Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Department of Mathematics

B.Sc. Mathematics

Programme Outcomes

1. Attain and apply fundamental knowledge in basic concepts of Science
2. Gain Competence to communicate effectively
3. Develop critical thinking for innovations
4. Identify problems and suggest appropriate scientific, technological and environmental solutions.
5. Function individually or as a team in work environment
6. Acquire research skills to inquire, synthesize and articulate solution for community development.
7. Create and apply ICT tools for learning and technology development
8. Exhibit professional ethics and norms for social development
9. Implement acquired knowledge in basic sciences for self directed and lifelong learning
10. Promote entrepreneurial skills

Programme Specific Outcomes

1. Attain firm foundation in Mathematics and thereby able to incorporate the attained knowledge in recent technological advancements.
2. Competency to meet global challenges through critical, rational, analytical and logical thinking.
3. Proficient in entrepreneurship and leadership qualities and capable to work in diverse fields.

N Balamani
8.2.2024

Scheme of Instruction & Examination
(for students admitted from 2023-2024 & onwards)

Part	*Subject Code*	*Name of Paper / Component*	*Hours of Instruction/ week*	*Scheme of Examination*				
				Duration of Exam	*CIA*	*CE*	*Total*	*Credit*
		First Semester						
I	23BLT001/ 23BLH001/ 23BLF001	பொதுத்தமிழ் தாள் I - இக்கால இலக்கியம் / Prose and Non Detailed Texts / French I	2	3	50	50	100	2
II	23BAEEC1	**Ability Enhancement Compulsory Course-I** English for Communication	4	3	50	50	100	4
	Generic Elective							
		Generic Elective-I	5+1/4+4	3	50	50	100	6
III	**Discipline Specific Core Courses**							
	23BMAC01	Calculus	5+1	3	50	50	100	6
	23BMAC02	Algebra and Geometry	5+1	3	50	50	100	6
IV	**23BVBNC1/ 23BVBNS1/ 23BVBSP1**	**Skill Enhancement Course Value Based Course Elective-I-** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1
	23BMAPA1	**Professional Aptitude Course** Computer Skills for Mathematics	5	-	-	-	-	Remark
		Games – Practical	1	-	-	-	-	-
	Total		**30/32**					**28/25**
		Second Semester						
I	23BLT002/ 23BLH002/ 23BLF002	பொதுத்தமிழ் தாள் II - அற இலக்கியம் / Grammar, Translation and General Essay / French II	2	3	50	50	100	2
II	23BAEES1	**Ability Enhancement Compulsory Course-II** Environmental Studies	4	3	50	50	100	4

	Generic Elective							
	23BENGE2A/ 23BENGE2B/ 23BENGE2C/ 23BENGE2D	**Generic Elective-II** Introduction to Literature / British Literature / Modern Indian Literature / New Literatures in English	5+1	3	50	50	100	6
III	**Discipline Specific Core Courses**							
	23BMAC03	Multivariable Calculus	5+1	3	50	50	100	6
	23BMAC04	Ordinary Differential Equations	5+1	3	50	50	100	6
IV	**23BVBNC2/ 23BVBNS2/ 23BVBSP2**	**Skill Enhancement course Value Based Course Elective-I** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1
	23BMAPA2	**Professional Aptitude Course** MATLAB	5	-	-	-	-	Remarks
		Games – Practical	1	-	-	-	-	-
	Total		**30**					**28/25**
		Third Semester						
I	23BLT003/ 23BLH003/ 23BLF003	பொதுத்தமிழ் தாள் III - சமய இலக்கியம் / Ancient and Modern Poetry / French III	2	3	50	50	100	2
II	**Generic Elective**							
		Generic Elective - III	5+1/4+4	3	50	50	100	6
III	**Discipline Specific Core Courses**							
	23BMAC05	Real Analysis	5+1	3	50	50	100	6
	23BMAC06	Group Theory	5+1	3	50	50	100	6
IV	**Skill Enhancement Courses**							
	23BSBCS1	**Skill Based Compulsory Course –I** Communication Skill	4	3	50	50	100	2
		Skill Based Elective Course –II	4	3	50	50	100	2
	23BVBNC3/ 23BVBNS3/ 23BVBSP3	**Value Based Course Elective-I-** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1
		Value Based Course Elective-II	2		100	-	100	2
	Total		**30/32**					**30/27**

		Fourth Semester						
I	23BLT004/ 23BLH004/ 23BLF004	பொதுத்தமிழ் தாள் IV - சங்க இலக்கியம் / Introduction to Functional Hindi and Journalism / French IV	2	3	50	50	100	2
II	**Generic Elective**							
		Generic Elective - IV	5+1/4+4	3	50	50	100	6
III	**Discipline Specific Core Courses**							
	23BMAC07	Mechanics	5+1	3	50	50	100	6
	23BMAC08	Linear Algebra	5+1	3	50	50	100	6
IV	**Skill Enhancement Courses**							
	23BSBSS1	**Skill Based Compulsory Course-III** Soft Skill	4	3	50	50	100	2
		Skill Based Elective Course-IV	4	3	50	50	100	2
	23BVBNC4/ 23BVBNS4/ 23BVBSP4	**Value Based Course Elective-I-** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1
		Value Based Course Elective-III	2		100	-	100	2
	Total		**30/32**					**30/27**
		Fifth Semester						
III	**Discipline Specific Core Courses**							
	23BMAC09	Set Theory and Metric Spaces	5+1	3	50	50	100	6
	23BMAC10	Advanced Algebra	5+1	3	50	50	100	6
	Discipline Specific Elective Courses							
	23BMADE1	**DSE – I** Internship / Project and Internship	2		100	-	100	6
	23BMADE2 - 23BMADE7	**DSE - II**	5+1	3	50	50	100	6
IV	**Skill Enhancement Course**							
	23BVBNC5/ 23BVBNS5/ 23BVBSP5	**Value Based Course Elective-I** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1
	23BMAPA3	**Professional Aptitude Course** Fundamentals of Data Science	5	-	-		-	Remarks

	23BMAPA4	**Professional Aptitude Course** Mathematics for Competitive Examinations	5	-	-	-	Remarks	
	Total		**30**				**28/25**	
		Sixth Semester						
III	**Discipline Specific Core Courses**							
	23BMAC11	Complex Analysis	5+1	3	50	50	100	6
	23BMAC12	Probability and Statistics	5+1	3	50	50	100	6
	Discipline Specific Elective Courses							
	23BMADE8 - 23BMADE11	**DSE - III**	5+1	3	50	50	100	6
	23BMADE12 - 23BMADE15	**DSE - IV**	5+1	3	50	50	100	6
	Skill Enhancement courses							
IV	**23BVBNC6/ 23BVBNS6/ 23BVBSP6**	**Value Based Course Elective-I** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1
	23BMAPA5	**Professional Aptitude Course** Applications of Mathematics	5	-	-	-	-	Remarks
		Library	1	-	-	-	-	
	Total		**30**					**28/25**
			Total credits					**172/154**

- **Ability Enhancement Compulsory Courses**
  - English for Communication
  - Environmental Studies

- **Skill Enhancement Courses**, are Skill Based and / or Value Based which are aimed at providing hands on training, competencies, skills etc. and may be opted by the students from the electives offered by the departments or from SWAYAM MOOCs / NPTEL

Skill Based Compulsory Courses

- **Skill Based Compulsory Course I – 23BSBCS1 – Communication Skill during 3rd semester**
- **Skill Based Compulsory Course III - 23BSBSS1 – Soft Skill during 4th semester**
- **Skill Based Courses** offered by Department of Mathematics

S.No	Skill Based Courses (II/IV)	Semester	Hours of Instruction	Credit/ Course
1.	23BMASE1 Numerical Methods using MATLAB	3 & 4	4P	2
2.	23BMASE2 Statistics with R			
3.	23BMASE3 Latex			
4.	23BMASE4 Statistical Quality control using R-Programming			

- **Value Based Courses - Elective I**

Value Based Courses Elective I	Subject Code	Semester	No of .Credits
NCC/	23BVBNC1-6/	1-6	24 Credits
NSS/	23BVBNS1-6/		6 Credits
Sports	23BVBSP1-6		6 Credits

* **Discipline Specific Elective Courses** should be related to their own core which may be from SWAYAM MOOCs / NPTEL also

- All the courses have 6 credits with 4 hours of theory and 4 hours of practicals or 5 hours of theory and 1 hour of Tutorials.

