

**St.Mary's College (Autonomous),  
Thoothukudi  
Re-accredited with 'A+' Grade by NAAC**



**SYLLABUS**



**2023 - 26**

**B.Sc. Mathematics**

**ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI**

**Bachelor of Science (Mathematics)**

**Course Structure (w.e.f. 2023)**

**Preamble**

Mathematics, the foundation of all sciences is a subject which offers limitless scope for diversification in higher education. The improvements and achievements in various fields are the gift of Mathematics. The world of education without mathematics would be non-existent. The fields of Information Technology, Social Research and Economic forecasts will not be successful but for the effective application of Mathematics. The demand for courses in Mathematics is bound to be consistent, continual and increasing.

**Vision**

To promote and support a comprehensive, innovative and dynamic learning environment that meets the changing needs of a diverse global student population.

**Mission**

- To provide an exemplary mathematics program that prepares students to be life-long learners and responsible, numerate citizens.
- To enhance the students logical, reasoning, analytical and problem solving skills.
- To provide meaningful support services, responds to the changing environment of mathematics education.
- To promote effective instructional strategies with students actively participating in the learning process.

### Programme Outcome

PO No.	After completion of the Undergraduate programme the students of St. Mary's College will be able to
PO 1	acquire an in-depth domain knowledge and a comprehensive knowledge of various disciplines to become skilled professionals
PO 2	enrich their communicative skills, and enhance their creative, numerical, analytical and problem solving skills
PO 3	gain potential skills to excel in digital literacy, team management, scientific reasoning, research and self-directed life-long learning to emerge as entrepreneurs
PO 4	be aware of the environment with a social responsibility for the well-being of humanity and the planet at large
PO 5	be an empowered, economically independent woman with a global perspective to emerge holistically in the egalitarian society

### Programme Specific Outcome

<b>PSO No.</b>	<b>Upon completion of the B.Sc. Mathematics program, students will be able to</b>
PSO 1	acquire a systematic understanding of the fundamental concepts and theories of mathematics.
PSO 2	adjust and adopt the changing scientific environment in the process of sustainable development by using mathematical tools.
PSO 3	develop the problem solving skills to succeed in various competitive examinations NET, SET, CAT and UPSC.
PSO 4	understand and appreciate integrated learning to create mathematical models, practice ethical values and realize societal responsibilities.
PSO 5	strengthen the mathematical ability, abstract intelligence and orient themselves towards higher mathematics and research.

**Course Structure (w.e.f. 2023)**

**Semester - I**

Part	Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
						CIA	ESE	Total
I	Tamil /	23ULTA11	,f;fhy ,yf;fpak; : (nra;As;> ,yf;fzk;>,yf;fpatuyhW>r pWfij) Foundation Course French I	6	3	25	75	100
	French	23ULFA11						
II	General English	23UGEN11	Poetry, Prose, Extensive Reading and Communicative English I	6	3	25	75	100
III	Core I	23UMAC11	Algebra and Trigonometry	4	4	25	75	100
	Core II	23UMAC12	Differential Calculus	4	4	25	75	100
	Generic Elective I	23UPHE11	Allied Physics I	4	4	25	75	100
	Generic Elective Practical I	23UPHER1	Allied Physics Practical I	2	1	40	60	100
IV	Skill Enhancement Course I (Discipline Specific)	23UMASE1	Quantitative Aptitude I	2	2	20	30	50
	Foundation Course	23UMAF11	Bridge Mathematics	2	2	20	30	50
<b>Total</b>				<b>30</b>	<b>23</b>			

## Semester – II

Part	Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
						CIA	ESE	Total
I	Tamil /	23ULTA21	rkaf;fpag;fs; : (nra;As;> ,yf;fzk;> ,yf;fpatuyhW)	6	3	25	75	100
	French	23ULFA21	Foundation Course: French II					
II	General English	23UGEN21	Poetry, Prose, Extensive Reading, and Communicative English II	6	3	25	75	100
III	Core III	23UMAC21	Analytical Geometry (Two and Three Dimensions)	4	4	25	75	100
	Core IV	23UMAC22	Integral Calculus	4	4	25	75	100
	Generic Elective II	23UPHE21	Allied Physics II	4	4	25	75	100
	Generic Elective Practical II	23UPHER2	Allied Physics Practical II	2	1	40	60	100
IV	Skill Enhancement Course II (Discipline Specific)	23UMASE2	Quantitative Aptitude II	2	2	20	30	50
	Skill Enhancement Course III (Discipline Specific)	23UMASE3	Documentation using LaTeX Lab	2	2	20	30	50
<b>Total</b>				<b>30</b>	<b>23</b>			

