLO₇</i>	<i>PLO₈</i>	<i>PLO₉</i>	<i>PLO₁₀</i>	<i>PLO₁₁</i>	<i>PSO₁</i>	<i>PSO₂</i>	<i>PSO₃</i>	<i>PSO₄</i>
<i>CLO₁</i>	3	1	1	2		1			1			3	1	2	1
<i>CLO₂</i>	3	1	1	3		2	1		1			3	2	3	1
<i>CLO₃</i>	2	3	2	3	1	3	2	1	2	2	1	3	3	3	3
<i>CLO₄</i>	2	3	2	3	1	3	2	1	2	3	1	2	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	60
Skill Enhancement	60
Communication Development	30
Public policies	10



Part A – Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	I		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Programming with Python		
Course Code	26L6.0-MAT-106		
Course Type	PC		
Course Level	400-499		
Pre-requisite for the course	Basic Computer Knowledge		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Understand Python programming fundamentals and data types	
	CLO ₂	Develop programs using control structures, functions and data structures	
	CLO ₃	Apply Python data structures (lists, tuple, dictionaries, and sets) for data manipulation and problem solving	
	CLO ₄	Develop Python applications using functions, modules, packages, and file handling	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	
Part B- Contents of the Course			
Instructions for Examiner:			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO's Attempt	Contact Hours
Unit-I	Problem Solving: Introduction to problem-solving techniques, algorithm development, flowcharts, and pseudocode. Introduction to Python: Introduction and features of Python, Python programming environment, execution modes, Python syntax, variables, keywords, identifiers, literals, data types, operators, expressions, type conversion, input-output operations, comments, indentation, algorithm development	CLO ₁	30
Unit-II	Control Statements: Decision making statements, iterative statements, nested loops, break, continue and pass statements, programming applications. Strings: Creation, indexing, slicing, concatenation, repetition, string formatting, built-in string methods and applications.	CLO ₂	30

Unit-III	Lists: Creation, indexing, slicing, updating, insertion, deletion, nested lists, list comprehensions, built-in list methods and problem-solving applications. Tuples: Creation, indexing, slicing, packing and unpacking, immutable properties, built-in tuple functions. Dictionaries: Creation, accessing, updating and deleting elements, nested dictionaries, dictionary comprehension, built-in methods and applications. Sets: Creation, set operations and built-in methods.	CLO ₃	30
Unit-IV	Functions: Built-in and user-defined functions, function arguments, default and keyword arguments, variable-length arguments, recursive functions, lambda functions, scope of variables, modules and packages. File Handling: Text, binary and CSV file handling, file operations, JSON and Pickle modules. File Handling applications.	CLO ₄	30
	Contact Hours	120	
Evaluation Methods			
Internal Assessment	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS): 1. Kamthane, A. N., & Kamthane, A. A. (2018). <i>Programming and problem solving with Python</i> . McGraw Hill Education. 2. Kanetkar, Y. (2017). <i>Let us Python</i> . BPB Publications. 3. Brown, M. C. (2018). <i>Python: The complete reference</i> . McGraw Hill Education. 4. Lutz, M. (2010). <i>Programming Python*</i> (4th ed.). O'Reilly Media. 5. Lambert, K. A. (2018). <i>Fundamentals of Python: First programs</i> (3rd ed.). Cengage Learning. 6. Downey, A. B. (2015). <i>Think Python: How to think like a computer scientist</i> (2nd ed.). O'Reilly Media. 7. Balagurusamy, E. (2016). <i>Introduction to computing and problem-solving using Python</i> . McGraw Hill Education.			

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	1	1	2	-	-	2	-	2	1	-	2	3	2	1
CLO ₂	3	2	2	3	1	2	3	-	2	1	1	2	3	3	2
CLO ₃	3	2	2	3	1	3	3	1	2	1	1	3	3	3	2
CLO ₄	3	2	2	3	2	2	3	1	3	1	2	2	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	120
Skill Enhancement	120



Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	II		
Nature of Course	Theory		
Nomenclature of the Course	Field Extensions and Galois Theory		
Course Code	26L6.0-MAT-201		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Algebra up to the level 299		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	To use diverse properties of field extensions in various areas	
	CLO ₂	To establish the connection between the concept of field extensions and Galois theory	
	CLO ₃	To describe the concept of automorphism, monomorphism and their linear independence in field theory.	
	CLO ₄	To solve polynomial equations by radicals along with the understanding of ruler and compass constructions.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Fields, Prime fields, Finite field extensions, Degree of field extensions, Simple Extensions, Algebraic extensions, Splitting fields, Algebraically closed fields.	CLO ₁	15
II	Separable and inseparable extensions, Perfect fields. Monomorphisms and their linear independence, Automorphism of fields, Fixed fields, Normal extensions, The fundamental theorem of Galois theory.	CLO ₂	15
III	Finite fields, Existence of GF(p^n), Construction of finite fields, Primitive elements, Langrange's theorem on primitive elements, Roots of unity, Cyclotomic polynomials, Cyclotomic extensions of rational number field.	CLO ₃	15

