FACULTY OF SCIENCES

SYLLABUS

Master of Science (Mathematics) (FYIP)

(Semester: V -VI)

(Under Credit Based Continuous Evaluation Grading System)
(CBCEGS)

Session: 2026-27

The Heritage Institution

KANYA MAHA VIDYALAYA JALANDHAR

(Autonomous)

Kanya Maha Vidyalaya, Jalandhar (Autonomous)
Scheme and Curriculum of Examinations of Five Years Integrated Programme
(Under Credit Based Continuous Evaluation Grading System) (CBCEGS)
Master of Science (Mathematics) (FYIP)
Semester-V
Session- 2026-27

Master of Science (Mathematics) (FYIP) Semester-V										
Course Code	Course Type	Course Title	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Max. Marks				Examination Time in Hours
						Total	TH	P	CA	
FMAL-5331	DSC	Group Theory -I	4-1-0	4-1-0	5	100	70	-	30	3
FMAL-5332	DSC	PDE's and System of ODE's	4-1-0	4-1-0	5	100	70	-	30	3
FMAL-5133	C	Machine Learning	4-0-0	4-0-0	4	100	70	-	30	3
FMAM-5334	MDC	Sawai Jai Singh and his Astronomy	3-0-2	3-0-1	4	100	40	30	30	3+3
FMAP-5335	DSC	PDE's and System of ODE's Laboratory	0-0-4	0-0-2	2	50	-	35	15	3
FMAI-5336	DSC	Internship	0-0-4	0-0-2	2	50	-	50	-	
FMAM-5330	SEC	Technical Writing and Latex	3-0-2	3-0-1	4	100	40	30	30	3+3
VACJ-5551	VAAC	* Job Readiness	2-0-0	2-0-0	2	50	35	-	15	1
Total					28					

C-Compulsory
VAAC-Value Added Audit Courses
SEC-Skill Enhancement Courses
DSC-Discipline Specific Courses
MDC-Multi Disciplinary Courses

* Credits/grades points of these courses will not be included in the calculation of SGPA/CGPA of the semesters/programme.

Kanya Maha Vidyalaya, Jalandhar (Autonomous)
Scheme and Curriculum of Examinations of Five Years Integrated Programme
(Under Credit Based Continuous Evaluation Grading System) (CBCEGS)
Master of Science (Mathematics) (FYIP)
Semester-VI
Session- 2026-27

Master of Science (Mathematics) (FYIP) Semester-VI										
Course Code	Course Type	Course Title	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Max. Marks				Examination Time in Hours
						Total	TH	P	CA	
FMAL-6331	DSC	Group Theory-II	4-1-0	4-1-0	5	100	70	-	30	3
FMAL-6332	DSC	Riemann Integration and Series of Function	4-1-0	4-1-0	5	100	70	-	30	3
FMAL-6333	DSC	Multivariate Calculus	4-1-0	4-1-0	5	100	70	-	30	3
FMAL-6134	C	Data and File Structures	4-0-0	4-0-0	4	100	70	-	30	3
FMAP-6335	DSC	Multivariate Calculus Laboratory	0-0-4	0-0-2	2	50	-	35	15	3
VACH-6401	VAC	*Human Rights and Constitutional Duties	2-0-0	2-0-0	2	50	35	-	15	3
Total					23					

C-Compulsory
VAC-Value Added Courses
DSC-Discipline Specific Courses
* Credits/grades points of these courses will not be included in the calculation of SGPA/CGPA of the semesters/programme.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: Group Theory-I
Course Code: FMAL-5331
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to explain the concept of groups through symmetries, identify and verify subgroups using subgroup tests, and analyze structural properties such as centralizer, normalizer, center, and products of subgroups.

CO2: Students will be able to describe cyclic groups and their properties, classify their subgroups, and analyze permutations using cycle notation, including identifying even and odd permutations and understanding alternating groups.