S.No	DSE Courses	Semester	Hours of Instruction Theory + Tutorial	Credits
1	23BMADE1 Internship / Project and Internship	5	2	6
2	23BMADE2 Mathematical Logic		5+1	
3	23BMADE3 Tensors and Differential Geometry			
4	23BMADE4 Linear Programming			
5	23BMADE5 Wavelets and Applications			
6	23BMADE6 Information Theory and Coding			
7	23BMADE7 Special Theory of Relativity			
8	23BMADE8 Discrete Mathematics	6		
9	23BMADE9 Integral Transforms and Fourier Analysis			
10	23BMADE10 Number Theory			
11	23BMADE11 Mathematical Finance			
12	23BMADE12 C++Programming for Mathematics			
13	23BMADE13 Cryptography			
14	23BMADE14 Advanced Mechanics			
15	23BMADE15 Graph Theory			

* **Generic Elective Courses** offered for other disciplines / departments
  - A Core Course offered in a Discipline / Subject may be offered as a Generic Elective for other departments.

S.No	Generic Elective Courses	Semester	Hours of Instruction Theory + Tutorial	Credits
1	23BMAGE1 Mathematics for Physics	1, 3, 4	5+1	6
2	23BMAGE2 Mathematics for Chemistry			
3	23BMAGE3 Mathematics for Computer Science			
4	23BMAGE4 Fundamentals of Statistics			
5	23BMAGE5 Mathematics for Information Technology			
6	23BMAGE6 Operations Research			
7	23BMAGE7 Quantitative Aptitude	3, 4, 6		
8	23BMAGE8 Indian Mathematics			

Total credits to earn the degree

1. Part I components - 8 Credits (Languages)
2. Part II components – 32 Credits [Ability Enhancement Compulsory Courses – 8 Credits and Generic Elective Courses – 24 Credits]
3. Part III components - 96 Credits (Discipline Specific Core Courses – 72 Credits and Discipline Specific Elective Courses - 24 Credits)
4. Part IV components -36/18 Credits (Skill Enhancement Courses -Skill Based Courses – 8Credits, Value Based Courses Elective I (NCC/NSS/Sports) –24 / 6 / 6, Value Based Elective Courses II &III – 4 Credits)
5. **Minimum One Course should be from SWAYAM MOOCs/ NPTEL.**

Total credits to earn the degree.

One to 4 Courses may be from SWAYAM MOOCs/NPTEL for Credit Transfer in DSE/Generic Elective.

Calculus

Semester - I **Hours of Instruction/week: 5+1**

23BMAC01 **No. of credits: 6**

Course Objectives:

1. To understand the concept of sequences, limit and continuity.
2. To learn various theorems on differentiability.
3. To know about curvature and curve tracing.

Unit - I: **15 hrs.**

Sequences and Integration: Real numbers - Sequences of real numbers - Convergence of sequences and series - Bounded and monotonic sequences - Definite integral as a limit of sum - Integration of irrational algebraic functions and transcendental functions - Reduction formulae - Definite integrals.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Limit and Continuity: ε-δ definition of limit of a real valued function - Limit at infinity and infinite limits - Continuity of a real valued function - Properties of continuous functions - Intermediate value theorem - Geometrical interpretation of continuity - Types of discontinuity - Uniform continuity.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Differentiability: Differentiability of a real valued function - Geometrical interpretation of differentiability - Relation between differentiability and continuity - Differentiability and monotonicity - Chain rule of differentiation - Darboux's theorem - Rolle's theorem - Lagrange's mean value theorem - Cauchy's mean value theorem - Geometrical interpretation of mean value theorems - Successive differentiation - Leibnitz's theorem.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Expansions of Functions: Maclaurin's and Taylor's theorems for expansion of a function in an infinite series - Taylor's theorem in finite form with Lagrange - Cauchy and Roche-Schlomilch forms of remainder - Maxima and minima.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Curvature, Asymptotes and Curve Tracing: Curvature - Asymptotes of general algebraic curves - Parallel asymptotes - Asymptotes parallel to axes - Symmetry - Concavity and convexity - Points of inflection - Tangents at origin - Multiple points - Position and nature of double points - Tracing of Cartesian - polar and parametric curves.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. Richard R Goldberg (1976), "***Methods of Real Analysis***", John willey and Sons, Newyork. (Unit I)
2. Gorakh Prasad (2015), "***Integral Calculas***", Pothishala Private Ltd., Allahabad (Unit I)
3. Gorakh Prasad (2016), "***Differential Calculus (19th edition)***", Pothishala Pvt. Ltd. (Unit II-V)

References:

1. Howard Anton, I. Bivens & Stephan Davis (2016), "***Calculus (10th edition)***", Wiley India.
2. Gabriel Klambauer (1986), "***Aspects of Calculus***", Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003), "***Calculus with Maple Labs***", Narosa.
4. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018), "***Thomas' Calculus (14th edition)***", Pearson Education.

Course Outcomes:

On completion of the course, the students will be able to

1. assimilate the notions of limit of a sequence and convergence of a series of real numbers.
2. calculate the limit and examine the continuity of a function at a point.
3. understand the consequences of various mean value theorems for differentiable functions.
4. sketch curves in Cartesian and polar coordinate systems.
5. apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H		L	M	L	L		L	H	L	H	H	L
CO 2	H		H	H	L	L			H	L	H	H	L
CO 3	H		M	M	L	L		L	H	L	H	H	L
CO 4	H	M	H	H	M	M	M	M	H	H	H	H	L
CO 5	H	H	H	H	M	H	H	M	H	H	H	H	H

Algebra and Geometry

Semester - I **Hours of Instruction/week: 5+1**

23BMAC02 **No. of credits: 6**

Course Objectives:

1. To acquire the knowledge on theory of equations and complex numbers.
2. To solve system of linear equations using different methods.
3. To learn properties of geometrical figures in two and three dimensions.

Unit - I: **15 hrs.**

Theory of Equations and Complex Numbers: Elementary theorems on the roots of an equations including Cardan's method - The remainder and factor theorems - Synthetic division - Factored form of a polynomial - The Fundamental theorem of algebra - Relations between the roots and the coefficients of polynomial equations - Imaginary roots - Integral and rational roots - Polar representation of complex numbers - The *n*th roots of unity - De Moivre's theorem for integer and rational indices and its applications.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Relations and Basic Number Theory: Relations - Equivalence relations - Equivalence classes – Functions - Composition of functions - Inverse of a function - Finite, countable and uncountable sets - The division algorithm - Divisibility and the Euclidean algorithm - The fundamental theorem of arithmetic - Modular arithmetic and basic properties of congruences - Principles of mathematical induction and well ordering.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Row Echelon Form of Matrices and Applications: Systems of linear equations - Row reduction and echelon forms - Linear independence - The rank of a matrix and applications - Introduction to linear transformations - The matrix of a linear transformation - Matrix operations – Determinants - The inverse of a matrix - Characterizations of invertible matrices - Applications to Computer Graphics - Eigenvalues and eigenvectors - The characteristic equation and the Cayley-Hamilton theorem.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Planes, Straight Lines and Spheres: Planes: Distance of a point from a plane - Angle between two planes - pair of planes - Bisectors of angles between two planes; Straight lines: Equations of straight lines - Distance of a point from a straight line - Distance between two straight lines - Distance between a straight line and a plane; Spheres: Different forms - Intersection of two spheres - Orthogonal intersection - Tangents and normal - Radical plane - Radical line - Coaxial system of spheres - Pole, Polar and Conjugacy.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Locus, Surfaces, Curves and Conicoids: Space curves - Algebraic curves - Ruled surfaces - Some standard surfaces - Classification of quadric surfaces - Cone - Cylinder - Central conicoids - Tangent plane - Normal - Polar planes and Polar lines.