### Semester III

Part	Components	Course Code	Course Title	Hrs/ Week	Credits	Max.Marks		
						CIA	ESE	Total
I	Tamil /	23ULTA31	French Literature and Grammar I	6	3	25	75	100
	French	23ULFA31						
II	General English	23UGEN31	English Poetry, Prose, Extensive Reading and Communicative English III	6	3	25	75	100
III	Core V	23UMAC31	Abstract Algebra	5	5	25	75	100
	Core VI	23UMAC32	Differential Equations	4	3	25	75	100
	Generic ElectiveIII	23UMME31	Mathematical Statistics	4	3	25	75	100
	NME I	23UMAN31	Mathematics for Competitive Examinations I	2	2	20	30	50
IV	Skill Enhancement Course IV (Discipline Specific)	23UMASE4	Statistics with R Programming Lab	2	2	20	30	50
	Ability Enhancement Course I	23UAYM31	Yoga and Meditation	1	1	20	30	50
	Self-Study/ MOOC / Internship (Compulsory)	23UMASS1	Foundation of Mathematics		+2		50	50
<b>Total</b>				<b>30</b>	<b>22+2</b>			

### Semester IV

Part	Components	Course Code	Course Title	Hrs/Week	Credits	Max.Marks		
						CIA	ESE	Total
I	Tamil /	23ULTA41	French Literature and Grammar II	6	3	25	75	100
	French	23ULFA41						
II	General English	23UGEN41	English Poetry, Prose, Extensive Reading and Communicative English IV	6	3	25	75	100
III	Core VII	23UMAC41	Elements of Mathematical Analysis	5	5	25	75	100
	Core VIII	23UMAC42	Vector Calculus	4	3	25	75	100
	Generic Elective IV	23UMME41	Industrial Statistics (Industry Module)	4	3	25	75	100
	NME II	23UMAN41	Mathematics for Competitive ExaminationsII	2	2	20	30	50
IV	Skill Enhancement Course V (Discipline Specific)	23UMASE5	Introduction to Data Science	2	2	20	30	50
	Ability Enhancement Course II (Entrepreneurial Based)	23UAMA41	Computing Mathematics with GeoGebra	1	1	20	30	50
V	NCC / NSS / Sports				1			
	CDP-Extension Activity				+1			
<b>Total</b>				<b>30</b>	<b>23+1</b>			

**Note :** Ability Enhancement course 23UAMA41

Evaluation 20 : 30 will be done only by the department.

Internal and External examinations will be in the form of Practical / Presentation of models / Reports.

### Semester V

Part	Components	Course Code	Course Title	Hrs/ Week	Credits	Max.Marks		
						CIA	ESE	Total
III	Core IX	23UMAC51	Linear Algebra	6	6	25	75	100
	Core X	23UMAC52	Real Analysis	6	5	25	75	100
	Core XI	23UMAC53	Operations Research	6	5	25	75	100
	Core XII	23UMAC54	Mathematical Modelling	6	5	25	75	100
	Discipline Specific Elective I	23UMAE51/ 23UMAE52	Transformation Techniques/ Numerical Methods	4	3	25	75	100
IV	Ability Enhancement Course III	23UAEV51	Environmental Studies	2	1	20	30	50
	Self-Study/ MOOC / Internship (Optional)	23UMASS2	Vedic Mathematics		+2		50	50
				<b>30</b>	<b>25+2</b>			

### Semester VI

Part	Components	Course Code	Course Title	Hrs/ Week	Credits	Max.Marks		
						CIA	ESE	Total
III	Core XIII	23UMAC61	Complex Analysis	6	5	25	75	100
	Core XIV	23UMAC62	Graph Theory	6	5	25	75	100
	Core XV	23UMAC63	Mechanics	6	5	25	75	100
	Core XVI (Project)	23UMAP61	Project and Viva Voce	6	4	40	60	100
	Discipline Specific Elective II	23UMAE61/ 23UMAE62	Programming Language with C++/ Introduction to Python Programming	4	3	25	75	100
IV	Skill Enhancement Course VI (Discipline Specific)	23UMASE6	Introduction to Machine Learning(Web Tools in Mathematics)	2	2	20	30	50
				<b>30</b>	<b>24</b>			



