

Karmaveer Bhaurao Patil University, Satara

Syllabus for

B.Sc. IV Mathematics

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic year 2026-27

1. STRUCTURE OF COURSE:

As per NEP-2020 (1.0)

Sem (Level)	Courses			OE	VSC/ SEC	AEC/ VEC/ IKS	OJT/FP/ CEP/CC/ RP	Total Credits	Degree/Cum. Cr. NEME
	Course I	Course II	Course III						
	Major Mandatory	Major Elective	-						
SEM VII (6.0)	Major XVII (4) Major XVIII (4) Major XIX (4) Major (P) IX (2)	Major XX (2) (Elect.) Major (P) X (Elect.) (2)	RM I (2) RM I (P) (2)	-	-	-	-	22	UG Honors Degree
SEM VIII (6.0)	Major XXI (4) Major XXII (4) Major XXIII (4) Major (P) XI (2)	Major XXIV (Elect.) (2) Major (P) XII (Elect.) (2)	-	-	-	-	OJT (4)	22	
Credit	28	08	04				04	44	

1) B.Sc. Honors (Mathematics) Semester VII:

Level	Sem	Course	Theory				Practical		
			Course No. & Course Code	Title of Paper	No. of lectures per week	Credits	Course No. & Course Code	No. of lectures per week	Credits
6.0	VII	Major XVII	BMT 471	Linear Algebra	4	4	Major IX (P) BMP 477	1	2
		Major XVIII	BMT 472	Advanced Calculus	4	4			
		Major XIX	BMT 473	Real Analysis	4	4			
		Major XX (Elect.)	BMT 474	Classical Mechanics	2	2	Major X (Elect.) (P) BMP 478	1	2
		Major XX (Elect.)	BMT 475	Graph Theory					
		RM	BMTRM 476	Research Methodology	2	2	BMPRM 479	1	2

2) B.Sc. Honors (Mathematics) Semester VIII:

Level	Sem	Course	Theory				Practical		
			Course No. & Course Code	Title of Paper	No. of lectures per week	Credits	Course No. & Course Code	No. of lectures per week	Credits
6.0	VIII	Major XXI	BMT 481	Algebra	4	4	Major XI (P) BMP 486	1	2
		Major XXII	BMT 482	Topology	4	4			
		Major XXIII	BMT 483	Complex Analysis	4	4			
		Major XXIV (Elect.)	BMT 484	Differential Geometry	2	2	Major XII (Elect.) (P) BMP 487	1	2
		Major XXIV (Elect.)	BMT 485	Lattice Theory					
		OJT	-	On Job Training (OJT)	-	-	BMPOJT 488	2	4

2. EVALUATION STRUCTURE:

B.Sc. Honors Semester VII

Course	**Course Category**	**Course Code**	**Internal Evaluation**			**ESE**	**Total Marks**	**Credits**
			CCE - I	**CCE - II**	**CCE - III**			
Major	T	BMT 471	20	20	20	60	100	04
	T	BMT 472	20	20	20	60	100	04
	T	BMT 473	20	20	20	60	100	04
	P	BMP 477	20			30		
Major (Elective) (1 Theory Papers Out of Two)	T	BMT 474	10	10	10	30	50	02
	T	BMT 475	10	10	10	30	50	02
	P	BMP 478	20			30		
RM	T	BMTRM 476	10	10	10	30	50	02
	P	BMPRM 479	20			30		
Total							**550**	**22**

B.Sc. Honors Semester VIII

Course	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE - I	CCE - II	CCE - III			
Major	T	BMT 481	20	20	20	60	100	04
	T	BMT 482	20	20	20	60	100	04
	T	BMT 483	20	20	20	60	100	04
	P	BMP 486	20			30	50	02
Major (Elective) (1 Theory Papers Out of Two)	T	BMT 484	10	10	10	30	50	02
	T	BMT 485	10	10	10	30	50	02
	P	BMP 487	20			30	50	02
OJT	P	BMP 488	40			60	100	04
Total							**550**	**22**

DSC: Discipline Specific Course; **DSE**: Discipline Specific Elective **RM:** Research Methodology; **OJT**: On Job Training; RP: Research Project; T: Theory; P: Practical

CONTINOUS AND COMPHERENSIVE EVALUATION (CCE) STRUCTURE:

- Internal evaluation of theory papers shall carry a weightage of 40%.
- For the internal evaluation of theory papers, departments have the flexibility to adopt a variety of assessment methods, including class tests, assignments, record books, tutorials, seminars, case studies, fieldwork, project work, quizzes, and similar tools for CCE I and CCE II.
- CCE III shall consist of multiple-choice questions.
- Each CCE will carry 10 marks for 2-credit theory papers and 20 marks for 4-credit theory
- papers, and the best two scores will be considered for final mark entry.
- Internal evaluation of practical papers shall carry a weightage of 50%.
- For practical examinations, internal evaluation will be based on student performance, attendance, journal records, and viva voce.

On Job Training: Duration: 1 Month (1st November to 30th November)

3. OTHER FEATURES:

A) LIBRARY:

Reference books, Textbooks, journals, and Periodicals are available in Institute and Departmental Library. (Separate reference lists are attached along with the respective course syllabus)

B) EQUIPMENT:

a) Computer, LCD projector, visualizer, smart board

SEMESTER – VII

	Karmaveer Bhaurao Patil University, Satara (A State Public University Est. u/s 3(6) of MPUA 2016) **Faculty of Science and Technology**
	Yashavantrao Chavan Institute of Science, Satara
	Board of Studies in Mathematics
Programme: B.Sc. Honors	**Semester:** VII
Type: Major	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27
Name of the Course and Code: BMT 471 Linear Algebra	

Course Objectives: By the end of the course, students should be able to……

1. understand linear functionals and dual spaces, including their structure and properties.
2. apply concepts of eigenvalues and eigenvectors to analyze linear transformations and solve related problems.
3. analyze canonical forms and bilinear forms to classify matrices.
4. evaluate and construct linear operators on inner product spaces, including studying adjoint operators, normal operators, and spectral properties.

Course Outcomes: By the end of the course, students will be able to……

1. explain and compute dual spaces and linear functionals, and use them in problem-solving contexts.
2. determine eigenvalues and eigenvectors, and analyze their role in diagonalization and stability of linear systems.
3. reduce matrices to canonical forms and examine bilinear forms for classification and equivalence.
4. investigate linear operators on inner product spaces, construct adjoints, and solve problems involving orthogonality and spectral theorems.

Module	Title and Contents	Hrs.
Module - 1:	**Linear Functionals and the Dual Space** 1.1 Linear Functionals and the Dual Space 1.2 Dual Basis 1.3 Second Dual Space 1.4 Annihilator of a subspace 1.5 Quotient Subspaces	15
Module - 2:	**Eigenvalues and Eigenvectors of linear transformations** 2.1 Introduction to linear transformations, Matrix Representation of linear transformation 2.2 Annihilating Polynomials, Eigenvalues and Eigenvectors of linear transformations 2.3 Diagonalization 2.4 Invariant Subspaces	15
Module - 3:	**Canonical Forms and Bilinear Forms** 3.1 Triangular Form 3.2 Primary decomposition theorem 3.3 Nilpotent Operators, Cyclic subspaces 3.4 Jordan Canonical Form, Rational Canonical Form 3.5 Bilinear Forms, symmetric bilinear forms, skew symmetric bilinear forms	15

Module - 4:	**Linear Operators on Inner Product Spaces** 4.1 Inner product spaces 4.2 Adjoint Operators, Self-Adjoint Operators 4.3 Orthogonal and Unitary Operators 4.4 Positive Definite and Positive Operators	15

Reference Books:

1. Herstein I. N., Topics in Algebra, 2nd edition, Wiley Eastern Limited, 1975.
2. Kenneth Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India Pvt. Ltd, 1971.
3. A. R. Rao and P. Bhimashankaran, Linear Algebra, Hindustan Book Agency, 2000.
4. Surjit Singh, Linear Algebra, Vikas Publication House, 1997.
5. Gilbert Strang, Introduction to Linear Algebra, 6th Edition, Wellesley Cambridge Press, 2023.