Tutorial **3 hrs.**

Total hours : 90

References:

1. Titu Andreescu, & Dorin Andrica (2014), "***Complex Numbers from A to...Z. (2nd edition)***", Birkhäuser.
2. Robert J. T. Bell (1994), "***An Elementary Treatise on Coordinate Geometry of Three Dimensions***", Macmillan India Ltd.
3. D. Chatterjee (2009), "***Analytical Geometry: Two and Three Dimensions***", Narosa Publishing House.
4. Leonard Eugene Dickson (2009), "***First Course in the Theory of Equations***", The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
5. Edgar G. Goodaire & Michael M. Parmenter (2015), "***Discrete Mathematics with Graph Theory (3rd edition)***", Pearson Education Pvt. Ltd. India.
6. Bernard Kolman & David R. Hill (2003), "***Introductory Linear Algebra with Applications (7th edition)***", Pearson Education Pvt. Ltd. India.
7. David C. Lay, Steven R. Lay & Judi J. McDonald (2016), "***Linear Algebra and its Applications (5th edition)***", Pearson Education Pvt. Ltd. India.

Course Outcomes:

On completion of the course, the students will be able to

1. understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
2. familiarize with relations, equivalence relations and partitions.
3. employ De Moivre's theorem in a number of applications to solve numerical problems.
4. recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
5. find eigenvalues and corresponding eigenvectors for a square matrix.
6. explain the properties of three dimensional shapes.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	H	L	L	L		H	M	H	H	L
CO 2	H	L	H	H	L			L	H	L	H	H	L
CO 3	H	L	H	M			M		H	M	H	H	M
CO 4	M		M	M	H	M	L	M	H		H	H	L
CO 5	H	L	H	H		L		L	H	L	H	H	H
CO 6	H	H	H	H	M	L	H	L	H	H	L	L	L

Department of Mathematics

Professional Aptitude Course

Computer Skills for Mathematics

Semester- I **Hours of Instruction/week: 5**

23BMAPA1

Course Objectives:

1. To acquire computer knowledge.
2. To work in Excel.
3. To learn Power point & Access.

Unit I: **6 hrs.**

Ms-Word: Introduction - Starting word - Creating Documents - Parts of Word Window - Mouse operations - Keyboard operations - Menus -Toolbars and their icons - New Document - Entering text - Change the Font - Font size - Aligning the text - Saving - Closing - Opening Document - Creating tables - Inserting Columns and Rows - Borders - Insert pictures - Print - Mail Merge.

Practical **9 hrs.**

Unit II: **6 hrs.**

Ms-Excel: Introduction - Menus - Commands Toolbars and their Icons - Starting Excel - Entering text in cells - Columns width - Alternative method - Series fill - Entering formulas - Formatting cells - Formatting text (Bold - Italic) - Inserting Rows and Columns – Worksheet.

Practical **9 hrs.**

Unit III: **6 hrs.**

Data Visualization through MS Excel: Charts: Chart Elements: Titles-Legend- Data Labels-Creating a new chart-Formatting the chart-Types of Charts- Using chart templates

Pivot tables: Creating a pivot table-Filtering and sorting-Using slicers to manipulate pivot table-creating a pivot chart

Practical **9 hrs.**

Unit IV: **6 hrs.**

Ms-PowerPoint: Introduction - Menus - Toolbar - Creating a new presentation - Opening a presentation - Creating a new slide - Deleting a slide -Copying a slide - Slide numbering - Saving a presentation - Auto Save - Changing Font - Font size - Bold - Insert a picture - Entering Data to graph - Master slide - Color Box - Templates - Animations.

Practical **9 hrs.**

Unit V: **6 hrs.**

Ms-Access: Introduction - What is a Database - Parts of an Access Window - Starting Microsoft Access - Creating a New Database - Creating a Database through Table Wizard - Creating a New Table - Saving the Database - Relationships - Creating Table through Design View - Relationship - Query - Form - Reports.

Practical **9 hrs.**

Total hours: 75

Text Book:

1. Sanjay Saxena (2009), "***MS Office 2000 for everyone***", Vikas Publishing House Pvt., Ltd.

Reference:

1. Stephen Moffat (2010), "***Microsoft Word 2010 Advanced***", Book Boon Publisher.

Course Outcomes:

On completion of the course, the students will be able to

1. perform documentation in Ms - Word.
2. solve problems using functions in Excel.
3. create pivot table and chart.
4. understand the various menus in MS powerpoint.
5. apply Ms-Access to retrieve data.

Multivariable Calculus

Semester - II **Hours of Instruction/week: 5+1**

23BMAC03 **No. of credits: 6**

Course Objectives:

1. To learn the concepts of differentiation and partial differentiation.
2. To know the fundamentals of vector field.
3. To study multiple integrals and its applications.

Unit - I: **15 hrs.**

Partial Differentiation: Functions of several variables - Level curves and surfaces - Limits and continuity - Partial differentiation - Tangent planes - Chain rule - Directional derivatives - The gradient - Maximal and normal properties of the gradient - Tangent planes and normal lines.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Differentiation: Higher order partial derivatives - Total differential and differentiability - Jacobians - Change of variables - Euler's theorem for homogeneous functions - Taylor's theorem for functions of two variables and more variables - Envelopes and evolutes.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Extrema of Functions and Vector Field: Extrema of functions of two and more variables - Method of Lagrange multipliers - Constrained optimization problems - Definition of vector field - Divergence - curl - gradient and vector identities.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Double and Triple Integrals: Double integration over rectangular and nonrectangular regions - Double integrals in polar coordinates - Triple integral over a parallelepiped and solid regions - Volume by triple integrals - Triple integration in cylindrical and spherical coordinates - Change of variables in double and triple integrals - Dirichlet integral.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Green's, Stokes' and Gauss Divergence Theorem: Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields -

Green's theorem - Area as a line integral - Surface integrals - Stokes' theorem - The Gauss divergence theorem.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. Edwin Jed Herman and Gilbert Strang (2018), "***Calculus Volume 3***", Openstax, Rice University, Houston, Texas.
2. S.K.Sengar and S.P.Singh (2011), "***Advanced Calculus***", Cengage Learning India Pvt. Ltd., Delhi.

References:

1. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). ***Basic Multivariable Calculus***, Springer India Pvt. Limited.
2. James Stewart (2012), "***Multivariable Calculus (7th edition)***", Brooks/Cole. Cengage.
3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011), "***Calculus (3rd edition)***", Pearson Education, Dorling Kindersley (India) Pvt. Ltd.
4. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018), "***Thomas' Calculus (14th edition)***", Pearson Education.

