

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.



Circular / Syll. Sec. / A.C. Res. / Curriculum / 2026.

It is hereby inform to all concerned that on the recommendation of Board of Studies, the Academic Council at it's Meeting held on 28th July, 2026 has accepted the "Curriculum of Pre-Ph.D. Course Work as per Guidelines of University".

This is effective from the Academic Year 2026-27 and onwards as per appended herewith.

All concerned are requested to note the contents of this circular and bring notice to the students, teachers and staff for their information and necessary action.

University campus,
Chhatrapati Sambhajinagar-431 004.
Ref. No. Syll. Sec./A.C. Res./
Curriculum/ 2026/ 2.2.1-2.2.2


Deputy Registrar
Syllabus Section

Date: 31/ 07/ 2026.

Copy forwarded with necessary action to:-

- 1] The Head, all concerned departments,
- 2] The Director, University Network & Information Centre, UNIC,
with a request to upload this Circular on University Website.
- 3] The Director, Board of Examinations & Evaluation,
- 4] Public Relation Officer [PRO],

Dr. Babasaheb Ambedkar Marathwada University,
Chhatrapati Sambhajinagar.

Dr.Babasaheb Ambedkar Marathwada University Chhatrpati Sambhajinagar.



Pre.Ph.d.Courses Subject wise curriculum List under the Faculty of Science & Technology

Sr.No.	Curriculum/Subject
1.	Biochemistry
2.	Biotechnology
3.	Botany
4.	Chemistry
5.	Computer Engineering
6.	Computer Science.
7.	Environmental Science
8.	Food Technology
9.	Geology
10.	Mathematics
11.	Microbiology
12.	Pharmacy
13.	Physics
14.	Statistics
15.	Zoology
16.	Civil Engineering
17.	Electronics Engineering
18.	Mechanical Engineering
19.	Nanotechnology
20.	Biophysics
21.	Pharmaceutical and Fine Chemical
22.	Forensic Science.
23.	Water and Land Managment

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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CHHATRAPATI SAMBAJINAGAR -431004 (MS) INDIA



PRE-Ph.D. Course Work (Mathematics)

Course Structure, Curriculum

and Scheme of Examination

(Effective from PET-2024)

Under the Faculty of Science and Technology

Prepared and submitted by BoS in Mathematics

¹
16/09/2026


Dr. Jagdish Nanaware
Chairman
BOS in Mathematics
Dr B.A. Marathwada University
Aurangabad - 431001 (M.S)

Dr.Babasaheb Ambedkar Marathwada University
Chhatrapati Sambhaji Nagar-431004 (MS) India

Course Structure of Pre-Ph.D. Coursework in Mathematics

Course No.	Course Name		Credits	Marks
Course.1. (C-1)	PPCRM - Research Methodology		4 credits	100
Course.2. (C-2)	1	Writing research proposal for financial assistance	1 credit	10
	2	Research article	1 credit	10
	3	Seminar	1 credit	10
Course.3. (C-3) (Choose any one)	PPCM01	Functional Analysis	3 credits	50
	PPCM02	Numerical Analysis		
	PPCM03	Fluid Dynamics		
	PPCM04	Operations Research		
	PPCM05	Difference Equations		
	PPCM06	Linear Integral Equations		
	PPCM07	Mechanics		
	PPCM08	Fractional Calculus		
	PPCM09	Fuzzy Mathematics		
	PPCM10	Differential Equations		
	PPCM11	Quantum Calculus		
	PPCM12	Any related online NPTEL/Swayam course		
Course.4. (C-4)	Research and Publication Ethics		2 credits	20
			12 Credits	200