Evaluation Pattern: (60:40)

Total Marks: 100

Internal Continuous Evaluation (40 Marks):	**End Semester Examination (60 Marks):**
• CCE - I: 20 Marks: Activity • CCE - II: 20 Marks: Activity • CCE - III: 20 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any four questions from question numbers 2 to 7.** Q.1 Define the following terms $[6 \times 2 = 12]$ Q.2 Long Answer Questions $[2 \times 6 = 12]$ Q.3 Long Answer Questions $[2 \times 6 = 12]$ Q.4 Long Answer Questions $[2 \times 6 = 12]$ Q.5 Short Answer Question $[3 \times 4 = 12]$ Q.6 Short Answer Question $[3 \times 4 = 12]$ Q.7 Short Answer Question $[3 \times 4 = 12]$

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VII
Type: Major	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 472 Advanced Calculus

Course Objectives: By the end of the course, students should be able to……

1. learn pointwise and uniform convergence of sequence of functions.
2. study rearrangement of sequence and series and effect of rearrangement on sum or limit.
3. understand Multivariable Calculus.
4. get knowledge of a line integral and properties.

Course Outcomes: By the end of the course, students will be able to……

1. understand convergence of double sequence and double series.
2. check the convergence of sequence and series of functions.
3. analyze differentiability of functions of several variables.
4. apply inverse and implicit function theorems for functions of several variables.

Module	Title and Contents	Hrs.
Module - 1:	**Sequence of Functions** 1.1 Pointwise convergence of a sequence of functions, and examples of sequences of real-valued functions 1.2 Definition of uniform convergence, Uniform convergence and continuity, and the Cauchy condition for uniform convergence 1.3 Uniform convergence and Riemann integration, and uniform convergence and differentiation 1.4 Double sequence, uniform convergence and double sequence, and mean convergence	15
Module - 2:	**Series of Functions** 2.1 Rearrangement of series, subseries, double series, and rearrangement theorem for double series 2.2 Multiplication of series, power series, and real power series 2.3 The Taylor series generated by a function, Bernstein's theorem, and binomial series	15
Module - 3:	**The Directional Derivative** 3.1 The Directional Derivative, and the Directional Derivative and Continuity 3.2 Total Derivative, and Total Derivative in terms of partial derivative 3.3 The Matrix of linear function, and the Jacobian Matrix 3.4 The Chain Rule, and the Mean value function for differentiable functions	15
Module - 4:	**Multivariable Calculus** 4.1 A sufficient condition for differentiability, and a sufficient condition for equality of mixed partial derivatives 4.2 Taylor's formula for functions R^n to R^1, the inverse function theorem	15

	(statement only), the implicit function theorem (statement only) and their applications 4.3 Extrema of real valued function of one variable, and Extrema of real valued function of several variables	

Reference Books:

1. Apostol, Mathematical Analysis, 2nd edition, Narosa Publishing House, 2002
2. Walter Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw Hill Book Company, 1976
3. Apostol T. M., Calculus Vol. I, Vol. II, 2nd edition, Wiley India Pvt. Ltd., 2022
4. Fleming W., Functions of several variables, 2nd edition, Springer Verlag, 1977.

Evaluation Pattern: (60:40)

Total Marks: 100

Internal Continuous Evaluation (40 Marks):

- CCE - I: 20 Marks: Activity
- CCE - II: 20 Marks: Activity
- CCE - III: 20 Marks: Objective

(The Best of two will be considered for the final mark entry)

End Semester Examination (60 Marks):

1. **Question No. 1 is compulsory.**
2. **Attempt any four questions from question numbers 2 to 7.**

Q.1 Define the following terms $[6 \times 2 = 12]$

Q.2 Long Answer Questions $[2 \times 6 = 12]$

Q.3 Long Answer Questions $[2 \times 6 = 12]$

Q.4 Long Answer Questions $[2 \times 6 = 12]$

Q.5 Short Answer Question $[3 \times 4 = 12]$

Q.6 Short Answer Question $[3 \times 4 = 12]$

Q.7 Short Answer Question $[3 \times 4 = 12]$

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VII
Type: Major	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 473 Real Analysis

Course Objectives: By the end of the course, students should be able to……

1. study Lebesgue outer Measure and Lebesgue Measurable Sets.
2. understand Lebesgue Measurable functions and properties.
3. acquire the concept of Lebesgue Integration.
4. learn norm linear space and inequalities.

Course Outcomes: By the end of the course, students will be able to……

1. understand the properties of Lebesgue measurable sets.
2. demonstrate the measurable functions and properties.
3. characterize Riemann and Lebesgue integrability.
4. derive completeness of normed linear spaces.

Module	Title and Contents	Hrs.
Module - 1:	**Lebesgue Measurable Sets** 1.1 Open Sets, Closed Sets and Borel sets 1.2 Lebesgue Outer measure 1.3 The sigma Algebra of Lebesgue Measurable Sets 1.4 Countable Additivity 1.5 Continuity and Borel-Cantelli Lemma 1.6 Non-measurable Sets.	15
Module - 2:	**Lebesgue Measurable Functions** 2.1 Sums, Product and Composition of Measurable Functions 2.2 Sequential Pointwise limits and simple Approximation 2.3 Littlewood's Three Principles 2.4 Egoroff's theorem and Lusin's Theorem Lebesgue Integration of a Bounded Measurable Function 2.5 Lebesgue Integration of a non- negative Measurable function	15
Module - 3:	**General Lebesgue Integral and Differentiation** 3.1 The General Lebesgue Integral 3.2 Characterization of Riemann and Lebesgue Integrability 3.3 Differentiability of Monotone Functions 3.4 Lebesgue's Theorem 3.5 Functions of Bounded Variations: Jordan's theorem.	15
Module - 4:	**Absolute Continuity and L^p Spaces** 4.1 Absolutely Continuous Functions 4.2 Integrating Derivatives: Differentiating Indefinite Integrals 4.3 Inequalities of Young, Holder and Minkowski	15

	4.4 The Riesz- Fischer Theorem.	

Reference Books:

1. Rana I. K., An Introduction to Measure and Integration, Narosa Book Company, 1997.
2. Jain P. K., Gupta V. P., Lebesgue measure and Integration, Wiley Easter Limited, 1986.
3. Barra G. de., Measure Theory and Integration, New Age International (P) Ltd., 1981.
4. Berberian S. K., Measure and Integration, McMillan, New York, 1965.
5. Rudin W., Principles of Mathematical Analysis, McGraw-Hill Book Co, 1964.
6. Halmos P. K., Measure Theory, Vas Nostrand, 1950.

Evaluation Pattern: (60:40)

Total Marks: 100

Internal Continuous Evaluation (40 Marks):

- CCE - I: 20 Marks: Activity
- CCE - II: 20 Marks: Activity
- CCE - III: 20 Marks: Objective

(The Best of two will be considered for the final mark entry)

End Semester Examination (60 Marks):

1. **Question No. 1 is compulsory.**
2. **Attempt any four questions from question numbers 2 to 7.**

Q.1 Define the following terms $[6 \times 2 = 12]$

Q.2 Long Answer Questions $[2 \times 6 = 12]$

Q.3 Long Answer Questions $[2 \times 6 = 12]$

Q.4 Long Answer Questions $[2 \times 6 = 12]$

Q.5 Short Answer Question $[3 \times 4 = 12]$

Q.6 Short Answer Question $[3 \times 4 = 12]$

Q.7 Short Answer Question $[3 \times 4 = 12]$

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Programme: B.Sc. Honors	**Semester** – VII
Type: Major (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 474 Classical Mechanics (E – I)

Course Objectives: By the end of the course, students should be able to……

1. understand conservative force and D'Alembert's Principle.
2. study Geodesics in a plane and space to find maximum and minimum enclosed area.
3. get the concept of Hamiltonian function and Routh's procedure.
4. learn Kinematics of rigid body motion.