Semester – I			
Part III Core I - Algebra and Trigonometry			
Course Code: 23UMAC11	Hrs/week: 4	Hrs/Semester: 60	Credits: 4

**Objectives:**

- To bridge the gap and facilitate transition from higher secondary to tertiary education
- To instil confidence among stakeholders and inculcate interest for Mathematics

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Demonstrate proficiency in recalling and applying fundamental algebraic principles, including equations, inequalities, and basic operations.	K1
CO-2	Apply algebraic concepts to solve real-world problems, fostering critical thinking and analytical reasoning in various contexts.	K2
CO-3	Apply mathematical principles and problem-solving strategies to solve practical problems related to reciprocal equations, series summation, characteristic equations, and trigonometric expansions.	K3
CO-4	Analyze and interpret mathematical patterns, enhancing the ability to recognize and solve complex algebraic problems.	K4
CO-5	Synthesize algebraic knowledge to solve advanced problems, demonstrating the ability to integrate multiple algebraic concepts and techniques effectively.	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	3	1	2	1	2	2	2	2
CO-2	2	3	2	2	3	2	2	2	2	2
CO-3	3	2	3	2	2	2	2	2	2	2
CO-4	2	1	2	3	3	2	2	2	2	2
CO-5	2	3	2	2	3	2	2	2	2	2
Ave.	2.4	2.2	2.4	2	2.6	1.8	2	2	2	2

Semester – I			
Part III Core I - Algebra and Trigonometry			
Course Code: 23UMAC11	Hrs/week: 4	Hrs/Semester: 60	Credits: 4

### Unit I

Reciprocal Equations-Standard form–Increasing or decreasing the roots of a given equation- Removal of terms, Approximate solutions of roots of polynomials by Horner’s method – related problems.

(Text Book 1)

### Unit II

Summation of Series: Binomial– Exponential –Logarithmic series (Theorems without proof) – Approximations - related problems.

(Text Book 2)

### Unit III

Characteristic equation – Eigen values and Eigen Vectors - Similar matrices - Cayley - Hamilton Theorem (Statement only) - Finding powers of square matrix, Inverse of a square matrix up to order 3, Diagonalization of square matrices - related problems.

(Text Book 3)

### Unit IV

Expansions of  $\sin^n\theta$ ,  $\cos^n\theta$  in powers of  $\sin\theta$ ,  $\cos\theta$  - Expansion of  $\tan^n\theta$  in terms of  $\tan\theta$ , Expansions of  $\cos^n\theta$ ,  $\sin^n\theta$ ,  $\cos^m\theta\sin^n\theta$  –Expansions of  $\tan(\theta_1+\theta_2+\dots+\theta_n)$ -Expansions of  $\sin\theta$ ,  $\cos\theta$  and  $\tan\theta$  in terms of  $\theta$  - related problems.

(Text Book 2)

### Unit V

Hyperbolic functions – Relation between circular and hyperbolic functions Inverse hyperbolic functions, Logarithm of complex quantities, Summation of trigonometric series - related problems.

(Text Book 2)

### Text Book

1. Arumugam S. and A. Thangapandi Isaac, *Algebra*, New Gamma Publishing House, August 2006.
2. Arumugam S. and A. Thangapandi Isaac, *Summation of Series and Trigonometry*, New Gamma Publishing House.
3. Manicavachagom Pillay T.K., Natarajan T., Ganapathy K.S., *Algebra*, Volume-II, Ananda Book Depot, Chennai, Reprint 2017.

### Books for Reference

1. Manicavachagom Pillay T.K., Natarajan T., Ganapathy K.S., *Algebra*, Volume-I, Ananda Book Depot, Chennai, Reprint 2017.
2. Arumugam .S and ThangapandiIssac.A , *Modern Algebra* , Scitech Publications (India) Pvt. Ltd., Chennai, Reprint 2017.