CO3: Students will be able to apply coset decomposition and Lagrange's theorem to finite groups, determine normal subgroups and construct factor groups, and use results like Fermat's Little Theorem and Cauchy's theorem in problem solving.

CO4: Students will be able to analyze and apply group homomorphisms and isomorphisms, understand Cayley's theorem, and use isomorphism theorems and automorphisms to study group structures.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: Group Theory-I
Course Code: FMAL-5331

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 1 0 | CA:30

Instructions for Paper Setters:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), Elementary properties of groups. Subgroups and examples of subgroups, Subgroup tests, centralizer, normalizer, Center of a group, product of two subgroups.

Unit II

Cyclic groups, Properties of cyclic groups, classifications of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group.

Unit III

Cosets, Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem finite groups.

Unit IV

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms acting on elements and groups, Isomorphism theorems, Automorphism.

Text Book:
Gallian, A.J., Contemporary Abstract Algebra, 8th Ed., Cengage Learning, 2012.

Reference Books:
1. Fraleigh, J.B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. Artin, M., Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Sahai, V. and Bist, V: Algebra, 4th edition, 2018

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: PDE's and System of ODE's
Course Code: FMAL-5332
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to analyze curves and surfaces in three dimensions and solve first-order simultaneous differential equations and Pfaffian differential equations in three variables.

CO2: Students will be able to formulate and solve first-order partial differential equations using various methods.

CO3: Students will be able to apply advanced techniques such as method of characteristics, Charpit's method, and Jacobi's method to solve nonlinear first-order PDEs and classify second-order PDEs

CO4: Students will be able to solve systems of linear differential equations using operator methods and analyze homogeneous linear systems with constant coefficients.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: PDE's and System of ODE's
Course Code: FMAL-5332

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 1 0 | CA:30

Instructions for Paper Setters:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

ODEs in 3 Variables:- Surfaces and curves in three dimensions, Simultaneous differential equations of first order and the first degree in three variables, Methods of solutions of $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$. Orthogonal trajectories of a system of curves on a surface. Pfaffian differential forms and equations, Solution of Pfaffian differential equations in three variables.

Unit II

PDEs of the 1st order-Partial differential equations, Origins of first order partial differential equations, Cauchy's problem for first order equations, linear equation of first order, Integral surface passing through a given curve, Surfaces orthogonal to a given system of surfaces, Linea PDEs with constant coefficients.

Unit III

Non-linear partial differential equation of the first order, Cauchy method of characteristics, Compatible system of first order equations, Charpit's method, Special types of first order equations, Solutions satisfying given conditions, Jacobi's method, classification of 2nd order PDEs.

Unit IV

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

Text Books:
1. Sneddon, I.N., Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
2. Ross, S.L., Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.

Reference Books:
1. TynMyint, U., and Debnath, L., Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
2. Abell, L.M., Braselton, J.P., Differential equations with MATHEMATICA, 3rd Ed., Elsevier Aca demic Press, 2004.
3. Boyce, W.E., and Diprima, R.C., Elementary Differential Equations and boundary value problems, John Wiley and Sons Inc., New York.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: Machine Learning
Course Code: FMAL-5133
Course outcomes

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: Machine Learning
Course Code: FMAL-5133

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 0 0 | CA:30

Instructions for Paper Setters:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Introduction: The Machine learning landscape: What is Machine Learning (ML), Why Machine Learning, Type of ML Systems, Main challenges of machine learning, Confusion Matrix, testing and validating. Applications of Machine Learning Applying Machine Learning to a project- Step through the machine learning workflow using an example. Working with real data, get data and prepare for machine learningby pre- processing data, deriving features, and training and refining models, fine tune the model, ready the solution for production. Probability and classification, Bayes optimal decisions, Naive Bayes and Gaussian class- conditional distribution.