Course Outcomes: By the end of the course, students will be able to……

1. discuss the motion of system of particles using Lagrangian and Hamiltonian approach.
2. solve extremization problems using variational calculus.
3. construct Hamiltonian using Routh Process.
4. use infinitesimal and finite rotations to analyze motion of rigid body.

Module	Title and Contents	Hrs.
Module - 1:	**Lagrange's Formulation** 1.1 Mechanics of a particle, Mechanics of a system of particles, Conservation theorems, and constraints 1.2 Degrees of freedom, Generalized coordinates, Conservative force, and Generalized velocity 1.3 D'Alembert's Principle, and Lagrange's equations of motion 1.4 Kinetic energy as a homogeneous function of generalized velocities, Cyclic coordinates and generalized momentum, and Conservation theorems	08
Module - 2:	**Variational Principles** 2.1 Functionals 2.2 Basic lemma in calculus of variations 2.3 Euler-Lagrange's equations 2.4 The problem of Brachistochrone 2.5 Isoperimetric problems.	06
Module - 3:	**Hamilton's Principle and Hamilton's Formulation** 3.1 Hamilton's Principle for conservative and non-conservative systems 3.2 Derivation of Hamilton's principle from D'Alembert's principle 3.3 Hamiltonian function 3.4 Hamilton's canonical equations of motion 3.5 Physical significance of Hamiltonian 3.6 The principle of least action 3.7 Cyclic co-ordinates and Routh's procedure.	08
Module - 4:	**The Kinematics of a Rigid Body Motion** 4.1 Rigid body, Generalized co-ordinates of rigid body, Orthogonal	08

	transformation, and Infinitesimal Rotation 4.2 Euler's theorem, Eulerian Angles, Moment of Inertia, and Euler's Equation of Motion 4.3 Cayley- Klein parameters, Matrix of transformation in Cayley- Klein parameters 4.4 Relations between Eulerian angles and Cayley- Klein parameters	

Reference Books:

1. Goldstein H., Classical Mechanics, Narosa Publishing House, New Delhi,1997.
2. Rana N. C. and Jog P. S., Classical Mechanics, Tata McGraw, Hill, 1992.
3. Gupta A. S., Calculus of Variations with Applications, Prentice Hall of India, 1997.
4. Weinstock R., Calculus of Variations with Applications to Physics and Engineering (International Series in Pure and Applied Mathematics), Mc Graw Hill Book Company, New York, 1952.
5. Whittaker E. T., A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, Cambridge University Press, 1965.

Evaluation Pattern: (60:40)

Total Marks: 50

Internal Continuous Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any two questions from question numbers 2 to 4.** Q.1 Define the following terms $[5 \times 2 = 10]$ Q.2 Long Answer Questions $[2 \times 5 = 10]$ Q.3 Long Answer Questions $[2 \times 5 = 10]$ Q.4 Long Answer Questions $[2 \times 5 = 10]$

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Programme: B.Sc. Honors	**Semester** – VII
Type: Major (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 475 Graph Theory (E – II)

Course Objectives: By the end of the course, students should be able to……

1. understand and apply fundamental concepts in Graph theory.
2. study the methods for characterizing distributive lattices.
3. learn graph theory-based tools in solving practical problems
4. acquire applications of graph theory to practical problems and other branches of Mathematics

Course Outcomes: By the end of the course, students will be able to……

1. explain trees and connectivity and its properties.
2. determine whether graph is Hamiltonian or planar.
3. solve problems using vertex and edge coloring.
4. construct models of real word problem using graph theory.

Module	Title and Contents	Hrs.
Module - 1:	**Trees and connectivity** 1.1 Definitions and simple properties, Bridges, and spanning trees 1.2 Cut vertices and Connectivity 1.3 Euler Tours: Euler graphs, and Properties of Euler graph 1.4 The Chinese postman problem	08
Module - 2:	**Hamiltonian Graphs and Matchings** 2.1 2.1 Hamiltonian Cycles, and Hamiltonian graphs 2.2 The travelling salesman problem 2.3 Matching's and Augmenting path 2.4 The marriage problem, and The Personal Assignment problem	07
Module - 3:	**Assignment and Planar Graphs** 3.1 The Optimal Assignment problem 3.2 A Chinese postman Problem 3.3 Postscript 3.4 Planer Graphs: Plane and Planar graphs 3.5 Euler's formula 3.6 Platonic bodies Kurotowski's theorem 3.7 Non-Hamiltonian plane Graphs 3.8 The dual of a plane graph	08
Module - 4:	**Graph Coloring and Networks** 4.1 Vertex coloring, vertex coloring algorithms, critical graphs, and cliques 4.2 Edge coloring, Map coloring, and Directed graphs: Definition 4.3 Indegree and outdegree, Tournaments, and traffic flow 4.4 Networks: Flows and Cuts	07

	4.5 The Ford and Fulkerson Algorithm 4.6 Separating seen	

Reference Books:

1. John Clark and Derek Holton, A first look at graph theory, World Scientific Publishing Co Pt Ltd, 1991.
2. West Douglas B., Introduction to Graph Theory,2nd Edition, Pearson Education Asia, 2001.
3. Parthasarathy K. R., Basic Graph Theory, Tata McGraw Hill publishing Co. Ltd. New Delhi,1994.
4. Harary F., Graph Theory, Narosa Publishing House 1989.

Evaluation Pattern: (60:40)

Total Marks: 50

Internal Continuous Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any two questions from question numbers 2 to 4.** Q.1 Define the following terms $[5 \times 2 = 10]$ Q.2 Long Answer Questions $[2 \times 5 = 10]$ Q.3 Long Answer Questions $[2 \times 5 = 10]$ Q.4 Long Answer Questions $[2 \times 5 = 10]$

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Programme: B.Sc. Honors	**Semester** – VII
Type: RM	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course and Code: BMTRM 476 Research Methodology

Course Objectives: By the end of the course, students should be able to……

1. learn fundamental principles and techniques of conducting research in mathematics.
2. understand various research methods and approaches used in mathematics research, such as experimental, theoretical, and computational methods.
3. gain the knowledge of different types of mathematical proofs, their structure, and their role in mathematical research.
4. study methods to conduct literature reviews, analyze existing mathematical research, and identify gaps or areas for further investigation.

Course Outcomes: By the end of the course, students will be able to……

1. explain the fundamental principles and theories underlying mathematical research.
2. apply mathematical writing techniques to effectively communicate complex ideas and results.
3. analyze existing mathematical research publications to identify the research question, methodology, and main findings.
4. evaluate the accuracy, reliability, and validity of the results obtained using research tools and techniques.