Course Outcomes:

On completion of the course, the students will be able to

1. learn conceptual variations while advancing from one variable to several variables in calculus.
2. apply multivariable calculus in optimization problems.
3. inter-relationship amongst the line integral, double and triple integral formulations.
4. applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.
5. realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	M			L	L	H		H	H	L
CO 2	H	H	H	H	L	M	L	L	H	H	H	H	L
CO 3	H	M	H	M			L		H	L	H	H	M
CO 4	H	L	H	H	M	H	M	M	H	M	H	H	M
CO 5	H	L	H	M		L	L		H	L	H	L	H

Ordinary Differential Equations

Semester - II **Hours of Instruction/week: 5+1**

23BMAC04 **No. of credits: 6**

Course Objectives:

1. To acquire skills to solve differential equations of first and second order.
2. To solve the higher order differential equations using different methods.
3. To understand the applications of differential equations.

Unit - I: **15 hrs.**

First Order Differential Equations: Basic concepts and genesis of ordinary differential equations - Order and degree of a differential equation - Differential equations of first order and first degree - Equations in which variables are separable - Homogeneous equations - Linear differential equations and equations reducible to linear form - Exact differential equations - Integrating factor - First order higher degree equations solvable for x, y and p - Clairaut's form and singular solutions - Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Second Order Linear Differential Equations: Statement of existence and uniqueness theorem for linear differential equations - General theory of linear differential equations of second order with variable coefficients - Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients - Transformations of the equation by changing the dependent/independent variable - Method of variation of parameters and method of undetermined coefficients - Reduction of order - Coupled linear differential equations with constant coefficients.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Higher Order Linear Differential Equations: Principle of superposition for a homogeneous linear differential equation - Linearly dependent and linearly independent solutions on an interval - Wronskian and its properties - Concept of a general solution of a linear differential equation - Linear homogeneous and non-homogeneous equations of higher order with constant coefficients

- Euler-Cauchy equation - Method of variation of parameters and method of undetermined coefficients - Inverse operator method.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Series Solutions of Differential Equations: Power series method - Legendre's equation - Legendre polynomials - Rodrigue's formula - Orthogonality of Legendre polynomials - Frobenius method - Bessel's equation - Bessel functions and their properties - Recurrence relations.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Applications: Orthogonal trajectories - Acceleration-velocity model - Minimum velocity of escape from Earth's gravitational field - Growth and decay models - Malthusian and logistic population models - Radioactive decay - Drug assimilation into the blood of a single cold pill - Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip - Phenomena of resonance - LCR circuits - Lotka-Volterra population model.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. S. Narayanan and T.K. Manickavachagom Pillay *(2016), **"Differential Equations and its Application"***, S.Viswanathan (Printers and Publishers) Pvt., Ltd.
2. Erwin Kreyszig (2011*), "**Advanced Engineering Mathematics (10th edition)"***, Wiley.
3. B. Rai, D. P. Choudhury & H. I. Freedman (2013), ***"A Course in Ordinary Differential Equations (2nd edition)"***, Narosa.
4. George F. Simmons (2017), ***"Differential Equations with Applications and Historical Notes (3rd edition)"***, CRC Press. Taylor & Francis.

References:

1. Belinda Barnes & Glenn Robert Fulford (2015), ***"Mathematical Modelling with Case Studies: A Differential Equation Approach Using Maple and MATLAB (2nd edition)"***, Chapman & Hall/CRC Press, Taylor & Francis.

2. H. I. Freedman (1980), ***"Deterministic Mathematical Models in Population Ecology"***, Marcel Dekker Inc.
3. Daniel A. Murray (2003), ***" Introductory Course in Differential Equations"***, Orient.
4. Shepley L. Ross (2007), ***"Differential Equations (3^{rd} edition)"***, Wiley India.

Course Outcomes:

On completion of the course, the students will be able to

1. understand the genesis of ordinary differential equations.
2. learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
3. know Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.
4. grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
5. formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H		L	L		H		H	H	M
CO 2	H	L	H	H	L	L	M		H		H	H	L
CO 3	H	H	H	H	L	M	M	L	H	L	H	H	M
CO 4	H	L	H	H		L	L		H		H	H	M
CO 5	H	H	H	H	M	H	M	H	H	M	H	L	H

Department of Mathematics

Professional Aptitude Course

MATLAB

Semester -II **Hours of Instruction/week: 5**

23BMAPA2

Course Objectives:

1. To learn the basic ideas of matrix.
2. To visualize the graphs by plotting 2-dim and 3-dim plots.
3. To study numerical differentiation and integration.

Creating and working with Arrays of numbers.
Creating and Printing Simple Plots.
Creating, saving and executing a Script file.
Creating and Executing a Function File.
Creating Command Line Functions.
Working with Matrices and Array Operations.
Working with Built-in Functions.
Solving a linear system of equations.
Finding eigen values and eigen vectors.
Solving numerical in Integration(quadrature).
Solving Ordinary Differential Equation.
Solving Nonlinear Algebraic equations.
Programs for Basic 2-D Plots-3-D Plots.

Total hours: 75

Text Book:

1. Rudra Pratap (2006), ***Gettting Started with MATLAB 7 - A Quick Introduction for Scientists and Engineer***, Oxford University Press.

Reference:

1. Y. Kirani Singh, B.B. Chandhuri (2007), ***MATLAB Programming***, Printice Hall of India, Pvt. Ltd., New Delhi.

Course Outcomes:

On completion of the course the students will be able to

1. understand the basic terminologies used in Matlab.
2. find the solution for any system of linear equations.
3. evaluate differentiation with the given data.
4. use the software (MATLAB) to do numerical calculations in their project work.
5. interpret the data using 2D and 3D plots.

Real Analysis

Semester - III **Hours of Instruction/week: 5+1**

23BMAC05 **No. of credits: 6**

Course Objectives:

1. To understand the fundamental concepts of Real Number System.
2. To demonstrate the theory of sequences and series, continuity, differentiation and integration.
3. To learn the concepts of Limits, Uniform Convergence and Ratio Test.

Unit-I: **15hrs.**

Real Number System : Algebraic and order properties of $\mathbb{R}$- Absolute value of a real number- Bounded above and bounded below sets- Supremum and infimum of a nonempty subset of $\mathbb{R}$- The completeness property of $\mathbb{R}$- Archimedean property- Density of rational numbers in $\mathbb{R}$- Definition and types of intervals- Nested intervals property-Neighborhood of a point in $\mathbb{R}$- Open, closed and perfect sets in $\mathbb{R}$-Connected subsets of $\mathbb{R}$- Cantor set and Cantor function.

Tutorial **3hrs.**

Unit-II: **15hrs.**

Sequences of Real Numbers : Convergent sequence- Limit of a sequence- Bounded sequence- Limit theorems- Monotone sequences- Monotone convergence theorem- Subsequences- Bolzano□Weierstrass theorem for sequences- Limit superior and limit inferior of a sequence of real numbers- Cauchy sequence- Cauchy's convergence criterion.

Tutorial **3hrs.**

Unit-III: **15hrs.**

Infinite Series : Convergence and divergence of infinite series of positive real numbers- Necessary condition for convergence- Cauchy criterion for convergence- Tests for convergence of positive term series- Basic comparison test- Limit comparison test- D'Alembert's ratio test-Cauchy's n^{th} root test- Integral test-Alternating series- Leibniz test-Absolute and conditional convergence-Rearrangement of series and Riemann's theorem.

Tutorial **3hrs.**

Unit-IV: **15hrs.**

Riemann Integration : Riemann integral- Integrability of continuous and monotonic functions- Fundamental theorem of integral calculus- First mean value theorem- Bonnet and Weierstrass forms of second meanvalue theorems.