Unit II

Linear regression; SSE; gradient descent; normal equations; features, Overfitting and underfitting. Classification problems; decision boundaries; nearest neighbour methods Supervised Learning: Linear classifiers, Bayes' Rule and Naive Bayes Model, Training a binary classifier, performance measures, multiclass classification, error analysis, multilabel classification, multioutput classification. Training Models: gradient descent, Polynomial regression, learning curves, regularized linear models, Logistic regression, Linear SVM classification, Non-linear SVM classification, SVM regression.

Unit III

Decision tree, Ensemble methods: Bagging, random forests, boosting, practical examples; the curse of dimensionality, dimensionality reduction, principal components analysis Unsupervised learning: clustering and clustering algorithms; Using clustering for image segmentation, for pre-processing, semi-supervised learning, DBSCAN; Gaussian Mixtures– anomaly detection, selecting number of clusters, Bayesian Gaussian mixture models, novelty detections algorithms.

Unit IV

Reinforcement learning and adaptive models, the model-based reinforcement learning paradigm, Explore Q-learning and SARSA.

Reference Books:
1. Alpaydin, E., Introduction to Machine Learning, Second Edition.
2. Geron,A., Hands on Machine Learning with Scikit Learn, Keras& Tensor Flow, O'Reilly
3. Marsland, S., Machine Learning: An Algorithmic Perspective
4. Bishop, C.M., Pattern Recognition and Machine Learning
5. Mitchell, T., Machine Learning 6. Raschka, S., Python Machine Learning, PACKT Publishing

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: Sawai Jai Singh and his Astronomy
Course Code: FMAM-5334
Course Outcomes

After passing this course, the students will be able to:

CO1: Explain the historical contributions of Sawai Jai Singh, the development of Indian observatories, and the classification of masonry astronomical instruments based on their precision.

CO2: Analyze the design, construction, working principles, and precision of Samrāt Yantra and Ṣaṣṭhāṁśa Yantra for astronomical observations and time measurement.

CO3: Describe the structure, operation, and astronomical applications of Dakṣiṇottara Bhitti Yantra, Nāḍīvalaya Yantra, Digaṁśa Yantra, Krāntivṛtta Yantra, Dhruvadarśaka Paṭṭikā, and Chakra Yantra.

CO4: Evaluate the coordinate systems, design, construction, and observational significance of Kapāla Yantras, Jaya Prakāśa Yantra, and Rāma Yantra.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: Sawai Jai Singh and his Astronomy
Course Code: FMAM-5334

Examination Time: (3+3) Hours | Max. Marks: 100

Theory: 40

L T P | Practical: 30

3 0 1 | CA: 30

Instructions for Paper Setters:

Eight questions of equal marks (8 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Sawai Jai Singh and his Times: The rulers of Amber, Education, Jai Singh The Ruler, Time measuring instruments, co-ordinate measuring devices, observatories in India.

Masonry Instruments-I: Sawai Jai Singh's low precision masonry instruments, Swai Jai Singh's medium precision masonry instruments, Sawai Jai Singh's high precision masonry instruments, instrument added after Sawai Jai Singh.

Unit II

SAMRĀṬ YANTRA: Design, Construction and Precision. The Gnomon and the polar axis, The quadrant plane and the equatorial plane, declination of the sun. ṢAṢṬHĀḾŠA YANTRA: History, deviation from median plane, the pin hole, diffraction broadening, precision of the Jaipur and Delhi Ṣaṣṭhāṁšas.

Unit III

DAKṢINOTTARA BHITTI YANTRA, NĀḌĪVALAYA YANTRA, DIGAḾŠA YANTRA, KRĀNTIVṚTTA YANTRA, DHRUVADARŠAKA PAṬṬIKĀ, CHAKRA YANTRA: Design, Construction and Precision.

Unit-IV

Masonry Instruments-II: KAPĀLA YANTRAS and JAYA PRAKĀŠA YANTRA: Coordinate systems, principle, ascendants and signs on the meridian, the complementary halves of jaya prakāša yantra. RĀMA YANTRA: History, Design, Construction and Precision

Text Book:

Sawai Jai Singh And His Astronomy: Virendra Nath Sharma, Motilal Banarsidass Publishers.