Semester – I			
Part III Core II- Differential Calculus			
Course Code: 23UMAC12	Hrs/week: 4	Hrs/Semester: 60	Credits: 4

**Objectives:**

- The basic skills of differentiation, successive differentiation, and their applications.
- Basic knowledge on the notions of curvature, evolutes, involutes and polar co-ordinates and in solving related problems.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	recognize and retrieve fundamental calculus concepts, including successive differentiation, partial differentiation, envelope analysis, and curvature	K1
CO-2	categorize and synthesize fundamental calculus concepts, incorporating successive differentiation, partial differentiation, homogeneous functions, Lagrange's method and envelope analysis.	K2
CO-3	apply and integrate fundamental calculus concepts, encompassing differentiation, envelope analysis, and curvature, demonstrating proficiency in the application	K3
CO-4	Apply concepts of homogeneous functions and Lagrange's method of undetermined multipliers for optimization.	K4
CO-5	Predict and compute the radius and center of curvature and discuss practical implications of envelope construction methods	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	1	2	2	3	2	3	2	1
CO-2	2	2	2	2	3	2	3	2	1	2
CO-3	3	2	2	2	2	3	2	2	2	2
CO-4	3	3	2	2	2	2	3	3	2	2
CO-5	2	2	2	2	2	3	2	2	2	3
Ave.	2.6	2.2	1.8	2.0	2.2	2.6	2.1	2.4	1.8	2

Semester – I			
Part III Core II - Differential Calculus			
Course Code: 23UMAC12	Hrs/week: 4	Hrs/Semester: 60	Credits: 4

### Unit I

**Successive Differentiation:** Introduction (Review of basic concepts) – The  $n^{th}$  derivative – Standard results– Trigonometrical transformation – Formation of equations involving derivatives – Leibnitz formula for the  $n^{th}$  derivative of a product.

(Chapter 3, Sec 1.1 - 1.6 & 2.1, Pages: 69 - 87)

### Unit II

**Partial Differentiation:** Partial derivatives – Successive partial derivatives – Function of a function rule – Total differential coefficient

Chapter 8, Sec 1.1 - 1.3, Pages: 178 - 188)

### Unit III

**Partial Differentiation (Continued):** Homogeneous functions – Partial derivatives of a function of two variables –Lagrange’s method of undetermined multipliers.

(Chapter 8, Sec 1.6 - 1.7 & 5, Pages: 191 - 204 & 231 - 240)

### Unit IV

**Envelope:** Method of finding the envelope – Another definition of envelope – Envelope of family of curves which are quadratic in the parameter.

(Chapter 10, Sec 1.1 - 1.3, Pages: 281 - 291)

### Unit V

**Curvature:** Definition of Curvature – Circle, Radius and Centre of Curvature – Evolutes and Involutives – Radius of Curvature in Polar Co-ordinates.

(Chapter 10, Sec 2.1 - 2.8, Pages: 291 - 317 & 320 -323)

### Text Book

1. S.Narayanan and T.K.ManicavachagomPillay, *Calculus*, Vol I,S.Viswanathan (Printers & Publishers) PVT. LTD. (Edition-2015).

### Reference Books

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2010.
3. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

Semester – I			
Part IV - Skill Enhancement Course I - Quantitative Aptitude I			
Code : 23UMASE1	Hrs/week : 2	Hrs/Semester : 30	Credits : 2

### Objectives:

1. To enable students to comprehend and apply mathematical concepts such as square roots, cube roots, time, etc.
2. To develop problem-solving skills for competitive exams and real-world applications.

### Course outcomes

Co No.	Upon completion of this course, students will be able to	Cognitive Level
Co-1	recall and recognize definitions and formulas related to the mathematical concepts	K1
Co-2	demonstrate an understanding of the principles and concepts behind the mathematical topics.	K2
Co-3	apply mathematical principles to solve problems related to the covered concepts	K3
Co-4	analyze and evaluate different mathematical problems to determine effective problem-solving strategies.	K4
Co-5	improve speed and accuracy in numerical calculations using shortcut methods, essential for efficient problem-solving within time constraints.	K5

### Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	2	2	1	2	2	2	2	2
CO-2	3	3	3	2	1	3	3	2	3	3
CO-3	2	3	3	2	1	3	3	3	3	3
CO-4	2	2	3	3	2	3	2	2	3	3
CO-5	2	2	3	2	3	2	2	1	2	2
Ave.	2.4	2.4	2.8	2.2	1.6	2.6	2.4	2	2.6	2.6

<b>Semester – I</b>			
<b>Part IV - Skill Enhancement Course I - Quantitative Aptitude I</b>			
<b>Code : 23UMASE1</b>	<b>Hrs/week : 2</b>	<b>Hrs/Semester : 30</b>	<b>Credits : 2</b>

**Unit I**

Numbers - Square roots & cube roots

(Chapters 1& 5, pages 1-24, 96-122)

**Unit II**

Time & Distance - Polygons

(Chapters 17 & 25, 343-360, pages 478-484)

**Unit III**

Problems on Numbers - Problems on Ages

(Chapters 7 & 8, pages 143-163)

**Unit IV**

True Discount - Banker's Discount - Calendar

(Chapters 26, 27 & 29, pages 485-493, 500-503)

**Unit V**

Simplification - Average.