Syllabus of Course .1. (C-1)**Research Methodology**

Course Code: PPCRM	Course Name: Research Methodology
Credits : 04	Total Periods: 60
Course Content	
Unit-I	Scientific research and literature survey. History of mathematics, finding and solving research problems, role of a supervisor, survey of a research topic, publishing a paper, reviewing a paper, research grant proposal writing, copyright issues, ethics and plagiarism
Unit-II	Research tools. Searching google (query modifiers), MathSciNet, ZMATH, Scopus, ISI Web of Science, Impact factor, h-index, Google Scholar, ORCID, JStor, Online and open access journals, Virtual library of various countries
Unit-III	Scientific writing and presentation. Writing a research paper, survey article, thesis writing; LaTeX, PSTricks, Beamer, HTML and MathJaX, Software for Mathematics. Mathematica/Matlab/Scilab
Textbook	J. Stillwell, Mathematics and its History, Springer International Edition, 4th Indian Reprint, 2005 L. Lamport, LaTeX, a Document Preparation System, 2nd ed, Addison-Wesley, 1994.
Reference books	Nicholas J. Higham, Handbook of Writing for the Mathematical Sciences, 2ed, SIAM, 1998. Michel Goossens, Frank Mittelbach, Sebastian Rahtz, Denis Roegel, Herbert Voss, The LaTeX Graphics Companion, 2nd edition (TTCT series), Addison-Wesley, 2004 Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011. http://euler-math-toolbox.de/ http://tug.org/PSTricks/main.cgi?file=doc/docs http://mirrors.ctan.org/macros/latex/contrib/mathtools/mathtools.pdf

Syllabus of Course. 3. Subject specific courses:

Course Code: PPCM01	Course Name: Functional Analysis
Credits : 03	Total Periods: 45
Course Content	
Unit-I	Definition of normed linear spaces, Banach spaces, continuity of norm, joint continuity of vector addition and scalar multiplication in normed linear spaces, quotient spaces, continuous linear transformations and different criterions of continuity of linear transformations on normed linear spaces, space of bounded linear transformations, isometric isomorphism.
Unit-II	Conjugate spaces, Hahn-Banach theorem and its consequences, natural imbedding of normed linear space into its second conjugate. the Uniform Boundedness theorem, conjugate of an operator
Unit-III	Inner product spaces, Schwarz's inequality, joint continuity of an inner product, parallelogram law in inner product spaces, Hilbert spaces. Orthogonal complements. Conjugate space of a Hilbert space, adjoint of an operator, self-adjoint operators, normal and unitary operators.
Textbook	G. F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw-Hill Edition, 2004.
Reference Books	Martin Schechter: Principles of Functional Analysis, American Mathematical Society, 2002. Erwin Kreyszig: Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 1978

Course Code: PPCM02	Course Name: Numerical Analysis
Credits :03	Total Periods: 45
Course Content	
Unit-I	Preliminaries, Iteration methods based on first degree equations, Newton-Raphson method; Secant and Regula-Falsi methods. Rate of convergence for secant method and Newton-Raphson method, General iteration methods, Polynomial Equations.
Unit-II	Introduction to linear systems of equations; Direct methods, Iteration methods, Lagrange and Newton interpolations; Eigenvalues and Eigenvectors, Finite difference operators; Interpolating polynomial using finite difference; Hermite interpolation.
Unit-III	Numerical differentiation; Numerical integration; Methods based on interpolation; Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule; Composite integration methods; Gauss quadrature methods; Numerical differentiation based on interpolation, Numerical integration based on interpolation.
Textbook	Jain, Iyengar and Jain: Numerical Methods for Scientific and Engineering Computation (4th Edition), New Age International Publishers, New Delhi.
Reference Books	S. S. Sastry: Introductory Methods of Numerical Analysis (4th Edition), Prentice Hall of India. J. I. Buchanan and P. R. Turner: Numerical Methods & Analysis, Prentice Hall.

Course Code: PPCM03	Course Name: Fluid Dynamics
Credits : 03	Total Periods: 45
Course Content	
Unit-I	Kinematics: Lagrangian and Eulerian methods; Real and ideal fluids, velocity at a point, streamlines, path lines, streak lines, velocity potential, irrotational and rotational motions, vorticity and circulation, local and particle rates of change. The equation of continuity.
Unit-II	Acceleration of a fluid, conditions at rigid boundary, general analysis of fluid motion. Pressure at a point in a fluid at rest and moving fluid, conditions at a boundary of two inviscid immiscible fluids. Euler's equation of motion, Bernoulli's equation.
Unit-III	Steady motion under conservative body forces, potential theorems, axially symmetric flows, two-dimensional flows. Impulsive motion, aspects of vortex motion, sources, sinks, doublets and their images.
Textbook	R. K. Rathy: An Introduction to Fluid Dynamics, Oxford & IBH Publishing, New Delhi, 1976 F. Chorlton: Text Book of Fluid Dynamics, C.B.S. Publishers and Distributors, Delhi, 1985
Reference books	S. W. Yuan: Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi, 1976. L.D.Landau and E.M.Lifshitz: Fluid Mechanics (Second Edition), Pergamon Press, New York, 1987.