Reference Books:

1. The Astronomical Observatories of Jai Singh by G.R. KAYE, Gyan Publishing House, 2021.
2. Sawai Jai Singh and His Observatories by V.N. Sharma by Publication Scheme.
3. The Astronomical Endeavours of Sawai Jai Singh,by Rachana Sankhalker, Astronomical Society of India (ASI), Karnataka

4. Understanding JANTAR MANTAR Observatories of Jai Singh, Ankur Hobby Centre Ahmedabad.

Note: Practical: The practical syllabus comprises hands-on activities related to the models of astronomical instruments of the Jantar Mantar included in the theory syllabus.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: PDE's and System of ODE's Laboratory
Course Code: FMAP-5335
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to solve first-order partial differential equations, including the Cauchy problem, and determine and plot their characteristic curves.

CO2: Students will be able to visualize integral surfaces of first-order partial differential equations corresponding to prescribed initial conditions.

CO3: Students will be able to analyze and solve Pfaffian differential equations in three variables, including testing integrability conditions and determining potential functions.

CO4: Students will be able to solve systems of ordinary differential equations and interpret their solutions in applied mathematical problems.

Master of Science (Mathematics) (FYIP)
Semester–V
Session-2026-27
Course Title: PDE's and System of ODE's Laboratory
Course Code: FMAP-5335

Examination Time: 3 Hours | Max. Marks: 50
Practical: 35
CA:15

L T P
0 0 2

Practical (Using any Software)

(i) Solution of Cauchy problem for first order PDE.
(ii) Finding and plotting the characteristics for the first order PDE.
(iii) Plot the integral surfaces of a given first order PDE with initial data.
(iv) Solution of Nonlinear First Order PDE using Charpit's Method.
(v) Solution of Pfaffian Differential Equations in Three Variables.
(vi) Solving system of ODEs.

Text Books:

1. Sneddon, I.N., Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
2. Ross, S.L., Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
3. Jain, C., Advanced Programming in SCILAB, Alpha Science International, Oxford, UK, 2020

Reference Books:

1. TynMyint, U., and Debnath, L., Linear Partial Differential Equations for Scientists and Engi neers, 4th edition, Springer, Indian reprint, 2006.
2. Boyce, W.E., and Diprima, R.C., Elementary Differential Equations and boundary value problems, John Wiley and Sons Inc., New York.
3. Campbell, S.L., Chanceller, J.P., Nikoukhah, R. Modeling and Simulation in Scilab/Scios, Springer, 2006.

Master of Science (Mathematics) (FYIP)

Semester–V

Session-2026-27

Course Title: Internship

Course Code: FMAI-5336

Students shall undertake Community Engagement and Service/ field based learning through an internship of four weeks during the fifth semester after completion of classes or during the summer vacation at the end of the fourth semester.

The internship shall be carried out in one of the areas related to the courses of study. Students participating in NCC or NSS activities may submit a certificate of participation for a minimum duration of four weeks in lieu of the internship.

Every student shall submit an internship report in the prescribed format along with the original internship completion certificate and permission letter issued by the college to carry out the internship/ community outreach.

The viva voce examination shall be conducted on the basis of the final internship report submitted and the presentation by the student.

Master of Science (Mathematics)(FYIP)
Semester–V
Session-2026-27
Course Title: Technical Writing and Latex
Course Code: FMAM- 5330
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to install and use Latex to create basic documents, including writing mathematical symbols, managing spacing, and formatting text structure.

CO2: Students will be able to design structured documents using title pages, sections, headers/footers, and generate tables of contents with proper labeling and referencing.

CO3: Students will be able to format documents using font styles, colors, lists, and insert tables and figures effectively in Latex.

CO4: Students will be able to typeset mathematical equations and symbols and manage bibliographies and citations in Latex documents.