Tutorial **3hrs.**

Unit-V: **15hrs.**

Uniform convergence and Improper integral: Pointwise and uniform convergence of sequence and series of functions- Weierstrass's M-test- Dirichlet test and Abel's test for uniform convergence- Uniform convergence and continuity- Uniform convergence and differentiability- Improper integrals- Dirichlet test and Abel's testfor improper integrals.

Tutorial **3hrs.**

Total hours : 90

Text Book:

1. Robert G. Bartle & Donald R. Sherbert (2015), ***"Introduction to Real Analysis* (4th edition)"**, Wiley India.

Reference:

1. K. A. Ross (2013), ***"Elementary Analysis: The Theory of Calculus (2nd edition)"***, Springer.

Course Outcomes:

On completion of the course, the students will be able to

1. understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
2. recognize bounded, convergent, divergent, Cauchy and monotonic sequences and tocalculate their limit superior, limit inferior, and the limit of a bounded sequence.
3. apply the ratio, root, alternating series and limit comparison tests for convergenceand absolute convergence of an infinite series of real numbers.
4. learn some of the properties of Riemann integrable functions, and the applications ofthe fundamental theorems of integration.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	H	H	M		H		L	H	L	H	M	L
CO 2	H	H	H	H		H			H	L	H	M	L
CO 3	H		M	M	L	L		L	H	L	H	H	L
CO 4	H	M	M	H		M	M	M	H	H	H	H	L

Group Theory

Semester - III **Hours of Instruction/week: 5+1**

23BMAC06 **No. of credits: 6**

Course Objectives:

1. To learn the concepts of group and its types
2. To understand the properties of permutation group and its consequences
3. To acquire on knowledge on homomorphisms and isomorphisms of groups

Unit-I: **15 hrs.**

Groups and its Elementary Properties: Symmetries of a square- Definition and examples of groups including dihedral- permutation and quaternion groups- Elementary properties of groups.

Tutorial **3 hrs.**

Unit-II: **15 hrs.**

Subgroups and Cyclic Groups: Subgroups and examples of subgroups- Cyclic groups- Properties of cyclic groups- Lagrange's theorem- Euler phi function- Euler's theorem- Fermat's little theorem.

Tutorial **3 hrs.**

Unit-III: **15 hrs.**

Normal Subgroups: Properties of cosets- Normal subgroups- Simple groups- Factor groups- Cauchy's theorem for finite abelian groups-Centralizer- Normalizer- Center of a group- Product of two subgroups-Classification of subgroups of cyclic groups.

Tutorial **3 hrs.**

Unit-IV: **15 hrs.**

Permutation Groups: Cycle notation for permutations- Properties of permutations- Even and odd permutations- alternating groups- Cayley's theorem and its applications.

Tutorial **3 hrs.**

Unit-V: **15 hrs.**

Group Homomorphism- Rings and Fields- Group homomorphisms- Properties of homomorphisms- Group isomorphisms- Properties of isomorphisms- First, second and third isomorphism theorems for groups- Definitions and elementary properties of rings and fields.

Tutorial **3 hrs.**

Total hours : 90

Text Book:

1. Joseph A. Gallian (2017). ***Contemporary Abstract Algebra*** (9^{th} edition). Cengage.

References:

1. Michael Artin (2014), "***Algebra* (2^{nd} edition)**", Pearson.
2. John B. Fraleigh (2007), "***A First Course in Abstract Algebra* (7^{th} edition)**", Pearson.
3. I. N. Herstein (2006), "***Topics in Algebra* (2^{nd} edition)**", Wiley India.
4. Nathan Jacobson (2009), "***Basic Algebra* I (2^{nd} edition)**", Dover Publications.
5. Ramji Lal (2017), "***Algebra 1: Groups, Rings, Fields and Arithmetic***", Springer.
6. I.S. Luthar & I.B.S. Passi (2013), "***Algebra: Volume 1: Groups***", Narosa.

Course Outcomes:

On completion of the course, the students will be able to

1. recognize the mathematical objects called groups.
2. link the fundamental concepts of groups and symmetries of geometrical objects.
3. explain the significance of the notions of cosets, normal subgroups, and factor groups.
4. analyze consequences of Lagrange's theorem.
5. learn about structure preserving maps between groups and their consequences.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	L		M		M	L	M	M	M	H
CO 2	H	H	M	L		H	L		M	M	M	M	M
CO 3	H	M	L			H		M	L	L	H	M	M
CO 4	M	L	M			M		H			M	L	M
CO 5	H	M	M	M		H	L	M	M	M	H	M	M

Mechanics

Semester - IV

Hours of Instruction/week: 5+1

23BMAC07

No. of credits: 6

Course Objectives:

1. To learn the fundamentals of Mechanics
2. To learn the Applications of Mechanics
3. To develop the skills of scientific applications using the techniques of Mechanics

Unit-I: **15 hrs.**

Statics: Equilibrium of a particle- Equilibrium of a system of particles- Necessary conditions of equilibrium- Moment of a force about a point- Moment of a force about a line- Couples- Moment of a couple- Equipollent system of forces- Work and potential energy- Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body- Forces which can be omitted in forming the equations of virtual work.

Tutorial **3 hrs.**

Unit-II: **15 hrs.**

Centres of Gravity and Common Catenary: Centres of gravity of plane area including a uniform thin straight rod- triangle, circular arc- semicircular area and quadrant of a circle- Centre of gravity of a plane area bounded by acurve- Centre of gravity of a volume of revolution- Flexible strings- Common catenary-Intrinsic and Cartesian equations of the common catenary- Approximations of the catenary.

Tutorial **3 hrs.**

Unit-III: **15 hrs.**

Rectilinear Motion: Simple harmonic motion (SHM) and its geometrical representation- SHM under elastic forces- Motion under inverse square law-Motion in resisting media- Concept of terminal velocity-Motion of varying mass.

Tutorial **3 hrs.**

Unit-IV: **15 hrs.**

Motion in a Plane: Kinematics and kinetics of the motion- Expressions for velocity and

acceleration in Cartesian- polar and intrinsic coordinates- Motion in a vertical circle- projectiles in a vertical plane andcycloidal motion.

Tutorial **3 hrs.**

Unit-V: **15 hrs.**

Central Orbits: Equation of motion under a central force- Differential equation of the orbit- (p, r) equation of the orbit- Apses and apsidal distances- Areal velocity- Characteristics of central orbits- Kepler's laws of planetary motion.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. *J. L. Synge & B. A. Griffith* (1949), ***"Principles of Mechanics"***, McGraw-Hill. (Unit I)
2. *M. K. Venkataraman (2002),* ***"A Text Book of Statics"***, Agasthiar Publications, Tenth edition. (Unit I, II)
3. *M. K. Venkataraman (2001),* ***"A Text Book of Dynamics"***, Agasthiar Publications, 10th edition (Unit III, IV,V)
4. *P. Duraipandian, Laxmi Duraipandian and Muthamizh Jayapragasam (2007),* ***"Mechanics"***, S.Chand& Company Ltd., New Delhi. (Unit IV ,V)

References:

1. S. L. Loney (2006), ***An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies***. Read Books.
2. A. S. Ramsey (2009), ***Statics.*** Cambridge University Press.
3. A. S. Ramsey (2009), ***Dynamics***. Cambridge University Press.

Course Outcomes:

This course will enable the students to:

1. familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers, and engineers together.
2. understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forcesacting on a rigid body.

3. determine the centre of gravity of some materialistic systems and discuss theequilibrium of a uniform cable hanging freely under its own weight.
4. deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
5. learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long beforethe mathematical theory given by Newton.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	M	H		M	M	H	H		H	M	M
CO 2	M	L		M		L	M	L	M		M	M	L
CO 3	M		M	L			M	M	M		M	M	L
CO 4	M	M		M		H	L		M		M	M	M
CO 5	H		L	M		M	M	L	L		M	M	L

Linear Algebra

Semester - IV **Hours of Instruction/week: 5+1**

23BMAC08 **No. of credits: 6**

Course Objectives:

1. To understand the concepts of linear transformation and its properties.
2. To acquire knowledge on Inner product spaces.
3. To understand the concept of canonical form.