IV	Solutions by radicals, Extension by radicals, Generic polynomial, Insolvability of the general polynomial of degree $n \geq 5$ by radicals, Ruler and compasses construction	CLO ₄	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Luther, I. S., & Passi, I. B. S. (2012). <i>Algebra: Vol. IV: Field theory</i> . Narosa Publishing House.			
2. Stewart, I. (2004). <i>Galois theory</i> (3rd ed.). Chapman & Hall/CRC.			
3. Sahai, V., & Bist, V. (1999). <i>Algebra</i> . Narosa Publishing House.			
4. Bhattacharya, P. B., Jain, S. K., & Nagpaul, S. R. (1997). <i>Basic abstract algebra</i> (2nd ed.) Cambridge University Press.			
5. Lang, S. (1993). <i>Algebra</i> (3rd ed.). Addison-Wesley.			
6. Adamson, I. T. (1982). <i>Introduction to field theory</i> . Cambridge University Press.			
7. Herstein, I. N. (1975). <i>Topics in algebra</i> (2nd ed.). Wiley Eastern.			

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	-	2	1	-	2	-	-	3	2	3	2
CLO ₂	3	3	2	3	-	3	1	-	2	-	-	3	2	3	3
CLO ₃	3	2	2	3	-	3	1	-	2	-	-	3	3	3	3
CLO ₄	3	2	2	3	-	3	1	-	2	-	-	3	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	60
Skill Enhancement	60
Communication Development	60

Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	II		
Nature of Course	Theory		
Nomenclature of the Course	Measure and Integration Theory		
Course Code	26L6.0-MAT-202		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Real Analysis up to the 299 level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Understand the concepts of measurable sets and Lebesgue measure; construct a non-measurable set; apply the knowledge to solve relevant exercises.	
	CLO ₂	Know about Lebesgue measurable functions and their properties; and apply the knowledge to prove Egoroff's theorem, Lusin's theorem and F. Riesz theorem.	
	CLO ₃	Understand the requirement and the concept of the Lebesgue integral (as a generalization of the Riemann integration) along its properties and demonstrate understanding of the statements and proofs of the fundamental integral convergence theorems.	
	CLO ₄	Know about the concepts of differentiation of monotonic function, functions of bounded variations, differentiation of an integral, absolutely continuous functions.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		

Part B- Contents of the Course			
Instructions for Paper- Setter:			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Set functions, Intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of sets of real numbers, Algebra of measurable sets, Borel sets and their measurability, Equivalent formulation of measurable sets in terms of open, closed, F_σ and G_δ sets, Non-measurable sets.	CLO ₁	15
II	Measurable functions and their equivalent formulations, Properties of measurable functions, Approximation of a measurable function by a sequence of simple functions, Measurable functions as nearly continuous functions, Egoroff's theorem, Lusin's theorem, Convergence in measure and F. Riesz theorem for convergence in measure, Almost uniform convergence.	CLO ₂	15
III	Shortcomings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties, Lebesgue integral as a generalization of Riemann integral, Bounded convergence theorem, Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.	CLO ₃	15
IV	Vitali's covering lemma, Differentiation of monotonic functions, Functions of bounded variation and their representation as difference of monotonic functions, Differentiation of indefinite integral, Fundamental theorem of calculus, Absolutely continuous functions and their properties, Convex functions, Jensen's Inequality.	CLO ₄	15
Total Contact hours			60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz /class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS): Recommended Text Books;

1. Bartle, R. G. (1966). *The elements of integration*. John Wiley & Sons.
2. De Barra, G. (2022). *Measure theory and integration*. New Age International.
3. Halmos, P. R. (1950). *Measure theory*. D. Van Nostrand Company.
4. Jain, P. K., Gupta, V. P., & Jain, P. (2019). *Lebesgue measure and integration*. New Age International Publishers.
5. Royden, H. L. (2015). *Real analysis* (4th ed.). Pearson Education India.