Master of Science (Mathematics)(FYIP)
Semester–V
Session-2026-27
Course Title: Technical Writing and Latex
Course Code: FMAM- 5330

Examination Time: (3+3) Hours | Max. Marks: 100
Practical: 30
Theory: 40
CA: 30

L T P
3 0 1

Instructions for the Paper Setters: Eight questions of equal marks (8 Marks each) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Unit I

Installation of the software Latex, Introduction to Latex, mathematical symbols, commands for writing mathematical symbols, spacing, Line breaking and page breaking, practical work on these topics.

Unit II

Title pages, Header and Footer, Text formatting, Essentials, troubleshooting, creating a title, sections, labelling, table of contents, practical work on these topics.

Unit III

Font effects, coloured text, font sizes, lists, comments and spacing, special characters, Practical for inserting tables and figures, practical work on these topics.

Unit IV

Inserting equations, mathematical symbols, inserting a bibliography, citing references, practical work on these topics.

Text Book:
Kopka, H., Daly, P.W., Guide to Latex, Addison-Wesley Professional, 4th Edition, 2003.

List of Practicals using Latex

1. Introduction to Latex, preparing and running a .tex file.

2. Inserting tables and figures.

3. Inserting line breaks, Foote notes.

4. Font Effects, Font sizes.

5. Write A Paragraph Containing Different colored text.

6. Use of special symbols like %, &,#,€,$ etc.

7. Mathematical symbols.

8. Write a mathematical text containing equations with equation numbers and unnumbered equations, and system of equations, arrays, matrices.

9. Preparing a bibliography using BibTeX

Semester-VI

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Group Theory-II
Course Code: FMAL-6331
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to analyze group actions, compute orbits and stabilizers, and apply results such as the Orbit-Stabilizer Theorem and Jordan–Holder Theorem to study group structure.

CO2: Students will be able to apply class equations, Sylow's theorems, and conjugacy concepts to investigate properties of finite groups, including simplicity and solvability.

CO3: Students will be able to study automorphisms, characteristic and commutator subgroups, and use derived series to determine structural properties like solvability of groups.

CO4: Students will be able to analyze and decompose groups using direct products and semidirect products, and apply the Fundamental Theorem of Finite Abelian Groups.

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Group Theory-II
Course Code: FMAL-6331

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 1 0 | CA: 30

Instructions for the Paper Setters:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Group actions, stabilizers and kernels, orbit stabilizer theorem, permutation representation associat ed with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theo rem, Simple Groups, Jordan Holder Theorem.

Unit II

Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, p groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for $n \geq 5$, non-simplicity tests, Solvable Groups.

Unit III

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, Automorphisms of Sn($n \geq 3$) , applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties, derived series & solvability of groups.

Unit IV

Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups, Semidirect product and recognition theorems.

Text Books:

1. Dummit, D.S. and Foote, R.M., Abstract-Algebra, 3rd Edition, Wiley India, 2004.
2. Gallian, J.A., Contemporary Abstract Algebra, 8th Edition, Cengage Learning, 2012.

Reference Books:

1. Fraleigh, J.B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. Artin, M., Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Rotman, J.J., An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
4. Herstein, I.N., Topics in Algebra, Wiley Eastern Limited, India, 1975

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Riemann Integration and Series of Function
Course Code: FMAL-6332
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to define and evaluate Riemann integrals using partitions and Riemann sums, and verify integrability using Riemann conditions and properties.

CO2: Students will be able to apply the Fundamental Theorems of Integral Calculus to solve problems and utilize the first and second mean value theorems of integral calculus in practical applications.

CO3: Students will be able to analyze power series, double series and test the convergence of double series using appropriate methods.

CO4: Students will be able to apply the concept of Fourier Series to represent periodic functions and compute their series expansions for problem-solving.