Unit-I: **15hrs.**

Vector Spaces : Definition and examples- Subspace, Linear span- Quotient space and direct sum of subspaces- Linearly independent and dependent sets- Bases and dimension.

Tutorial **3hrs.**

Unit-II: **15hrs.**

Linear Transformations : Definition and examples- Algebra of linear transformations- Matrix of a linear transformation-Change of coordinates-Rank and nullity of a linear transformation and rank-nullity theorem.

Tutorial **3hrs.**

Unit-III: **15hrs.**

Further Properties of Linear Transformations : Isomorphism of vector spaces- Isomorphism theorems- Dual and second dual of a vector space- Transpose of a linear transformation- Eigen vectors and eigen values of a linear transformation- Characteristic polynomial and Cayley–Hamilton theorem- Minimal polynomial.

Tutorial **3hrs.**

Unit-IV: **15hrs.**

Inner Product Spaces : Inner product spaces and orthogonality- Cauchy–Schwarz inequality-Gram–Schmidt orthogonalisation- Diagonalisation of symmetric matrices.

Tutorial **3hrs**

Unit-V: **15hrs**

Adjoint of a Linear Transformation and Canonical Forms : Adjoint of a linear operator- Hermitian, unitary and normal linear transformations- Jordan canonical form- Triangular form- Trace and transpose, Invariant subspaces.

Tutorial **3hrs.**

Total hours: 90

Text Books:

1. Kenneth Hoffman & Ray Kunze (2015), **"*Linear Algebra* (2nd edition)"**,Prentice-Hall.
2. Stephen H.Friedberg, Arnold J.Insel& Lawrence E. Spence (2003), **"*Linear Algebra* (4thedition)"**, Prentice-Hall of India Pvt. Ltd.

References:

1. Vivek Sahai & Vikas Bist (2013), **"*Linear Algebra (2nd Edition)"*,**Narosa Publishing House.
2. I.N.Herstein (2009), **"*Topics in Algebra (2nd edition)"*,** Narain printers and Binders.

Course Outcomes:

This course will enable the students to:

1. understand the concepts of vector spaces, subspaces, bases, dimension and theirproperties.
2. relate matrices and linear transformations, compute eigen values and eigen vectors oflinear transformations.
3. learn properties of inner product spaces and determine orthogonality in inner productspaces.
4. realise importance of adjoint of a linear transformation and its canonical form.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L		M	M	M	L	M	H		M	H	L
CO 2	H	L	L	M	H	M	M	L	H		M	H	M
CO 3	M	L		M	M		M	L	H	M	H	M	L
CO 4	M		M	M	L	L	M	M	H		H	H	M

Set Theory and Metric Spaces

Semester - V

23BMAC09 **Hours of Instruction/week: 5+1**

No. of credits: 6

Course Objectives:

1. To know the basic concepts of set theory.
2. To understand metric spaces and continuous functions.
3. To learn compactness and connectedness

Unit - I: **15 hrs.**

Theory of Sets: Finite and infinite sets - Countable and uncountable sets - Cardinality of sets - Schröder-Bernstein theorem - Cantor's theorem - Order relation in cardinal numbers - Arithmetic of cardinal numbers - Partially ordered set - Zorn's lemma and Axiom of choice - Various set theoretic paradoxes.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Concepts in Metric Spaces: Definition and examples of metric spaces - Open spheres and closed spheres – Neighbourhoods - Open sets – Interior - exterior and boundary points - Closed sets - Limit points and isolated points - Interior and closure of a set - Boundary of a set - Bounded sets - Distance between two sets - Diameter of a set - Subspace of a metric space.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Complete Metric Spaces and Continuous Functions: Cauchy and Convergent sequences - Completeness of metric spaces - Cantor's intersection theorem - Dense sets and separable spaces - Nowhere dense sets and Baire's category theorem - Continuous and uniformly continuous functions - Homeomorphism - Banach contraction principle.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Compactness: Compact spaces - Sequential compactness - Bolzano-Weierstrass property - Compactness and finite intersection property - Heine-Borel theorem - Totally bounded sets -

Equivalence of compactness and sequential compactness - Continuous functions on compact spaces.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Connectedness: Separated sets - Disconnected and connected sets – Components - Connected subsets of $\mathbb{R}$ - Continuous functions on connected sets.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. G. F. Simmons (2004), ***"Introduction to Topology and Modern Analysis"***, McGraw-Hill. (Unit I)
2. P. K. Jain & Khalil Ahmad (2019), ***"Metric Spaces"***, Narosa. (Units II to V)

References:

1. E. T. Copson (1988), ***"Metric Spaces"***, Cambridge University Press.
2. P. R. Halmos (1974), ***"Naive Set Theory"***, Springer.
3. S. Kumaresan (2011), ***"Topology of Metric Spaces"***, 2nd Edition, Narosa.
4. Satish Shirali & Harikishan L. Vasudeva (2006), ***"Metric Spaces"***, Springer-Verlag.
5. Micheál O'Searcoid (2009), ***"Metric Spaces"***, Springer-Verlag.

Course Outcomes:

On completion of the course, the students will be able to

1. learn basic facts about the cardinality of a set.
2. understand several standard concepts of metric spaces and their properties like openness and closedness.
3. identify the continuity of a function defined on metric spaces and homeomorphisms.
4. know the concepts of compactness, Bolzano-Weierstrass property and Totally Bounded sets.
5. recognize the difference between connected and disconnected sets and their properties.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	M	L	M	L	L		H	M	H	M	L
CO 2	H	L	H	M	M	L	M	L	H	M	H	H	M
CO 3	H		H	L	H		L		H	L	H	H	
CO 4	H	L	H	M	H	M	M	L	H	M	H	H	L
CO 5	H	L	H	M	H	L		M	H		H	H	

Advanced Algebra

Semester - V **Hours of Instruction/week: 5+1**

23BMAC10 **No. of credits: 6**

Course Objectives:

1. To know the concepts of orbits and stabilizers in groups.
2. To understand rings and polynomial rings.
3. To learn field extensions and finite fields.

Unit - I: **15 hrs.**

Group Actions: Group actions - Orbits and stabilizers - Conjugacy classes - Orbit-stabilizer theorem - Normalizer of an element of a group - Center of a group - Class equation of a group - Inner and outer automorphisms of a group.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Sylow Theorems: Cauchy's theorem for finite abelian groups - Finite simple groups - Sylow theorems and applications including nonsimplicity tests.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Rings and Fields: Definition - examples and elementary properties of rings - Commutative rings, Integral domain - Division rings and fields - Characteristic of a ring, Ring homomorphisms and isomorphisms - Ideals and quotient rings - Prime, principal and maximal ideals - Relation between integral domain and field - Euclidean rings and their properties - Wilson and Fermat's theorems.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Polynomial Rings: Polynomial rings over commutative ring and their basic properties - The division algorithm - Polynomial rings over rational field - Gauss lemma and Eisenstein's criterion - Euclidean domain - principal ideal domain - unique factorization domain.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Field Extensions and Finite Fields: Extension of a field - Algebraic element of a field - Algebraic and transcendental numbers - Perfect field - Classification of finite fields.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. I. N. Herstein (2006), ***"Topics in Algebra"***, 2nd Edition, Wiley India.
2. Joseph A. Gallian (2017), ***"Contemporary Abstract Algebra"***, 9th Edition, Cengage.