Module	Title and Contents	Hrs.
Module - 1:	**Fundamentals of Research** 1.1 Aims and objectives of research 1.2 Types of research: basic, novel and applied research 1.3 Tools for searching research topic: books, journals, internet, discussions etc. 1.4 Research hypothesis 1.5 Steps in research design	06
Module - 2:	**Mathematical Writing** 2.1 Mathematical Writing: What Is a Theorem? Proofs, and The Role of Examples 2.2 Definitions, Notation, and Words versus Symbols 2.3 Displaying Equations, Parallelism, and Dos and Don'ts of Mathematical Writing 2.4 Writing a Paper: Audience, Organization and Structure 2.5 Title, Author List, Date, Abstract, Key Words and Subject Classifications 2.6 The Introduction, Review of Literature, and Computational Experiments 2.7 Tables, Citations, Conclusions, and Acknowledgements 2.8 Appendix, Reference List, Specifics and Deprecated Practices 2.9 Revising a Draft: How to Revise, Examples of Prose, and Examples Involving Equations 2.10 Examples from My Writing, A Revised Proof, and A Draft Article for Improvement	09

Module - 3:	**Research Publication** 3.1 Publishing a Paper: Choosing a Journal, submitting a Manuscript, and The Refereeing Process 3.2 How to Referee, The Role of the Copy Editor, Checking the Proofs, and Copyright Issues 3.3 SIAM Journal Article: A case study 3.4 Writing and defending a thesis: The Purpose of a Thesis, Content, Presentation, and The Thesis Defense 3.5 Quality indices of research publication: impact factor, H-index, and science citation index	08
Module - 4:	**Research Tools and Techniques** 4.1 Latex: Basics of LaTeX, simple typesetting, fonts, type size, document class, page style, page numbering, and parts of document 4.2 Tables in LaTeX, typesetting mathematics: custom commands, symbols, equations, operators, etc., and Cross references in LaTeX 4.3 Scilab: Introduction, installation, the console, the editor, using exec, and basic elements of language 4.4 Matrices and matrix operations, Looping and branching, functions, and plotting in Scilab	07

Reference Books:

1. Carol Ellison, Concise Guide to Writing Research Papers, McGraw Hill, New York, 2010.
2. Kothari C. R., Research Methodology, 2nd revised edition, New Age International Publishers Pvt. Ltd., New Delhi, 2004.
3. Kaltenborn K. F. and Kuhn K, The journal impact factor as a parameter for the evaluation of researchers and research, Revista Espanola de Enfermedades Digestivas, 96(7), (2004), 460-476.
4. Steven G. Krantz, A Primer of Mathematical Writing, University Press Hyderabad, 1998. https://arxiv.org/pdf/1612.04888.pdf
5. Stegmann J., How to evaluate journal impact factors, Nature, 390(6660), (1997), 550-550.
6. Higham Nicholas J., Handbook of writing for the mathematical sciences, SIAM, 1961.
7. Hirsch J. E., An index to quantify an individual's scientific research output, https://arxiv.org/abs/physics/0508025
8. Latex Tutorials: A Primer, Indian Tex Users Group, http://sarovar.org/projects/ltxprimer ; http://www.tug.org.in/tutorials.html
9. Michael Baudin, Introduction to Scilab, www.scilab.org/content/download/247/1702/file/introscilab.pdf

Evaluation Pattern: (60:40)

Total Marks: 50

Internal Continuous Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any two questions from question numbers 2 to 4.** Q.1 Define the following terms $[5 \times 2 = 10]$ Q.2 Long Answer Questions $[2 \times 5 = 10]$ Q.3 Long Answer Questions $[2 \times 5 = 10]$ Q.4 Long Answer Questions $[2 \times 5 = 10]$

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Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VII
Type: Major Practical	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code & Code: BMP 477 LAB IX

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. understand algebra of linear transformation.
2. acquire the concept of Hermitian and self-adjoint linear transformation.
3. learn pointwise and uniform convergence of sequence of functions.
4. describe Lebesgue Measurable functions and properties.

Course Outcomes: By the end of the course, students will be able to……

1. determine the properties of linear transformation and inner product spaces.
2. apply basic notions in Linear Algebra and use the results in developing advance mathematics.
3. analyze differentiability of functions of several variables.
4. explain the properties of Lebesgue measurable sets.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Direct sum of a vector space	60
2.	Annihilator of a subspace	
3.	Eigen values and Eigen Vectors of a Linear Transformation	
4.	Diagonalization	
5.	Canonical forms	
6.	Similarity of Linear transformations	
7.	Invariants of Linear transformations	
8.	Pointwise Convergence of Sequence of Functions	
9.	Uniform Convergence of Sequence of Functions	
10.	Double Sequence	
11.	Real Power series	
12.	Directional Derivative and Continuity	
13.	Matrix of linear function	
14.	Open Sets, Closed Sets and Borel sets	
15.	Lebesgue Outer measure	
16.	Non-measurable Sets	
17.	Sums, Product and Composition of Measurable Functions	
18.	Lebesgue Integration	
19.	Functions of Bounded Variations	
20.	Differentiating Indefinite Integrals	

Reference Books:

1. Herstein I. N., Topics in Algebra, 2nd edition, Wiley Eastern Limited, 1975.
2. Kenneth Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India Pvt. Ltd., 1971.
3. A. R. Rao and P. Bhimashankaran, Linear Algebra, Hindustan Book Agency, 2000
4. Apostol, Mathematical Analysis, 2nd edition, Narosa Publishing House, 1974
5. Walter Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw Hill book company, 1976
6. Apostol T. M., Calculus Vol. I, Vol. II, 2nd edition, Wiley India Pvt. Ltd., 2022
7. Fleming W., Functions of several variables, 2nd edition, Springer Verlag, 1977.
8. Rana I. K., An Introduction to Measure and Integration, Narosa Book Company, 1997.
9. Jain P. K., Gupta V. P., Lebesgue measure and Integration, Wiley Easter Limited, 1986.
10. Barra G. de., Measure Theory and Integration, New Age International (P) Ltd., 1981.
11. Berberian S. K., Measure and Integration, McMillan, New York, 1965.
12. Rudin W., Principles of Mathematical Analysis, McGraw-Hill Book Co, 1964.

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VII
Type: Major Practical (Elective)	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code: BMP 478 LAB X (E – I)

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. recall fundamental concepts of conservative forces and D'Alembert's Principle.
2. solve problems using Lagrange's equations of motion and variational principles.
3. calculate geodesics for given surfaces using the Euler-Lagrange equation.
4. apply the matrix of transformation in Cayley-Klein parameters to practical examples.

Course Outcomes: By the end of the course, students will be able to……

1. apply the concept to set up the equations of motion for a given system.
2. solve isoperimetric problems using appropriate techniques from calculus of variations.
3. formulate the equations of motion for novel mechanical systems using Lagrange's, Hamilton's and Routhian approach.
4. implement Cayley-Klein parameters to solve rotation transformation problems.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Examples on Conservative force.	60
2.	Examples based on D' Alembert's Principle.	
3.	Simple applications of Lagrangian formulation.	
4.	Applications of Lagrange's equation of motion-I.	
5.	Applications of Lagrange's equation of motion-II.	
6.	Geodesics on a Plane	
7.	Geodesics on a Surface	
8.	Examples on Euler-Lagrange's equations-I.	
9.	Examples on Euler-Lagrange's equations-II.	
10.	The case of several dependent variables undetermined end conditions and examples on it.	
11.	The Brachistochrone problem.	
12.	The Isoperimetric problems.	
13.	Problem of maximum enclosed area.	
14.	Calculating Variations of Functionals	
15.	Examples based on Hamilton's principle	
16.	Problems on Hamiltonian and Hamilton's canonical equation of motion-I	
17.	Problems on Hamiltonian and Hamilton's canonical equation of motion-II	
18.	Examples on Lagrangian, Hamiltonian and Routhian.	
19.	Examples on Infinitesimal Rotation.	
20.	Angular velocity and Orthogonal transformations.	

Reference Books:

1. Goldstein H., Classical Mechanics, Narosa Publishing House, New Delhi,1997.
2. Rana N. C. and Jog P. S., Classical Mechanics, Tata McGraw, Hill, 1992.
3. Gupta A. S., Calculus of Variations with Applications, Prentice Hall of India, 1997.
4. Weinstock R., Calculus of Variations with Applications to Physics and Engineering (International Series in Pure and Applied Mathematics), Mc Graw Hill Book Company, New York, 1952.
5. Whittaker E. T., A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, Cambridge University Press, 1965.