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	-	2	1	-	2	1	-	3	2	3	2
CLO ₂	3	3	2	3	-	3	1	-	2	1	-	3	3	3	3
CLO ₃	3	3	2	3	-	3	1	-	2	1	-	3	2	3	3
CLO ₄	3	3	2	3	-	3	1	-	2	1	-	3	2	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	20
Entrepreneurship	2
Skill Enhancement	24
Communication Development	3
Indian Knowledge System	2

Part A–Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	II		
Nature of Course/Course Composition	Theory		
Name of the Course	Integral Equations and Calculus of Variations		
Course Code	26L6.0-MAT-203		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Differential Equation and Real Analysis up to the 299 level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁ :	Know about integral equations and various methods to solve Volterra integral equations.	
	CLO ₂ :	Understand various methods to solve Fredholm integral equations.	
	CLO ₃ :	Construct Green's function for solving boundary value problems associated with ordinary differential equations.	
	CLO ₄ :	Solve some mathematical and physical problems using variational techniques.	
	Theory	Practical	Total
Credits	4	0	4
Teaching hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	03		
Part B-Contents of the Course			
Instructions for Theory Paper-Setter			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Linear Integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations, Resolvent kernel as a series, Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind.	CLO ₁	15

II	Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations, Resolvent kernel as a sum of series, Fredholm resolvent kernel as a ratio of two series, Fredholm equations with separable kernels, Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homogeneous Fredholm equations with degenerate kernels.	CLO ₂	15
III	Green's function, Use of method of variation of parameters to construct the Green's function for a non-homogeneous linear second order boundary value problem, Basic four properties of the Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green's function, Hilbert-Schmidt theory for symmetric kernels.	CLO ₃	15
IV	Motivating problems of calculus of variations, Shortest distance, Minimum surface of resolution, Brachistochrone problem, Isoperimetric problem, Geodesics, Fundamental lemma of calculus of variations, Euler's equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints.	CLO ₄	15
Total		60	
Evaluation Methods			
Internal Assessment:30 Marks		End Term Examination: 70 Marks	
Class Participation:	5	Written Examination: 70	
Seminar/presentation/assignment/quiz/class test etc.:	10		
Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/e-resources/Learning Management System:			
1. Courant, R. P. Kanwal, R. (1997). <i>Linear integral equations: Theory and technique</i> (2nd ed.). Academic Press.			
2. Gelfand, I. M., & Fomin, S. V. (1963). <i>Calculus of variations</i> . Prentice-Hall.			
3. Hildebrand, F. B. (1987). <i>Methods of applied mathematics</i> (2nd ed.). Dover Publications.			
4. Jerri, A. J. (1999). <i>Introduction to integral equations with applications</i> (2nd ed.). Wiley-Interscience.			
5. Lovitt, W. V. (1924). <i>Linear integral equations</i> . McGraw-Hill.			

**Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes
& Programme Specific Outcomes**

CLO _s	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	1	2	1	-	2	-	-	3	2	3	3
CLO ₂	3	2	1	3	1	2	1	-	2	-	-	3	2	3	3
CLO ₃	3	2	1	3	1	3	1	1	2	-	-	3	2	3	3
CLO ₄	3	3	1	3	1	3	1	2	2	-	-	3	2	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability/Entrepreneurship	60
Skill Enhancement	60
Communication Development	30



Part A – Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	II		
Nature of Course	Theory		
Nomenclature of the Course	General Topology		
Course Code	26L6.0-MAT-204		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course	Courses on Real Analysis up to the 299 level		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Determine interior, closure, boundary, exterior, limit points of subsets of topological spaces and define topology in terms of closure operator, interior operator, exterior operator, and neighbourhood system.	
	CLO ₂	Learn about the concepts of relative topology, basis and subbasis for a topology, continuous functions, homeomorphism, topological properties, connectedness and local connectedness	
	CLO ₃	Learn about separation axioms, countability axioms and concept of convergence of sequences in topological spaces.	
	CLO ₄	Learn about compact, sequentially compact, countably compact and locally compact spaces, and one point compactification.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Definition and examples of topological spaces, Comparison of topologies on a set, Intersection and union of topologies on a set, Limit point of a set, Derived set, Closed set, Closure of a set, Kuratowski closure axioms, Closure operator, Dense sets, Interior point and Interior of a set, Interior axioms, Exterior of a set, Exterior axioms, Boundary of a set, Interior, exterior and boundary operators, Neighborhoods, Alternative methods of defining a topology in terms of neighborhood system and Kuratowski closure operator.	CLO ₁	15