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Riemann Integration and Series of Function
Course Code: FMAL-6332

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 1 0 | CA: 30

Instructions for the Paper Setters:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Definition and Existence of the Riemann Integral, Partitions and Riemann (or Darboux) sums, Some properties of Darboux Sums, Upper and lower Riemann integrals, Refinement of partitions, Darboux's Theorem, Necessary and sufficient conditions for integrability.

Unit II

Particular classes of Integrable functions, Properties of integrable functions, Integrability of the sum, difference, product, quotient and modulus, The Fundamental theorem of integral calculus, First and Second mean value theorems of integral calculus.

Unit III

Power Series, Radius of Convergence and Interval of Convergence, Cauchy Hadmard theorem, Abel's theorem, Double Sequence, Double Series, Convergence of double series.

Unit IV

Periodic functions, trigonometric series, Fourier series expansion, Fourier series for even and odd functions, half range series.

Text Books:
1. Ross, K.A., Elementary analysis, The Theory of calculus, Undergraduate Texts.
2. Malik, S.C., and Arora, S., Mathematical Analysis.

Reference Books:
1. Rudin, W., Principles of mathematical Analysis.
2. Narayan, S., A course of Mathematical Analysis.

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Multivariate Calculus
Course Code: FMAL-6333
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to analyze functions of several variables, evaluate limits and continuity, and apply partial differentiation and Taylor's theorem to study differentiability and homogeneous functions.

CO2: Students will be able to compute double and triple integrals over various regions, apply change of variables, and use these integrals to determine area, volume, surface area, and center of mass.

CO3: Students will be able to analyze vector fields by computing gradient, divergence, and curl, and apply line and volume integrals to solve problems involving work, mass, and circulation.

CO4: Students will be able to apply major integral theorems such as Green's theorem, Stokes' theorem, and the Divergence theorem to evaluate integrals and solve physical problems.

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Multivariate Calculus
Course Code: FMAL-6333

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 1 0 | CA: 30

Instructions for the Paper Setters:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, Differentiability of real valued functions of two variables, Total differentiability, sufficient condition for differentiability, Schwarz's Theorem, Young's Theorem, Euler's Theorem on homogeneous functions of two variables, Euler's Theorem on homogeneous functions of three variables, Taylor's theorem for functions of two variables.

Unit II

Double integration over rectangular and non-rectangular region, Change of variables in double integrals, Triple integrals, Triple integral over a parallelepiped and solid regions, Change of variables in triple integrals, Area by use of double integrals, Volume by use of triple integration, Surface Area by use of double integrals, Centre of Gravity (or Centre of Mass) in R2, Centre of Mass in R^3

Unit III

Definition of vector field, divergence and curl, directional derivatives, Divergence of a vector point function, Solenoidal Vector, Irrotational Vector, Physical interpretation of Curl of a vector point function, Laplacian operator, Integration of Vectors, the gradient, Tangential Line integrals, Applications of line integrals: Mass and Work, conservative vector fields, Circulation, Volume Integral .

Unit IV

The Divergence theorem, Green's theorem in a plane, Stoke's theorem and problems based on these theorems.

Text Books:-

1. G.B. Thomas and R.L. Finney. Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley, and K. J. Smith. Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba, and A. Weinstein. Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. J. Stewart. Multivariable Calculus Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001

Reference Books:-

1. S.R. Ghorpade & B.V. Limaye. A Course in Multivariable Calculus and Analysis, Springer, 2020.

2. M. Fitzpatrick. Advanced Calculus, American Mathematical Society, 2006.
3. T.M. Apostol. Calculus-II: An Indian Adaptation, Wiley India, 2023

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Data and File Structures
Course Code: FMAL-6134
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to analyze fundamental data structures (arrays, linked lists) and evaluate algorithm complexity using Big-O notation and time–space trade-offs.

CO2: Students will be able to implement and apply linear and hierarchical data structures such as stacks, queues, and trees to solve computational problems.

CO3: Students will be able to design and apply algorithms including greedy methods, graph algorithms, and heap operations for optimization and problem-solving.