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VII
Type: Major Practical (Elective)	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code: BMP 478 LAB X (E – II)

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. understand planar graphs, graph coloring, and directed graphs using practical approaches.
2. develop understanding of fundamental concepts and structures in graph theory.
3. develop analytical and computational skills for solving network flow and graph-related problems.
4. study trees, connectivity, Eulerian and Hamiltonian graphs through practical applications.
5. apply graph theoretic techniques in optimization and assignment problems.

Course Outcomes: By the end of the course, students will be able to……

1. construct and analyse trees, spanning trees, and connected graphs.
2. identify Eulerian and Hamiltonian properties and solve related graph problems.
3. apply matching and assignment methods to real-life optimization problems.
4. examine planar graphs, graph colouring techniques, and dual graphs.
5. analyse directed graphs and solve network flow problems using standard algorithms such as Ford–Fulkerson Algorithm.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Basic properties of graphs and degree sequence	60
2.	Construction and identification of different types of trees	
3.	Spanning trees of a connected graph	
4.	Determination of bridges and cut vertices in a graph	
5.	Verification of connectivity and components of graphs	
6.	Construction and analysis of Euler graphs	
7.	Euler paths and Euler circuits in graphs	
8.	Application of Euler graph concepts to the Chinese Postman Problem	
9.	Determination of Hamiltonian paths and Hamiltonian cycles	
10.	Verification of properties of Hamiltonian graphs	
11.	Simple Travelling Salesman Problems using graphs	
12.	Construction of matchings in bipartite graphs	
13.	Maximum matching using augmenting paths	
14.	Solution of the Marriage Problem using bipartite graphs	
15.	Solution of Personnel Assignment Problems using graph theoretic methods	
16.	Applications of matching theory in optimization problems	
17.	Optimal Assignment Problems using graph methods	
18.	Construction of duals of plane graphs	
19.	Vertex coloring of graphs using coloring algorithms	

20.	Edge coloring and map coloring of planar graphs	

Reference Books:

1. John Clark and Derek Holton, A first look at graph theory, World Scientific Publishing Co Pt Ltd, 1991.
2. West Douglas B., Introduction to Graph Theory,2nd Edition, Pearson Education Asia,2001.
3. Parthsarthy K. R., Basic Graph Theory, Tata McGraw Hill publishing Co. Ltd. New Delhi,1994.
4. Harary F., Graph Theory, Narosa Publishing House 1989.

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

Karmaveer Bhaurao Patil University, Satara

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VII
Type: RM Practical	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code: BMPRM 479 RM Practical

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. develop understanding of research methodology, ethics, and problem identification in mathematics.
2. enhance mathematical writing and scientific communication skills using standard academic practices.
3. train students in preparation, presentation, and publication of research papers and theses.
4. provide practical exposure to research tools such as LaTeX and Scilab for mathematical documentation and computation.

Course Outcomes: By the end of the course, students will be able to……

1. explain the basic concepts, methods, and ethics involved in mathematical research.
2. apply principles of mathematical writing for preparing research articles, reports, and theses.
3. analyze research publications using citation indices, impact factor, and peer review processes.
4. use LaTeX and Scilab tools for mathematical typesetting, computation, and graphical representation.
5. design and prepare research-oriented documents following standard academic and publication practices.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Identification and selection of a research problem	60
2.	Preparation of research objectives and hypothesis	
3.	Study of different types of research methodologies	
4.	Literature survey using books, journals, and online resources	
5.	Preparation of a research design framework	
6.	Writing mathematical definitions and statements of theorems	
7.	Preparation of proofs using proper mathematical writing style	
8.	Use of mathematical symbols and notation in technical writing	
9.	Drafting of abstract, keywords, and introduction of a research paper	
10.	Preparation of tables, citations, and bibliography in mathematical writing	
11.	Writing review of literature and conclusion sections	
12.	Revision and editing of a mathematical research draft	
13.	Identification and selection of suitable journals for publication	
14.	Preparation and submission of a manuscript for publication	
15.	Study of the refereeing and peer review process	
16.	Analysis of impact factor, H-index, and citation indices	
17.	Preparation and presentation of a thesis synopsis	
18.	Typesetting mathematical documents using LaTeX	
19.	Creation of mathematical equations, tables, and cross references in LaTeX	
20.	Matrix operations, programming, and plotting using Scilab	

Reference Books:

1. Carol Ellison, Concise Guide to Writing Research Papers, McGraw Hill, New York, 2010.
2. Kothari C. R., Research Methodology, 2nd revised edition, New Age International Publishers Pvt. Ltd., New Delhi, 2004.
3. Kaltenborn K. F. and Kuhn K, The journal impact factor as a parameter for the evaluation of researchers and research, Revista Espanola de Enfermedades Digestivas, 96(7), (2004), 460-476.
4. Steven G. Krantz, A Primer of Mathematical Writing, University Press Hyderabad, 1998. https://arxiv.org/pdf/1612.04888.pdf
5. Stegmann J., How to evaluate journal impact factors, Nature, 390(6660), (1997), 550-550.
6. Higham Nicholas J., Handbook of writing for the mathematical sciences, SIAM, 1961.
7. Hirsch J. E., An index to quantify an individual's scientific research output, https://arxiv.org/abs/physics/0508025
8. Latex Tutorials: A Primer, Indian Tex Users Group, http://sarovar.org/projects/ltxprimer ; http://www.tug.org.in/tutorials.html
9. Michael Baudin, Introduction to Scilab, www.scilab.org/content/download/247/1702/file/introscilab.pdf

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

SEMESTER – VIII

Karmaveer Bhaurao Patil University, Satara

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Faculty of Science and Technology

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Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VIII
Type: Major	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 481 Algebra

Course Objectives: By the end of the course, students should be able to……

1. learn some special groups and their properties.
2. study group action on a set and its applications.
3. understand ring of polynomials, UFD and PID.
4. obtain information about modules and its properties.

Course Outcomes: By the end of the course, students will be able to……

1. introduce and discuss module structure over a ring.
2. check irreducibility of polynomials over Q using Eisenstein criterion.
3. use homomorphism and isomorphism theorems.
4. apply Sylow theorems on p-groups.

Module	Title and Contents	Hrs.
Module - 1:	**Advanced Group Theory** 1.1 Simple groups, simplicity of A_n $(n > 5)$, and Commutator subgroups 1.2 Normal subgroup and subnormal series, and Jordan-Holder theorem 1.3 Solvable groups, and isomorphism theorems 1.4 Zassenhaus Lemma, and Schreier refinement theorem	15
Module - 2:	**Group Actions and Their Applications** 2.1 Group Action on a set, isometry subgroups, and Burnside theorem 2.2 Sylow's theorems, and p-groups 2.3 Class equation and applications	15
Module - 3:	**Polynomial Rings and their Ideals** 3.1 Rings of polynomials, Factorization of polynomials over fields, and irreducible polynomials 3.2 Eisenstein criterion, and ideals in $F[x]$ 3.3 Unique factorization domain, and principle ideal domain 3.4 Gauss lemma, and Euclidean Domain	15
Module - 4:	**Modules and Homomorphisms** 4.1 Modules, sub-modules, and quotient modules 4.2 Homomorphism and isomorphism theorems 4.3 Fundamental theorem for modules	15

Reference Books:

1. Fraleigh John B., A first course in Abstract Algebra, 3rd edition, Narosa Publishing house, New Delhi, 1982

2. Musili C., Introduction to Rings and Modules, 2nd revised edition, Narosa Publishing House, New Delhi, 1994
3. Jacobson N., Basic Algebra, Hind Publishing Corporation, 1984.
4. Gallian Joseph A., Contemporary Abstract Algebra, 4th edition, Narosa Publishing House, New Delhi, 1999
5. Bhattacharya, Jain and Nagpal, Basic Abstract Algebra, 2nd edition, Narosa Publishing House, New Delhi, 1995

Evaluation Pattern: (60:40)

Total Marks: 100

Internal Continuous Evaluation (40 Marks):

- CCE - I: 20 Marks: Activity
- CCE - II: 20 Marks: Activity
- CCE - III: 20 Marks: Objective

(The Best of two will be considered for the final mark entry)

End Semester Examination (60 Marks):

1. **Question No. 1 is compulsory.**
2. **Attempt any four questions from question numbers 2 to 7.**

Q.1 Define the following terms $[6 \times 2 = 12]$

Q.2 Long Answer Questions $[2 \times 6 = 12]$

Q.3 Long Answer Questions $[2 \times 6 = 12]$

Q.4 Long Answer Questions $[2 \times 6 = 12]$

Q.5 Short Answer Question $[3 \times 4 = 12]$

Q.6 Short Answer Question $[3 \times 4 = 12]$

Q.7 Short Answer Question $[3 \times 4 = 12]$

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Programme: B.Sc. Honors	**Semester** – VIII
Type: Major	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 482 Topology

Course Objectives: By the end of the course, students should be able to……

1. study Topological spaces and their geometric properties.
2. learn homeomorphic topological spaces.
3. describe compact and connected spaces.
4. acquire the concept of completely regular and completely normal spaces.