References:

1. Michael Artin (2014), ***"Algebra"***, 2nd Edition, Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003), ***"Basic Abstract Algebra"***, 2nd Edition, Cambridge University Press.
3. David S. Dummit & Richard M. Foote (2008), ***"Abstract Algebra"***, 2nd Edition, Wiley.
4. John B. Fraleigh (2007), ***"A First Course in Abstract Algebra"***, 7th Edition, Pearson.
5. N. S. Gopalakrishnan (1986), ***"University Algebra"***, New Age International Publishers.
6. Thomas W. Hungerford (2004), ***"Algebra"***, 8th Edition, Springer.
7. Nathan Jacobson (2009), ***"Basic Algebra I & II"***, 2nd Edition, Dover Publications.
8. Serge Lang (2002), ***"Algebra"***, 3rd Edition, Springer-Verlag.
9. I. S. Luthar & I. B. S. Passi (2013), ***"Algebra: Volume 1: Groups"***, Narosa.
10. I. S. Luthar & I. B. S. Passi (2012), ***"Algebra: Volume 2: Rings"***, Narosa.

Course Outcomes:

On completion of the course, the students will be able to

1. understand the basic concepts of group actions and their applications.
2. recognize and use the Sylow theorems to characterize certain finite groups.
3. know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains and fields.
4. learn in detail about polynomial rings.
5. grasp the fundamental properties of finite field extensions and classification of finite fields.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	H	L	L	M	H	L	H	H	L
CO 2	H	L	H	M	H	M	M	L	H	M	H	H	M
CO 3	H	M	H	M	H	L	L	M	H	L	H	H	L
CO 4	H	M	H	M	H	M	M	M	H	M	H	H	M
CO 5	H	L	H	L	H	L	M	L	H	M	H	H	M

Department of Mathematics

Professional Aptitude Course

Fundamentals of Data Science

Semester - V **Hours of Instruction/week: 5**

23BMAPA3 **No. of credits: Remarks**

Course Objectives:

1. To understand the fundamental concepts of Data Science.
2. To enable students to handle various dataset.
3. To analyze large datasets by identify patterns and make data-driven decisions.

Unit - I: **15 hrs.**

Basics of Data Science: Steps in doing Data Science - Data Science relation to other fields - Data Science and Information Science - Computational Thinking - Skills and tools needed to do Data Science.

Unit - II: **15 hrs.**

Basics of Data Science continued: Storing data - Combining bytes into larger structures - Creating data sets - Identifying data problem - Understanding data sources - Exploring data models- Introduction to Big Data.

Unit - III: **15 hrs.**

Data Handling: Structured and unstructured data - Challenges with unstructured data - Data collection: Open data - multimodal data.

Data Preprocessing: Data Cleaning - Data Integration, Data Transformation - Data Reduction – Data Discretization.

Unit - IV: **15 hrs.**

Artificial Intelligence: Introduction - History - Overview - Intelligent Agents - Performance Measure, Rationality - Structure of Agents - Problem solving agents - Problem Formulation - Uninformed Search Strategies - Informed (Heuristic) Search and Exploration.

Unit - V: **15 hrs.**

Machine Learning: Introduction - Examples of Machine Learning applications - Learning associations – Classification – Regression - Unsupervised Learning - Reinforcement Learning - Supervised learning - Input representation - Hypothesis class.

Total hours : 75

Text books:

1. Jeffrey S. Saltz & Jeffrey M. Stanton (2018), ***"An Introduction to Data Science"***, SAGE Publications.
2. Chirag Shah (2020), ***"A Hands - On Introduction to Data Science"***, Cambridge University Press.
3. Russel & Norvig (2007), ***"Artificial Intelligence: A Modern Approach"***, Pearson Education, 2nd Edition.
4. Kevin P. Murphy (2012), ***"Machine Learning: A Probabilistic Perspective"***, MIT Press.

References:

1. Cathy O'Neil & Rachel Schutt (2013), ***"Doing Data Science, Straight Talk from the Frontline"***, O'Reilly.
2. M. Tim Jones (2009), ***"Artificial Intelligence: A Systems Approach (Computer Science)"***, Jones and Bartlett Publishers, Inc.; First Edition.
3. David Barber (2012), ***"Bayesian Reasoning and Machine Learning"***, Cambridge University Press.

Course Outcomes:

On completion of the course, the students will be able to

1. understand the fundamental concepts of data science.
2. learn the concepts of data storage and Big Data.
3. illustrate the different types of process and tools used in data science.
4. validate the performance measures on agents and search agencies.
5. construct models to make predictions.

Department of Mathematics

Professional Aptitude Course

Mathematics for Competitive Examinations

Semester - V **Hours of Instruction/week: 5**

23BMAPA4 **No. of credits: Remarks**

Course Objectives:

1. To improve the problem solving skills.
2. To enhance the basic mathematical concepts.
3. To develop skill to meet the competitive examinations.

Unit - I: **15 hrs.**

Computation of Numbers: Number System, H.C.F and L.C.M of Numbers, Decimal Fractions, Simplification, Square Roots and Cube Roots, Problem on Numbers, Surds and Indices, Logarithms.

Unit - II: **15 hrs.**

Fundamentals of Arithmetical Operations: Average, Percentage, Profit and Loss, Ratio and Proportion, Partnership, Chain Rule.

Unit - III: **15 hrs.**

Distance and Work Problems: Time and Work, Time and Distance, Pipes and Cisterns, Boats and Streams, Problems on Trains, Alligation and mixture.

Unit - IV: **15 hrs.**

Arithmetical Ability: Simple Interest, Compound Interest, Area, Volume and Surface Area, Stock and Shares, Probability, True Discount, Banker's Discount, Heights and Distances.

Unit - V: **15 hrs.**

Mental Ability: Races and Games of Skills, Calendar, Clocks, Problems on Ages, Permutations and Combinations, Odd man out and Series.

Total hours: 75

Text Book:

1. R. S. Aggarwal (2016), ***"Quantitative Aptitude"*** (Fully solved), S. Chand.

References:

1. R. V. Praveen (2013), ***"Quantitative Aptitude and Reasoning"***, 2nd Revised Edition, Prentice Hall of India Pvt. Ltd.
2. G. K. Ranganath, C. S. Sampangiram & Y. Rajaram (2008), ***"A text Book of business Mathematics"***, Himalaya Publishing House.

Course Outcomes:

On completion of the course, the students will be able to

1. solve the problems related to numbers.
2. impart knowledge about fundamentals of arithmetical operations.
3. understand the concepts of distance and work.
4. compute the problems on business mathematics and mensuration.
5. identify an appropriate approach to solve quantitative problems.

Complex Analysis

Semester - VI **Hours of Instruction/week: 5+1**

23BMAC11 **No. of credits: 6**

Course Objectives:

1. To learn complex plane and analytic functions.
2. To understand complex integration and Cauchy's theorems.
3. To know power series, singularities and contour Integration.

Unit - I: **15 hrs.**

Complex Plane and functions: Complex numbers and their representation - algebra of complex numbers - Complex plane - Open set - Domain and region in complex plane - Stereographic projection and Riemann sphere - Complex functions and their limits including limit at infinity – Continuity - Linear fractional transformations and their geometrical properties.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Analytic Functions and Cauchy-Riemann Equations: Differentiability of a complex valued function - Cauchy-Riemann equations - Harmonic functions - necessary and sufficient conditions for differentiability - Analytic functions - Analyticity and zeros of exponential - trigonometric and logarithmic functions - Branch cut and branch of multi-valued functions.