II	Relative (Induced) topology, Base and subbase for a topology, Base for neighbourhood system. Continuous functions, Composition of continuous functions, Pasting lemma, Open and closed functions, Homeomorphisms, Topological properties. Connectedness and its characterization, Connected subsets and their properties, Continuity and connectedness, Components, Locally connected spaces.	CLO ₂	15
III	Separation axioms: T_0 , T_1 , T_2 -spaces, their characterization and basic properties, T_2 -spaces and sequences. First countable, Second countable and Separable spaces, Hereditary and topological property, Countability of a collection of disjoint open sets in separable and second countable spaces, Lindelöf theorem.	CLO ₃	15
IV	Compact spaces and subsets, Compactness in terms of finite intersection property, Continuity and compact sets, Basic properties of compactness, Closedness of compact subset of a Hausdorff space and of a continuous map from a compact space into a Hausdorff and its consequence. Sequentially and Countably compact spaces Locally compact spaces and One point compactification	CLO ₄	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Pervin, W. J. (1964). <i>Foundations of general topology</i> . Academic Press.			
2. Patty, C. W. (2009). <i>Foundations of topology</i> . Jones and Bartlett Publishers.			
3. Croom, F. H. (1978). <i>Principles of topology</i> . Saunders College Publishing.			
4. Joshi, K. D. (1983). <i>Introduction to general topology</i> . New Age International.			
5. Kelley, J. L. (1975). <i>General topology</i> . Springer-Verlag.			
6. Munkres, J. R. (2002). <i>Topology</i> (2nd ed.). Prentice Hall.			
7. Chandrasekhara Rao, K. (2009). <i>Topology</i> . Alpha Science International.			

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	-	2	1	-	2	-	-	3	2	3	2
CLO ₂	3	2	2	3	-	3	1	-	2	-	-	3	3	3	3
CLO ₃	3	3	2	3	-	3	1	-	2	-	-	3	2	3	3
CLO ₄	3	2	2	3	-	3	1	-	2	-	-	3	2	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	60
Skill Enhancement	60
Communication Development	60

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Part A - Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	II		
Nature of Course	Theory		
Nomenclature of the Course	Operations Research Techniques		
Course Code	26L6.0-MAT-205		
Course Type	CC		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Understand the need and origin of Operational Research, Solution of the Linear Programming Problems by graphical, simplex, Big-M and Two-phase methods.	
	CLO ₂	Learn about the Basic feasible solution, Optimal solution by stepping stone and MODI method of Transportation Problems and Solution of Assignment Problems by Hungarian method.	
	CLO ₃	Introduce the Queuing theory, Stochastic process, Birth-death process, Markovian queuing models and Sequencing problems.	
	CLO ₄	Study about the Inventory control models, Economic order quantity model with uniform demand, when shortage are allowed, with uniform replenishment, and Game theory.	
	Theory	Tutorial	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO's Attempt	Contact Hours
I	Operations Research: Origin, Definition and scope. Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big-M and two-phase methods, Degeneracy, Duality in linear programming.	CLO ₁	15

II	Transportation Problems: Basic feasible solutions, Optimum solution by stepping stone and modified distribution methods, Unbalanced and degenerate problems, Transshipment problem. Assignment problems: Solution by Hungarian method, Unbalanced problem, Case of maximization, Travelling salesman and crew assignment problems.	<i>CLO₂</i>	15
III	Queuing models: Basic components of a queuing system, Concepts of stochastic processes, Poisson process, Birth-death process. Steady-state solution of Markovian queuing models with single and multiple servers (M/M/1, M/M/C, M/M/1/k, M/MC/k). Sequencing problems: Solution of sequencing problems, processing n jobs through 2 machines, n jobs through 3 machines, n jobs through m machines, 2 jobs through m machines.	<i>CLO₃</i>	15
IV	Inventory control models: Economic order quantity(EOQ) model with uniform demand and with different rates of demands in different cycles, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks. Game Theory: Two person zero sum game, Game with saddle points, The rule of dominance, Algebraic, Graphical and linear programming methods for solving mixed strategy games.	<i>CLO₄</i>	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
Instructions			
1. Taha, H. A. (1997). <i>Operations research: An introduction</i> (6th ed.). Prentice Hall.			
2. Gupta, P. K., & Hira, D. S. (2014). <i>Operations research</i> (16th rev. ed.). S. Chand Publishing.			
3. Sharma, S. D. (2009). <i>Operations research</i> . Kedar Nath Ram Nath.			
4. Sharma, J. K. (1989). <i>Mathematical models in operations research</i> . Tata McGraw-Hill Publishing Company.			
5. Swarup, K., Gupta, P. K., & Man Mohan. (2005). <i>Operations research</i> (15th ed.). Sultan Chand & Sons.			

**Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes
& Programme Specific Outcomes**

<i>CLOs</i>	<i>PLO₁</i>	<i>PLO₂</i>	<i>PLO₃</i>	<i>PLO₄</i>	<i>PLO₅</i>	<i>PLO₆</i>	<i>PLO₇</i>	<i>PLO₈</i>	<i>PLO₉</i>	<i>PLO₁₀</i>	<i>PLO₁₁</i>	<i>PSO₁</i>	<i>PSO₂</i>	<i>PSO₃</i>	<i>PSO₄</i>
<i>CLO₁</i>	3	2	1	3		2	2	1	2		1	3	2	3	2
<i>CLO₂</i>	3	2	1	3		3	2	1	2		1	3	3	3	2
<i>CLO₃</i>	3	3	2	3		3	2	2	2		1	3	3	3	3
<i>CLO₄</i>	3	3	2	3	1	3	2	2	2	1	2	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	60
Entrepreneurship	20
Skill Enhancement	60
Communication Development	30
Current Issues and Social Awareness	10
Public policies	10



Part A – Introduction			
Name of Programme	M.Sc. Mathematics		
Semester	II		
Nature of Course	Practical		
Nomenclature of the Course	Typesetting in LaTeX		
Course Code	26L6.0-MAT-206		
Course Type	PC		
Course Level	400-499		
Pre-requisite for the course	Basic Computer Knowledge		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Typeset mathematical formulas, use nested lists, tabular & array environments.	
	CLO ₂	Use alignment commands, multiline formulas, bibliographies, citations, and create indices and glossaries.	
	CLO ₃	Design structured documents using boxes, list-making environments, and style customization features in LaTeX.	
	CLO ₄	Use Beamer to create presentations and typeset mathematical projects, dissertations, theses, and books.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	04	
Part B- Contents of the Course			
<u>Instructions for Examiner:</u>			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO's Attempt	Contact Hours
Unit-I	Preparing an input file, writing sentences and paragraphs, selecting document class, sectioning, displayed material, running LaTeX, changing type styles, producing mathematical symbols and formulae, arrays, delimiters, multiline formulae, superscripts/subscripts, and spacing in math mode.	CLO ₁	30
Unit-II	Defining commands and environments, producing and including graphs, figures and floating bodies, multicolumn layouts, generating table of contents, cross-referencing, bibliographies and citations, creating index and glossary, slides, overlays, notes, and letters.	CLO ₂	30

Unit-III	Custom document design: document class, page style, title page, style customization, line/page breaking, numbering, lengths, spacing, boxes, list-making environments, font size changes, special symbols.	CLO ₃	30
Unit-IV	Creating Beamer class presentations, Beamer styles and dynamic slides. Postscript macros for generic TeX (PSTricks): arguments, dimensions, coordinates, angles, line styles, fill styles, custom styles/graphics, picture tools, text manipulation, nodes and connections.	CLO ₄	30
	Contact Hours	120	
Evaluation Methods			
Internal Assessment	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS): Instructions			
1. Binder, D., & Erickson, M. (2010). <i>A student's guide to the study, practice, and tools of modern mathematics</i> . CRC Press.			
2. Datta, D. (2017). <i>LaTeX in 24 hours: A practical guide for scientific writing</i> . Springer.			
3. Kottwitz, S. (2011). <i>LaTeX beginner's guide</i> . Packt Publishing.			
4. Lamport, L. (2009). <i>LaTeX: A document preparation system: User's guide and reference manual</i> (2nd ed.). Pearson Education.			
5. Oetiker, T., Serwin, M., Partl, H., Hyna, I., & Schlegl, E. (2023). <i>The not so short introduction to LaTeX2ε</i> . https://tobi.oetiker.ch/lshort/			
6. Tantau, T. (2023). <i>The beamer class: User guide for version 3.70</i> . Beamer Project.			

Mapping of Course Learning Outcomes (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	2	-	3	2	1	-	3	-	2	2	1	2	3	1	1
CLO ₂	2	3	3	2	1	2	3	-	2	3	2	2	3	2	3
CLO ₃	2	1	3	2	2	1	3	-	2	2	2	2	3	1	2
CLO ₄	2	3	3	2	2	2	3	-	3	3	3	2	3	2	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	48
Entrepreneurship	8
Skill Enhancement	80
Communication Development	24

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