Course Outcomes: By the end of the course, students will be able to……

1. explain fundamental concepts in topological spaces.
2. use properties of connected and compact spaces.
3. classify various topological spaces using properties.
4. apply Urysohn Lemma and Urysohn Metrization theorem.

Module	Title and Contents	Hrs.
Module - 1:	**Topologies, Bases, and Neighborhoods** 1.1 Topological Spaces, Examples, Open Sets, closed sets 1.2 Neighborhoods, Bases, Subbases 1.3 Limit Points, Closer Interior 1.4 Various ways of defining topologies 1.5 Hereditary properties	15
Module - 2:	**Continuity, Compactness, and Connectedness** 2.1 Continuous functions, homeomorphisms, 2.2 Topological properties 2.3 Compact spaces, connected spaces, connected subspaces of real lines 2.4 Components, separation axioms T0, T1, and T2 axioms	15
Module - 3:	**Advanced Topological Properties and Products** 3.1 First and second axioms spaces, Separable Spaces, Lindelöf spaces 3.2 Regular and normal Spaces 3.3 Product Spaces (For T0, T1, T2 Compact and Connected)	15
Module - 4:	**Functions on Topological Spaces and Metrization** 4.1 Completely regular and completely normal Spaces 4.2 Urysohn Lemma 4.3 Urysohn Metrization theorem	15

Reference Books:

1. Munkers J. R., Topology, 2nd edition, Pearson Education (Singapore), 2000.
2. Joshi K. D., Introduction to General Topology, New Age International, 1983.
3. Willard S., General Topology, Addition-Wesley Publishing Company,1970.
4. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw Hill Book Company, New

Delhi, 1963.
5. Kelley J. L., General Topology, Springer-Verlag, New York, 1955.

Evaluation Pattern: (60:40)

Total Marks: 100

Internal Continuous Evaluation (40 Marks):	**End Semester Examination (60 Marks):**
• CCE - I: 20 Marks: Activity • CCE - II: 20 Marks: Activity • CCE - III: 20 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any four questions from question numbers 2 to 7.** Q.1 Define the following terms $[6 \times 2 = 12]$ Q.2 Long Answer Questions $[2 \times 6 = 12]$ Q.3 Long Answer Questions $[2 \times 6 = 12]$ Q.4 Long Answer Questions $[2 \times 6 = 12]$ Q.5 Short Answer Question $[3 \times 4 = 12]$ Q.6 Short Answer Question $[3 \times 4 = 12]$ Q.7 Short Answer Question $[3 \times 4 = 12]$

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Programme: B.Sc. Honors	**Semester** – VIII
Type: Major	**Marks:** 100
Credits: 4	**From:** A. Y. 2025-26

Name of the Course and Code: BMT 483 Complex Analysis

Course Objectives: By the end of the course, students should be able to……

1. study power series and its properties.
2. learn Analytical functions and examples on it.
3. understand Laurent series and classification of singularities.
4. acquire the concept of conformal maps and discuss Riemann Mapping Theorem.

Course Outcomes: By the end of the course, students will be able to……

1. compute region of convergence of Power Series.
2. evaluate complex integration along the curve via Cauchy's theorem and integral formula.
3. derive the Cauchy residue theorem and apply it to several kinds of real integrals.
4. construct conformal maps and apply its properties.

Module	Title and Contents	Hrs.
Module - 1:	**Fundamentals of Complex Analysis** 1.1 Power series, Radius of convergence 1.2 Bilinear Transformation 1.3 Analytic functions 1.4 Cauchy's- Riemann equations 1.5 Harmonic functions 1.6 Power series representation of analytic functions	15
Module - 2:	**Global Properties of Analytic Functions** 2.1 Zeros of Analytic functions 2.2 Cauchy's theorem 2.3 Morera's theorem 2.4 Cauchy's Integral formula, Cauchy's inequality 2.5 Liouville's Theorem 2.6 Fundamental theorem of algebra 2.7 Maximum modulus theorem 2.8 Open mapping theorem	15
Module - 3:	**Residue Theory and Its Applications** 3.1 Laurent series expansion theorem 3.2 Cauchy residue theorem 3.3 Classification of singularities 3.4 Evaluation of integral 3.5 The argument principle 3.6 Rouche's theorem	15

Module - 4:	**Advanced Complex Mappings** 4.1 Conformal maps 4.2 Normal families 4.3 Hurwitz theorem 4.4 Riemann mapping theorem	15

Reference Books:

1. Ponnusamy S., Foundations of Complex Analysis, 2nd edition, Narosa Publication House, 2015.
2. Brown J. and Churchill R., Complex Variables and Applications, 8th edition, McGraw Hill India, 2014.
3. Ponnusamy S. and Silverman H., Complex Variables and Applications, Birkhauser Boston, 2006.
4. Serge Lang, Complex Analysis, 4th edition, Springer, 1999.
5. Alfors L. V., Complex Analysis, McGraw Hill, 1979.

Evaluation Pattern: (60:40)

Total Marks: 100

Internal Continuous Evaluation (40 Marks):

- CCE - I: 20 Marks: Activity
- CCE - II: 20 Marks: Activity
- CCE - III: 20 Marks: Objective

(The Best of two will be considered for the final mark entry)

End Semester Examination (60 Marks):

1. **Question No. 1 is compulsory.**
2. **Attempt any four questions from question numbers 2 to 7.**

Q.1 Define the following terms $[6 \times 2 = 12]$

Q.2 Long Answer Questions $[2 \times 6 = 12]$

Q.3 Long Answer Questions $[2 \times 6 = 12]$

Q.4 Long Answer Questions $[2 \times 6 = 12]$

Q.5 Short Answer Question $[3 \times 4 = 12]$

Q.6 Short Answer Question $[3 \times 4 = 12]$

Q.7 Short Answer Question $[3 \times 4 = 12]$

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Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VIII
Type: Major (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 484 Differential Geometry (E – I)

Course Objectives: By the end of the course, students should be able to……

1. study Euclidean space, curves and their properties.
2. learn the Frenet Formulae & Frenet approximation of curves.
3. understand co-ordinate Patches, fundamental forms of a surface.
4. acquire concepts of the Shape operator, Asymptotic and Geodesic Curves.

Course Outcomes: By the end of the course, students will be able to……

1. understand fundamental notions in Euclidean Space.
2. evaluate Frenet formulae for unit speed curve and arbitrary speed curve.
3. apply coordinate patches for identification of surfaces.
4. formulate shape operator for evaluation of Principal and Normal curvatures.