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Cauchy's Theorems and Fundamental Theorem of Algebra: Line integral - Path independence - Complex integration - Green's theorem - Anti-derivative theorem – Cauchy-Goursat theorem - Cauchy integral formula - Cauchy's inequality - Derivative of analytic function - Liouville's theorem - Fundamental theorem of algebra - Maximum modulus theorem and its consequences.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Power Series: Sequences - series and their convergence - Taylor series and Laurent series of analytic functions - Power series - Radius of convergence - Integration and differentiation of power series - Absolute and uniform convergence of power series.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Singularities and Contour Integration: Meromorphic functions - Zeros and poles of meromorphic functions - Nature of singularities - Picard's theorem – Residues - Cauchy's residue theorem - Argument principle - Rouche's theorem - Jordan's lemma - Evaluation of proper and improper integrals.

Tutorial **3 hrs.**

Total hours : 90

Text Books:

1. P. Duraipandian & K. Pachaiyappa (2009), ***"Complex Analysis"***, Muhil Publishers.
2. James Ward Brown & Ruel V. Churchill (2009), ***"Complex Variables and Applications"***, 9th Edition, McGraw-Hill Education.

References:

1. Lars V. Ahlfors (2017), ***"Complex Analysis"***, 3rd Edition, McGraw-Hill Education.
2. Joseph Bak & Donald J. Newman (2010), ***"Complex Analysis"***, 3rd Edition, Springer.
3. John B. Conway (1973), ***"Functions of One Complex Variable"***, Springer-Verlag.
4. E.T. Copson (1970), ***"Introduction to Theory of Functions of Complex Variable"***, Oxford University Press.
5. Theodore W. Gamelin (2001), ***"Complex Analysis"***, Springer-Verlag.
6. George Polya & Gordon Latta (1974), ***"Complex Variables"***, Wiley.
7. H. A. Priestley (2003), ***"Introduction to Complex Analysis"***, Oxford University Press.
8. E. C. Titchmarsh (1976), ***"Theory of Functions"***, 2nd Edition, Oxford University Press.

Course Outcomes:

On completion of the course, the students will be able to

1. visualize complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere.
2. understand the significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.

3. learn the role of Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals.
4. apply Liouville's theorem in fundamental theorem of algebra.
5. understand the convergence, term by term integration and differentiation of a power series.
6. learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	L	H	H	M	H	M	L	H	M	H	H	M
CO 2	H	L	M	H	M	L	L	M	H	L	H	H	M
CO 3	M		L	M	M		L	L	H	M	H	M	L
CO 4	M		L	M	M		L	L	H	M	H	M	L
CO 5	H	L	H	M	H	M	M	L	H	M	H	H	L
CO 6	H	L	H	H	M	M	L	L	H	M	H	H	M

Probability and Statistics

Semester - VI **Hours of Instruction/week: 5+1**

23BMAC12 **No. of credits: 6**

Course Objectives:

1. To lay out fundamental concepts in probability theory.
2. To gain knowledge on theoretical distributions.
3. To learn the concept of correlation and regression.

Unit - I: **15 hrs.**

Theory of Probability and Random Variables: Basic notions of Probability - Conditional Probability and Independence - Baye's theorem - Random variables - Discrete and Continuous - Two dimensional random variables - Mathematical expectation - Covariance.

Tutorial **3 hrs.**

Unit - II: **15 hrs.**

Moment generating function and Law of Large Numbers: Moment generating function- Characteristic function - Chebyshev's Inequality - Weak law of large numbers - Strong law of large numbers - Central limit theorem..

Tutorial **3 hrs.**

Unit - III: **15 hrs.**

Univariate Discrete and Continuous Distributions: Discrete distributions: Uniform - Bernoulli - Binomial - Negative Binomial - Geometric and Poisson. Continuous distributions: Uniform - Gamma - Exponential - Chi-square - Beta and Normal - Normal approximation to the Binomial distribution.

Tutorial **3 hrs.**

Unit - IV: **15 hrs.**

Bivariate Distribution: Joint cumulative distribution function and its properties - Joint probability density function - Marginal distributions - Expectation of function of two random variables - Joint moment generating function - Conditional distributions and expectations.

Tutorial **3 hrs.**

Unit - V: **15 hrs.**

Correlation and Regression: Correlation – Scatter Diagram - Karl Pearson's Coefficient of Correlation – Rank Correlation - Regression – Regression Coefficients – Properties of Regression Coefficients- Angle between two lines of Regression.

Tutorial **3 hrs.**

Total hours : 90

Text Book:

1. S. C. Gupta & V.K. Kapoor (2018), ***"Fundamental of Mathematical Statistics"***, S. Chand & Sons, New Delhi.

Reference:

1. S. P. Gupta (2010), ***"Statistical Methods"***, Sultan Chand & Sons, New Delhi.

Course Outcomes:

On completion of the course, the students will be able to

1. perform basic concepts in the study of probability.
2. derive moment generating function and understand central limit theorem.
3. acquire a sound knowledge in univariate discrete distributions.
4. demonstrate the concept of bivariate Distribution function.
5. understand the concepts of correlation and regression.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	H	H	M	M	H	H	H	H	H
CO 2	H	M	H	M	M	L	M	M	H	M	H	H	M
CO 3	H	L	H	M	M	M	L		H	L	H	H	L
CO 4	H	H	H	H	H	M	M	M	H	H	H	H	H
CO 5	H	M	H	M	H	L	L	M	H	M	H	H	M

Department of Mathematics

Professional Aptitude Course

Applications of Mathematics

Semester - VI **Hours of Instruction/week: 5**

23BMAPA5 **No. of credits: Remarks**

Course Objectives:

1. To learn about solving systems of Differential Equations
2. To apply graph theory based tools in solving practical problems.
3. To know the applications of Combinations and Permutations.

Unit - I: **15 hrs.**

The nature of differential equations: Separable equations: Introduction - General Remarks on solutions - Families of curves - Orthogonal Trajectories - Growth, Decay, Chemical Reactions and Mixing.

Unit - II: **15 hrs.**

First order equations: The hanging chain - Pursuit curves - Simple Electric Circuits.

Unit - III: **15 hrs.**

Graph Theory: Graphs and sub graphs - The shortest path problem - Sperner's Lemma.

Unit - IV: **15 hrs.**

Graph Theory Continued: Euler Tours - Hamilton Cycles - The Chinese Postman Problem - The Travelling Salesman Problem.

Unit - V: **15 hrs.**

Combinatorial Mathematics: Introduction - Principle of Inclusion and Exclusion - General Formula - the Rook Polynomials - Permutations with Forbidden Positions.

Total hours : 75

Text Books:

1. George F. Simmons (2017), ***"Differential Equations with applications and Historical Notes"***, 3rd Edition, CRC Press, Taylor & Francis group. (Units I & II)

2. J. A. Bondy and U. S. R. Murty (1982), ***"Graph Theory with Applications"***, Elsevier Science Publishing co.inc. (Units III & IV)
3. C. L. Liu (2000), ***"Introduction to Combinatorial Mathematics"***, Mc Graw Hill, New York. (Unit V)

References:

1. Martin Braun (1993), ***"Differential Equations and Their Applications - An Introduction to Applied Mathematics"***, 4th Edition, Springer.
2. Narsingh Deo (1974), ***"Graph Theory with Applications to Engineering & Computer Science"***, Dover Publications Inc.
3. J. R. Marshall (1967), ***"Combinatorial Theory"***, John Wiley & Sons, New York.

Course Outcomes:

On completion of the course, the students will be able to

1. understand that physical systems can be described by differential equations.
2. apply differential equations in engineering problems.
3. demonstrate the basic concepts of graphs.
4. know the concepts of Euler graph and Hamiltonian graph.
5. identify, formulate and solve real time problems using the principles of inclusion and exclusion.