(Chapters 4 & 6, 68-95, pages 123-142)

**Text Book**

Agarwal R.S., *Arithmetic Subjective and Objective for Competitive Examinations*, S.Chand and Company Ltd. , Ram Nagar, New Delhi – 55, Revised Edition 2011

<b>SEMESTER – I</b>			
<b>Part IV -Foundation Course – Bridge Mathematics</b>			
<b>Course Code: 23UMAF11</b>	<b>Hrs / Week: 2</b>	<b>Hrs / Semester: 30</b>	<b>Credits: 2</b>

**Objectives:**

- To bridge the gap and facilitate transition from higher secondary to tertiary education.
- To instil confidence among stakeholders and inculcate interest for Mathematics.

**Course Outcome:**

<b>CO. No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
CO-1	explain the binomial theorem and apply it to find the expansions of any $(x + y)^n$ and also, solve the related problems.	K1
CO-2	define various sequences and series and solve the problems related to them. explain the principle of counting.	K2
CO-3	compute the number of permutations and combinations in different cases. Apply the principle of counting to solve the problems on permutations and combinations..	K3
CO-4	explain various trigonometric ratios and find them for different angles, including sum of the angles, multiple and submultiple angles, etc. Also, they can solve the problems using the transformations.	K4
CO-5	find the limit and derivative of a function at a point, the definite and indefinite integral of a function. Find the points of min/max of a function.	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>CO-2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>CO-3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>CO-4</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>CO-5</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>Ave.</b>	<b>1.4</b>	<b>1</b>	<b>1</b>	<b>1.4</b>	<b>1.4</b>	<b>1</b>	<b>1.8</b>	<b>1</b>	<b>1</b>	<b>1</b>

<b>SEMESTER – I</b>			
<b>Part IV -Foundation Course – Bridge Mathematics</b>			
<b>Course Code: 23UMAF11</b>	<b>Hrs / Week: 2</b>	<b>Hrs / Semester: 30</b>	<b>Credits: 2</b>

### **UNIT-I**

Algebra: Binomial theorem, General term, middle term, problems based on these concepts.

### **UNIT II**

Sequences and series (Progressions). Fundamental principle of counting. Factorial n.

### **UNIT III**

Permutations and combinations, Derivation of formulae and their connections, simple applications, combinations with repetitions, arrangements within groups, formation of groups.

### **UNIT IV**

Trigonometry: Introduction to trigonometric ratios, proof of  $\sin(A+B)$ ,  $\cos(A+B)$ ,  $\tan(A+B)$  formulae, multiple and sub multiple angles,  $\sin(2A)$ ,  $\cos(2A)$ ,  $\tan(2A)$  etc., transformations sum into product and product into sum formulae, inverse trigonometric functions, sine rule and cosine rule

### **UNITV:**

Calculus: Limits, standard formulae and problems, differentiation, first principle, uv rule, u/v rule, methods of differentiation, application of derivatives, integration - product rule and substitution method.

### **Text Books**

1. NCERT class XI and XII text books.
2. Any State Board Mathematics text books of class XI and XII



<b>SEMESTER – II</b>			
<b>Part III Core III - Analytical Geometry (Two and Three Dimensions)</b>			
<b>Course Code: 23UMAC21</b>	<b>Hrs / Week: 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits: 4</b>

**Objectives:**

- Necessary skills to analyze characteristics and properties of two- and three-dimensional geometric shapes.
- To present mathematical arguments about geometric relationships.
- To solve real world problems on geometry and its applications.