Course Code: PPCM04	Course Name: Operations Research
Credits :03	Total Periods: 45
Course Content	
Unit-I	Linear Programming Problems (LPP), convex sets, feasible solutions, formulation of LPP, methods for solution of LPP.
Unit-II	Simplex method: theory and problems. Computational procedure, artificial variables, inverse of a matrix using simplex method.
Unit-III	Concept of duality, properties, dual simplex method and its algorithm. Parametric linear programming, Transportation and assignment problems/
Textbook	Kanti Swarup, P. K. Gupta and Man Mohan: Operations Research, S. Chand & Sons, New Delhi
Reference books	H. A. Taha: Operations Research – An Introduction, Macmillan, New York. N. S. Kambo: Mathematical Programming Techniques, Affiliated East-West Press, New Delhi K. V. Mittal: Optimization Methods, Wiley, New Delhi.

Course Code: PPCM05	Course Name: Difference Equations
Credits :03	Total Periods: 45
Course Content	
Unit-I	The Difference Operator, summation, generating functions and approximate summation, First order equations. General results for linear equations. Equations with constant coefficients.
Unit-II	Equations with variable coefficients, non-linear equations which can be linearized. The Z-transform.
Unit-III	Initial value problems for linear systems. Stability of linear systems, stability of non-linear systems, chaotic behaviors.
Textbook	Walter G. Kelley and Allan C. Peterson: Difference Equations – An Introduction with Applications, Academic Press, Harcourt Brace Jovanovich Pub., 1991.
Reference books	Calvin Ahlbrandt and Allan C. Peterson: Discrete Hamiltonian Systems: Difference Equations, Continued Fractions and Riccati Equations, Kluwer Academic Publishers, Boston, 1996. Paul M, Batchelder: An Introduction to Linear Difference Equations, Cambridge, Mass, The Harvard University Press, 1927.

Course Code: PPCM06	Course Name: Linear Integral Equations
Credits : 03	Total Periods: 45
Course Content	
Unit-I	Linear Integral Equations, Types of Linear Integral Equations, Special kinds of Kernels: Separable or degenerate kernel, symmetric kernel, convolution-type kernels, Eigenvalues and Eigenfunctions of kernels, Solution of linear integral equations, Verification of solution of linear integral equations, Conversion of Boundary Value Problems (BVP) to integral equations and vice-versa, conversion of Initial Value Problems (IVP) to integral equations and vice-versa
Unit-II	Methods of obtaining solution for Fredholm integral equations, Fredholm integral equations with separable kernels, Approximating kernels by separable kernels, Method of successive approximation, Iterated kernel method for Fredholm integral equations, Resolvent kernels and their properties. Methods of solutions for Volterra integral equations, Volterra type kernel, Method of differentiation, Method of successive approximations, Method of iterative kernels, Resolvent kernels
Unit-III	Laplace and Fourier Transforms, Application of Laplace transform to Volterra integral equations with convolution-type kernel and examples, Application of Fourier transform to some singular integral equations and examples.
Textbook	R. P. Kanwal: Linear Integral Equations: Theory and Applications, Academic Press, 1971.
Reference books	W.V.Lovitt: Linear Integral Equations, Dover Publications, New York, 1924 Abdul-Majid Wazwaz: Linear and Nonlinear Integral Equations, Springer-Verlag, New York, 2011

Course Code: PPCM07	Course Name: Mechanics
Credits : 03	Total Periods: 45
Course Content	
Unit-I	D'Alembert's Principle and Lagrange's equation of motion, different forms of Lagrange's equation. Generalized potential, conservative fields and its energy equation, application of Lagrange's formulation.
Unit-II	Functional, linear functional. Fundamental lemma of Calculus of Variations, simple variational problems. The variation of a functional, extremum of a functional, necessary condition for extremum, Euler's equation. Euler's equation of several variables, invariance of Euler's equation. Motivating problems of calculus of variations: Shortest distance, Minimum surface of revolution, Brachistochrone Problem, Isoperimetric problem, Geodesic.
Unit-III	The fixed end point problem for unknown functions, variational problems in parametric form, generalization of Euler's equation to: (i) 'n' dependent functions, (ii) higher order derivatives. Variational problems with subsidiary conditions. Hamilton's principle, Hamilton's canonical equations. Lagrange's equation from Hamilton's principle.
Textbook	H. Goldstein, Charles Poole, John Safko: Classical Mechanics (3rd Edition), Pearson Education, 2002
Reference books	M. Gelfand & S. V. Fomin: Calculus of Variations, Prentice-Hall C. Rana and P. S. Joag: Classical Mechanics, Tata McGraw-Hill, 1991. F. Gantmacher: Lectures in Analytic Mechanics, MIR Publishing House, New Delhi.