CO4: Students will be able to implement searching and sorting techniques, utilize hashing methods, and analyze file organization strategies for efficient data management.

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Data and File Structures
Course Code: FMAL-6134

Examination Time: 3 Hours | Max. Marks: 100
L T P | Theory: 70
4 0 0 | CA: 30

Instructions for the Paper Setters: Eight questions of equal marks (14 Marks each) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Unit I

Preliminaries: Various data structures, common operations on data structures, algorithm complexity, big O notation, time–space trade off between algorithms. Arrays: Arrays defined, representing arrays in memory, various operations on linear arrays, Multi dimensional arrays, Records. Linked Lists: Types of linked lists, representing linked lists in memory, advantage of using linked lists over arrays, various operation on linked lists

Unit II

Stacks: Description of stack structure, implementation of stack using arrays and linked lists. Applications of stacks– converting arithmetic expression from infix notation to polish and their subsequent evaluation, quicksort technique to sort an array, parenthesis checker. Queues: Description of queue structure, implementation of queue using arrays and linked lists, description of priorities queues. Applications of queues– Operating system simulations Trees: Description of tree structure and its terminology, binary search tree, implementing binary search tree using linked lists, various operations on binary search trees, AVL Trees, Threaded Binary Trees, B Trees, B+ trees.

Unit III

Greedy Method: Knapsack Problem, Prim's and Kuruskal's Algorithm to find MSTs. Heaps: Description of heap structure, implementing heaps using arrays, various operations on heaps, Applications of heaps– heapsort technique to sort an array, implementation of priority queues. Graphs: Description of graph structure, implementing graphs in memory using adjacency matrix or adjacency lists, various graphs traversing algorithms, finding shortest path between two nodes, Dijkastra’s shortest path algorithm., finding biconnected component, strongly connected component and finding cycles in the graphs.

Unit IV

Searching and Sorting: Sorting Types, External and Internal sort Linear Search, Binary search, Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Shell Sort, Quick sort, Radix Sort. Hash Tables: Direct address tables, hash tables, collision resolution by chaining, hash functions, open addressing– linear probing, quadratic probing, double hashing. Files: Operations on files, Types of files, File Organizations: Sequential files, Indexed Sequential file, Directed files and multi–key files, File performance criteria and terms.

Reference Books:

1. Lipschutz, S., Theory and Problems of Data Structures, Schaum Outline Series, McGraw–Hill Book Company. Third Edition

2. Esakov, J., Data Structures– An Advanced Approach Using C, Tom Weiss, Prentice– Hall International, Inc. 2007
3.Trembley and Sorenson: An Introduction to Data Structures with Application, Tata–McGraw Hill Company, Delhi. 2003
4.Tanenbaum: Data Structures and C. Second Edition

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Multivariate Calculus Laboratory
Course Code: FMAP-6335
Course Outcomes
After passing this course, the students will be able to:

CO1: Students will be able to determine and visualize maxima and minima of functions of two variables and plot surfaces $z=f(x,y)$.

CO2: Students will be able to approximate areas and volumes using double integrals.

CO3: Students will be able to approximate triple integrals for evaluating volumes and related quantities.

CO4: Students will be able to represent and analyze vector fields in a plane graphically.

Master of Science (Mathematics) (FYIP)
Semester–VI
Session: 2026-27
Course Title: Multivariate Calculus Laboratory
Course Code: FMAP-6335

Examination Time: 3 Hours | Max. Marks: 50
Practical: 35
CA:15

L T P
0 0 2

List of Practicals (using any package)

1. Finding and visualizing extremes of function of two variables.

2. Approximating area and volume using double integration.

3. Plotting graph of the surface z=f (x, y).

4. Approximating triple Integrals.

5. Draw vector fields in plane.

Text Books:-

1. G.B. Thomas and R.L. Finney. Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley, and K. J. Smith. Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba, and A. Weinstein. Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. J. Stewart. Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.