Module	Title and Contents	Hrs.
Module -1:	**Vector Fields and Curves in $\mathbb{R}^3$** 1.1 Vector Space, Euclidean Space in $\mathbb{R}^3$ 1.2 Tangent Vectors and vector fields, Frame fields, and Natural Frame Fields 1.3 Directional Derivatives, 1.4 Curve in $\mathbb{R}^3$ and reparameterization of curves 1.5 Standard curves, Speed of curve, length of curve 1.6 1-forms, and differential forms	08
Module -2:	**Advanced Curve Theory and Transformations** 2.1 The Frenet Formulae for unit speed curve 2.2 Frenet approximation of curves 2.3 Arbitrary Speed Curves, and Frenet formulae for arbitrary speed curves 2.4 Co-variant Derivative 2.5 Isometries in $\mathbb{R}^3$ 2.6 Orthogonal Transformations	07
Module -3:	**Parameterization and Geometry of Surfaces** 3.1 Co-ordinate Patches 3.2 Surface in $\mathbb{R}^3$, Simple Surface, Cylinder Surface 3.3 Surface of Revolution and parameterization of a region 3.4 parameterization of a cylinder and surface of revolution 3.5 Smooth overlapping patches 3.6 Tangent and normal vector fields on a surface	07
Module -4:	**The Shape Operator and Curvature** 4.1 The Shape operator of surface M in $\mathbb{R}^3$	08

	4.2 Normal curvature, Principal curvature 4.3 Gaussian and mean curvatures, Umbilic Points 4.4 Fundamental forms of a surface 4.5 Computational Techniques 4.6 Special curves on surface 4.7 Asymptotic and Geodesic Curves	

Reference Books:

1. Joel W. Robbin and Dietmar A. Salamon, Introduction to Differential Geometry, Springer, 2022.
2. Neill O', Elementary Differential Geometry, revised edition, B, Academic Press, 2006.
3. Somasundaram D., Differential Geometry- First Course, Narosa Publishing House, New Delhi, 2010.
4. Thomas F. Banchoff and Stephen Lovett, Differential Geometry of Curves and Surfaces (3rd Edition), CRC Press, 2024.

Evaluation Pattern: (60:40)

Total Marks: 50

Internal Continuous Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any two questions from question numbers 2 to 4.** Q.1 Define the following terms $[5 \times 2 = 10]$ Q.2 Long Answer Questions $[2 \times 5 = 10]$ Q.3 Long Answer Questions $[2 \times 5 = 10]$ Q.4 Long Answer Questions $[2 \times 5 = 10]$

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Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VIII
Type: Major (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course and Code: BMT 485 Lattice Theory

Course Objectives: By the end of the course, students should be able to……

1. explain the basic theories and equivalence of mathematical lattices.
2. analyze the methods used for characterizing distributive lattices.
3. examine pseudo-complemented lattices and their specific subsets.
4. acquire concept of ideals and filters in lattices.

Course Outcomes: By the end of the course, students will be able to……

1. understand the relation between Posets and Lattice.
2. describe the basic Properties and characterizations of Lattice.
3. apply the ideals and filters in lattices to solve the examples.
4. construct pseudo complemented lattices.

Module	Title and Contents	Hrs.
Module - 1:	**Fundamentals of Posets and Lattice Structures** 1.1 Posets, Definition and examples of posets 1.2 Definitions of lattices and their equivalence, examples of lattices, and description of Lattices 1.3 Some algebraic concepts 1.4 Duality principle, Special elements 1.5 Homomorphism, Isomorphism and isotone maps	08
Module - 2:	**Morphisms and Algebraic Properties of Lattices** 2.1 Distributive lattices – Properties and characterizations 2.2 Modular lattices – Properties and Characterizations 2.3 Congruence relations 2.4 Boolean algebras – Properties and characterizations	07
Module - 3:	**Special Classes of Lattices and Boolean Algebra** 3.1 Ideals and filters in lattices 3.2 Lattice of all ideals I(L) 3.3 Properties and characterizations of I(L) 3.4 Stone's theorem and its consequences of operators 3.5 Aggregation operations	08
Module - 4:	**Advanced Lattice Theory: Ideals, Filters and Stone Structures** 4.1 Pseudo complemented lattices 4.2 S(L) and D(L) – special subsets of pseudo complemented lattices 4.3 Distributive pseudo complemented lattice 4.4 Stone lattices – properties and Characterizations	07

Reference Books:

1. Birkhoff G., Amer, Lattice Theory Math. Soc. Coll. Publications, 3rd Edition, 1973.
2. George Gratzer, Freeman W. H., First concepts and distributive lattices by and company, San Francisco, 1971.
3. George Grätzer, Lattice Theory: A Brief Tour, Springer Nature Switzerland, 2026
4. Thomas Donnellan, Lattice Theory, Academic Publication, 2024

Evaluation Pattern: (60:40)

Total Marks: 50

Internal Continuous Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: Objective (The Best of two will be considered for the final mark entry)	**1. Question No. 1 is compulsory.** **2. Attempt any two questions from question numbers 2 to 4.** Q.1 Define the following terms $[5 \times 2 = 10]$ Q.2 Long Answer Questions $[2 \times 5 = 10]$ Q.3 Long Answer Questions $[2 \times 5 = 10]$ Q.4 Long Answer Questions $[2 \times 5 = 10]$

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Programme: B.Sc. Honors	**Semester** – VIII
Type: Major Practical	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code: BMP 486 LAB XI

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. strengthen understanding of abstract algebraic structures through computational and proof-based exercises.
2. develop skills in analysing group actions, Sylow theorems, and structural properties of groups.
3. build strong foundations in topology including continuity, compactness, and separation axioms.
4. develop analytical skills in complex analysis including integration, series expansion, and mapping techniques.

Course Outcomes: By the end of the course, students will be able to……

1. explain structural properties of groups, rings, modules, and topological spaces.
2. examine topological properties including compactness, connectedness, and separation axioms.
3. analyze algebraic structures such as rings of polynomials, UFD, PID, and module homomorphisms.
4. apply complex analysis theorems including Cauchy's theorem, residue theorem, and conformal mappings to evaluate integrals and mappings.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Finding commutator subgroup of a given group	60
2.	Construction of subnormal series of a group	
3.	Study of group actions on a set	
4.	Application of Sylow's theorems to find p-subgroups	
5.	Determination of isometry subgroups of geometric figures	
6.	Factorization of polynomials over fields	
7.	Reducible and irreducible polynomial over given field	
8.	Verification of irreducibility using Eisenstein criterion	
9.	Construction of modules and submodules over rings	
10.	Construction of different topologies	
11.	Identification of interior, closure, and limit points of sets in a topological space	
12.	Verification of continuity of functions between topological spaces	
13.	Verification of compactness and connectedness in topological spaces	
14.	Examination of separation axioms (T0, T1, T2) with examples	
15.	Verification of Cauchy–Riemann equations for analytic functions	
16.	Expansion of functions using power series and finding radius of convergence	
17.	Evaluation of integrals using Cauchy's integral formula	
18.	Application of residue theorem to evaluate complex integrals	

19.	Study of conformal mappings and bilinear transformations	
20.	Identification and classification of singularities of complex functions	

Reference Books:

1. Alfors L. V., Complex Analysis, McGraw Hill, 1979.
2. Bhattacharya, Jain, and Nagpal, Basic Abstract Algebra, 2nd edition, Narosa Publishing House, New Delhi, 1995
3. Brown J. and Churchill R., Complex Variables and Applications, 8th edition, McGraw Hill India, 2014.
4. Fraleigh, John B., A first course in Abstract Algebra, 3rd edition, Narosa Publishing House, New Delhi, 1982
5. Gallian Joseph A., Contemporary Abstract Algebra, 4th edition, Narosa Publishing House, New Delhi, 1999
6. Jacobson N., Basic Algebra, Hind Publishing Corporation, 1984.
7. Joshi K. D., Introduction to General Topology, New Age International, 1983.
8. Kelley J. L., General Topology, Springer-Verlag, New York, 1955.
9. Serge Lang, Complex Analysis, 4th edition, Springer, 1999. (Sorted by Lang)
10. Munkers J. R., Topology, 2nd edition, Pearson Education (Singapore), 2000.
11. Musili C., Introduction to Rings and Modules, 2nd revised edition, Narosa Publishing House, New Delhi, 1994
12. Ponnusamy S., Foundations of Complex Analysis, 2nd edition, Narosa Publication House, 2015.
13. Ponnusamy S. and Silverman H., Complex Variables and Applications, Birkhauser Boston, 2006.
14. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw Hill Book Company, New Delhi, 1963.
15. Willard S., General Topology, Addition-Wesley Publishing Company, 1970.