Course Code: PPCM08	Course Name: Fractional Calculus
Credits : 03	Total Periods: 45
Course Content	
Unit-I	Gamma function, Mittag-Leffler functions. Fractional derivatives and Integrals: Grünwald-Letnikov Fractional Derivatives, Riemann-Liouville Fractional Derivatives, Caputo's Fractional Derivatives, Sequential Fractional Derivatives, Left and Right Fractional Derivatives, Properties of Fractional Derivatives
Unit-II	Laplace transform of Fractional Derivatives, Fourier Transform of Fractional Derivatives, Mellin Transform of Fractional Derivatives, Linear Fractional Differential Equations. General form of Fractional Differential Equations.
Unit-III	Method of solutions, Dependence on initial conditions, Standard Fractional Differential Equations, Sequential Fractional Differential Equations
Textbook	Igor Podlubny: Fractional Differential Equations, Academic Press, San Diego, California, USA. Anatoly A. Kilbas, Hari M. Srivastava, Juan J. Trujillo: Theory and Applications of Fractional Differential Equations, Elsevier, New York, 2006.
Reference books	Keith B. Oldham and Jerome Spanier: The Fractional Calculus: Theory and Applications of Differentiation and Integration to Arbitrary Order, Academic Press, ISBN978-0-12-525550-9. Kenneth S. Miller and Ross, Bertram,(Eds.): An Introduction to the Fractional Calculus and Fractional Differential Equations, John Wiley & Sons, ISBN978-0-47158884-9. S. Samko, A. A. Kilbas, O. Marichev,0: Fractional Integrals and Derivatives: Theory and Applications, Gordon and Breach / Taylor & Francis,

Course Code: PPCM09	Course Name: Fuzzy Mathematics
Credits : 03	Total Periods: 45
Course Content	
Unit-I	Basic concepts in fuzzy sets; Convex fuzzy sets, Additional properties of α -cuts; Representation of fuzzy sets; Decomposition Theorems
Unit-II	Operations on Fuzzy sets: Types of operations; Fuzzy complements, Types of operations; Fuzzy complements Fuzzy intersections (t-norms), Examples of t-norms: standard intersection, algebraic product, bounded difference, drastic intersection, Fuzzy unions (t-conorms), Examples of t-conorms: standard union, algebraic sum, bounded sum, drastic union, Combinations of operations, Aggregation operations
Unit-III	Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals of real numbers, Arithmetic operations on fuzzy numbers. Fuzzy relations: Introduction, Fuzzy relations, Operations on fuzzy relations, Alpha-cuts of a fuzzy relation, Composition of fuzzy relations, Fuzzy relation on a domain, Projection and cylindrical extension
Textbook	George J. Klir and Bo Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
Reference books	M. Ganesh: Introduction to Fuzzy Sets and Fuzzy Logic, PHI Learning, New Delhi, 2006. A. Kaufmann and M. M. Gupta: Introduction to Fuzzy Arithmetic, Van Nostrand, 1989. H. J. Zimmermann: Fuzzy Set Theory and Its Applications 1997

Course Code: PPCM10	Course Name: Differential Equations
Credits :03	Total Periods: 45
Course Content	
Unit-I	Review of existence and uniqueness of solutions of initial value problems for a system of first order differential equations, Existence and uniqueness theorem for a linear system, homogeneous and inhomogeneous linear systems, linear equations with constant coefficients, fundamental matrix.
Unit-II	Floquet theory, stability for linear systems, principle of linearized stability, stability for autonomous systems, Liapunov functions, plane autonomous systems, classification of second order partial differential equations, Nonlinear first order partial differential equations, conservation laws, Riemann's problem, long time behavior.
Unit-III	Separation of variables, similarity solutions, Transform methods, converting nonlinear partial differential equations into linear partial differential equations, asymptotics, maximum principles
Textbook	R.Grimshaw, Nonlinear ordinary differential equations, Blackwell Scientific publications,1990. Lawrence C. Evans, Partial Differential Equations, American Mathematical Society,1991
Reference books	David Betounes, Differential equations: Theory and applications, Springer,2010 L. Perko, Differential equations and dynamical systems, Springer,2001 Mathew P. Coleman, An introduction to partial differential equations with MATLAB, CRC press,2005 Paul Waltman, A Second Course in Elementary Differential Equations, Academic Press Robert E. Terrell, Notes on Differential Equations, Cornell University,1997

Course Code: PPCM11	Course Name: Quantum Calculus
Credits : 03	Total Periods: 45
Course Content	
Unit-I	q-Derivative and h-Derivative, Generalized Taylor's formula for polynomials, q-Taylor's formula for polynomials, Gauss's binomial formula, properties of q-binomial coefficients, q-binomial coefficients and linear algebra over finite fields, q-Taylor's formula for formal power series and Heine's binomial formula
Unit-II	Two Euler's identities and two q-exponential functions, q-Trigonometric functions, Jacobi's triple product identity, classical partition function and Euler's product formula, q-hypergeometric functions and Heine's formula, Ramanujan product formula, Explicit formulas for sums of two and four squares
Unit-III	Explicit formulas for sums of two and four triangular numbers, q-antiderivative and Jackson integral, Fundamental theorem of q-calculus, q-gamma and q-beta functions, h-derivative and h-integral, Bernoulli polynomials and Bernoulli numbers, sums and powers, Euler- Maclaurin formula, symmetric quantum calculus
Textbook	Victor Kac, Pokmen Cheung: Quantum Calculus, Springer Verlag, New York, 2002
Reference books	Bipin Hazarika, Sanket Tikare, Mehmet Dik, Dimplekumar Chalishajar: Quantum Calculus and Functional Analysis with Applications, Chapman and Hall/CRC, 2025 Thomas Ernst, A Comprehensive Treatment of q-Calculus, Birkhauser, 2012

Course Code: PPCM12	Course Name: Any online course (NPTEL/SWAYAM) of minimum three credits shall be treated as equivalent.
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Scheme of Examination:

The formative continuous internal evaluation and summative evaluation shall be done by the concerned teacher/ coordinator. The course wise distribution of marks is as per the table given below:

Course No.	Continuous Internal Evaluation (CIE)	Summative Evaluation/ Central Evaluation (CE)
Course.1.	40% (40 Marks)	60% (60 Marks)
Course.2.	-	100%
Course.3.	40% (20 Marks)	60% (30 Marks)
Course.4.	-	100%

Formative continuous internal evaluation (CIE) shall be conducted by the concerned teacher/ coordinator for 40% marks of the maximum marks allotted for each course. Three CIE, each of 20% marks would be conducted at different phases throughout the duration. Total performance in CIE (i.e. 40%) would be based on best two out of three CIE examinations. The outline for distribution of marks for continuous internal activities for CIE I, CIE-II and CIE-III of a course shall be as under.

Table I : Distribution of Marks for Continuous Internal Activities

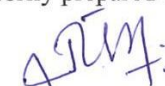
Sr.No.	Particulars	CIE-I	CIE-II	CIE-III	Addition of Best two out of three CIE
1	Unit test/Session test	20% marks	20% marks	20% marks	20% marks
2	Assignments/Tutorials	20% marks	20% marks	20% marks	20% marks
	Total	Average of Sr.No.1 and Sr.No.2 (20% marks)	Average of Sr.No.1 and Sr.No.2 (20% marks)	Average of Sr.No.1 and Sr.No.2 (20% marks)	40% Marks

The summative evaluation shall be done by the teacher/ coordinator. It shall be done as per the following instructions:

1. Duration of theory examination shall be 2 hours for 60 marks per course.
2. Duration of theory examination shall be 1 hour for 30 marks per course.
3. Duration of theory examination shall be 2 hours for 60 marks per course.
4. The question paper shall be consists of short answer questions and long answer questions and be set by concerned teacher/ coordinator.
5. Research proposal and seminar presentation shall be compulsorily prepared using Latex/Beamer.


16/09/2016.

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Dr. Jagdish Nanaware
Chairman
BOS in Mathematics
Dr B.A. Marathwada University
Aurangabad - 431001 (M.S.)