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VIII
Type: Major Practical (Elective)	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code: BMP 487 LAB XII (E – I)

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. understand the geometry of curves and surfaces focusing on their intrinsic properties and parameterizations.
2. study various curvatures and the shape operator, and to understand their roles in characterizing the local and global geometry of surfaces.
3. learn mathematical tools such as Frenet frames, covariant derivatives, and differential forms in the analysis and approximation of curves and surfaces.
4. acquire theoretical concepts in differential geometry with practical applications.

Course Outcomes: By the end of the course, students will be able to……

1. reparametrize curves with respect to arc length, compute speed functions, and use Frenet frames to analyze the geometry of curves.
2. use computational methods to calculate the shape operator, covariant derivatives, and wedge products of differential forms, applying these techniques to solve complex problems.
3. apply the concepts learned in differential geometry to practical problems in science and engineering, demonstrating the ability to connect theoretical insights with real-world applications.
4. compute normal, principal, Gaussian, and mean curvatures for various surfaces, and interpret these curvatures in the context of surface geometry.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Compute directional derivatives of scalar fields along specified directions.	60
2.	Reparametrize given curves with respect to arc length.	
3.	Calculate the speed function of parameterized curves.	
4.	Compute the arc length of curves over a specified interval.	
5.	Use wedge products to combine differential forms and compute results.	
6.	Compute the tangent, normal, and binormal vectors for a unit speed curve.	
7.	Approximate a given curve using its Frenet frame at a specific point.	
8.	Compute the speed function of an arbitrary speed curve and verify its unit speed reparameterization.	
9.	Derive the Frenet formulae for a curve parameterized by a non-unit speed parameter.	
10.	Compute covariant derivative for vector fields along a curve.	
11.	Map given coordinate patches onto specific surfaces in $\mathbb{R}^3$.	
12.	Examples of Surfaces in $\mathbb{R}^3$.	
13.	Generate a surface of revolution from a given curve.	
14.	Parameterize a rectangular region on the plane and map it to a surface.	

15.	Parameterize a circular region and map it to a surface.	
16.	Compute the shape operator for a plane, sphere and cylindrical surface.	
17.	Compute the normal curvature for a given direction on a surface.	
18.	Determine the principal curvatures and directions for a given surface.	
19.	Compute the Gaussian curvature and Mean Curvature for various surfaces.	
20.	Identify and analyze umbilic points on a surface.	

Reference Books:

1. Joel W. Robbin and Dietmar A. Salamon, Introduction to Differential Geometry, Springer, 2022.
2. Neill O', Elementary Differential Geometry, revised edition, B, Academic Press, 2006.
3. Somasundaram D., Differential Geometry- First Course, Narosa Publishing House, New Delhi, 2010.
4. Thomas F. Banchoff and Stephen Lovett, Differential Geometry of Curves and Surfaces (3rd Edition), CR Press, 2024.

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VIII
Type: Major Practical (Elective)	**Marks:** 50
Credits:2	**From:** A. Y. 2026-27

Name of the Course and Code: BMP 487 LAB XII (E – II)

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. develop conceptual and visual understanding of posets and lattice structures.
2. enable students to construct and analyse Hasse diagrams and lattice representations.
3. apply algebraic operations such as homomorphism, isomorphism, and isotone mappings.
4. explore properties of distributive, modular, and Boolean lattices through examples.
5. enhance logical reasoning and proof-writing skills in abstract algebraic structures.

Course Outcomes: By the end of the course, students will be able to……

1. Explain basic concepts of posets, lattices, and their representations using Hasse diagrams.
2. Construct and verify lattice structures and identify special elements in lattices.
3. Analyze homomorphisms, isomorphisms, and isotone mappings between lattices.
4. Examine properties of distributive, modular, and Boolean lattices through practical examples.

Practical No.	Contents (Any 15 of the following)	Hrs.
1.	Construction of partially ordered sets (posets) from given relations.	60
2.	Verification of poset properties (reflexive, antisymmetric, transitive).	
3.	Representation of posets using Hasse diagrams.	
4.	Identification of maximal and minimal elements in a poset.	
5.	Finding least upper bound (LUB) and greatest lower bound (GLB).	
6.	Verification of lattice structure from a given poset.	
7.	Construction of lattices from algebraic structures	
8.	Verification of duality principle in lattices.	
9.	Identification of special elements in lattices (identity, zero, complement).	
10.	Construction of homomorphisms between lattices.	
11.	Verification of isomorphism between two lattices.	
12.	Testing isotone (order-preserving) maps.	
13.	Study of algebraic properties of lattices through examples.	
14.	Verification of distributive lattice properties.	
15.	Testing modular lattice properties.	
16.	Construction and verification of Boolean algebra properties.	
17.	Identification of congruence relations in lattices.	
18.	Application of Boolean algebra in logical operations.	
19.	Construction of ideals and filters in lattices and verification of properties of I(L).	
20.	Study of pseudo-complemented lattices and Stone lattices with examples.	

Reference Books:

1. Birkhoff G., Amer, Lattice Theory Math. Soc. Coll. Publications, 3rd Edition, 1973.
2. George Gratzer, Freeman W. H., First concepts and distributive lattices by and company, San Francisco, 1971.
3. George Grätzer, Lattice Theory: A Brief Tour, Springer Nature Switzerland, 2026
4. Thomas Donnellan, Lattice Theory, Academic Publication, 2024

Evaluation Pattern: (60:40)

Total Marks: 50

End Semester Examination:

Internal Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students Performance: 05 Marks • Viva: 05 Marks	• Q.1) Answer the following questions. (Any Two) [2 X 10 = 20] • Q.2) Answer the following questions. (Any Two) [2 X 05 = 10]

Karmaveer Bhaurao Patil University, Satara

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Mathematics

Programme: B.Sc. Honors	**Semester** – VIII
Type: OJT	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27

Name of the Course and Code: BMPOJT 488 ON JOB TRAINING

Practical Batch: 20 Students / Batch

Course Objectives: By the end of the course, students should be able to……

1. provide practical exposure to the applications of mathematics in industry, business, research, and technology.
2. develop analytical, computational, and problem-solving skills through real-world tasks.
3. familiarize students with mathematical software, data analysis tools, and modern technological practices.
4. bridge the gap between theoretical mathematical knowledge and practical industrial requirements.

Course Outcomes: By the end of the course, students will be able to……

1. explain the role and applications of mathematics in professional and industrial environments.
2. apply mathematical and computational techniques to solve practical problems in workplace settings.
3. analyze data, processes, and results using appropriate mathematical and statistical methods.
4. demonstrate professional ethics, communication skills, teamwork, and time management in organizational activities.

Credits = 4	**Contents**	**Hrs.**
4	OJT will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. so that students may actively engaged with the employability opportunities. Students will undergo 4 credit work-based learning/OJT/internship. **Duration: 1 Month (1st April to 30th April)**	120

Evaluation Pattern: (60:40)

Total Marks: 100

End Semester Examination:

Internal Evaluation (40 Marks):	**End Semester Examination (60 Marks):**
• Appendix VII: Supervisor Evaluation of intern: 20 Marks • Attendence Diary / Logbook: 20 Marks	• Viva Voce / Presentation: 20 Marks • Depth of Knowledge and skill acquired: 20 Marks • Report: 20 Marks