**Course Outcome:**

<b>CO. No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
CO-1	recall and identify the properties of poles, polar, conjugate points, and conjugate lines in the context of conic sections.	K1
CO-2	comprehend the concepts of polar coordinates and be able to apply them to derive equations of lines, circles, and conics.	K2
CO-3	apply the principles of system of planes, orthogonal projection, and understanding the length of perpendiculars in various geometric scenarios.	K3
CO-4	analyze the representation of lines, calculating angles between lines and planes, and determining the shortest distance between two skew lines.	K4
CO-5	synthesize knowledge to formulate equations for spheres, circles, and the tangent plane. They will also be able to analyze the intersection and orthogonality of two spheres.	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	3	2	1	2	2	3	2	3	2	1
<b>CO-2</b>	2	2	2	2	3	2	3	2	1	2
<b>CO-3</b>	3	2	2	2	2	3	2	2	2	2
<b>CO-4</b>	3	3	2	2	2	2	3	3	2	2
<b>CO-5</b>	2	2	2	2	2	3	2	2	2	3
<b>Ave.</b>	<b>2.6</b>	<b>2.2</b>	<b>1.8</b>	<b>2.0</b>	<b>2.2</b>	<b>2.6</b>	<b>2.1</b>	<b>2.4</b>	<b>1.8</b>	<b>2</b>

<b>SEMESTER – II</b>
<b>Part III Core III-Analytical Geometry (Two &amp; Three Dimensions)</b>

<b>Course Code: 23UMAC21</b>	<b>Hrs / Week: 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits: 4</b>
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### **UNIT I**

Pole, Polar - conjugate points and conjugate lines – diameters – conjugate diameters of an ellipse - semi diameters- conjugate diameters of hyperbola.

### **UNIT II**

Polar coordinates: General polar equation of straight line – Polar equation of a circle given a diameter, Equation of a straight line, circle, conic – Equation of chord, tangent, normal.

Equations of the asymptotes of a hyperbola.

### **UNIT III**

System of Planes-Length of the perpendicular–Orthogonal projection.

### **UNIT IV**

Representation of line–angle between a line and a plane – co – planar lines–shortest distance between two skew lines –length of the perpendicular–intersection of three planes.

### **UNIT V**

Equation of a sphere-general equation-section of a sphere by a plane-equation of the circle-tangent plane- angle of intersection of two spheres- condition for the orthogonality- radical plane.

### **Text Book**

1. T.K. ManicavachagamPillay& T. Natarajan, Analytical geometry (Part-I – Two dimensions), S. Viswanathan (Printers and Publishers) Pvt. Ltd. (2012).
2. T.K. ManicavachagamPillay& T. Natarajan, Analytical geometry (Part-II – Three dimensions), S. Viswanathan (Printers and Publishers) Pvt. Ltd. (2012).
3. S. Arumugam and A. ThangapandiIssac, Analytical geometry 3D and Vector Calculus, New Gamma Publishing House, Palayamkottai, 2011.

<b>SEMESTER – II</b>			
<b>Part III Core IV - Integral Calculus</b>			
<b>Course Code: 23UMAC22</b>	<b>Hrs / Week: 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits: 4</b>

**Objectives:**

- To gain knowledge on integration and its geometrical applications, double, triple integrals and improper integrals.
- To acquire knowledge about Beta and Gamma functions and their applications.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	describe the integrals of algebraic, trigonometric and logarithmic functions and to find the reduction formulae.	K1
CO-2	estimate double and triple integrals and problems using change of order of integration	K2
CO-3	solve multiple integrals and to find the areas of curved surfaces and volumes of solids of revolution.	K3
CO-4	examine beta and gamma functions and use them in solving problems of integration.	K4
CO-5	explain geometric and physical applications of integral calculus.	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	1	1	1	1	2	3	1	1
CO-2	3	2	1	1	1	3	2	1	1	1
CO-3	3	2	3	1	1	3	2	1	1	1
CO-4	3	2	3	1	1	3	2	1	1	1
CO-5	3	1	3	2	1	3	2	1	1	1
Ave.	3	1.8	2.2	1.2	1	2.6	2	1.4	1	1

**SEMESTER – II****Part III Core IV- Integral Calculus**

<b>Course Code: 23UMAC22</b>	<b>Hrs / Week: 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits: 4</b>
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### **UNIT I**

Reduction formulae -Types, integration of product of powers of algebraic and trigonometric functions, integration of product of powers of algebraic and logarithmic functions - Bernoulli's formula.

**(Chapter 1, Sec 13.1 - 15.1, Pages: 79 - 100)**

### **UNIT II**

Geometric and Physical Applications of Integral calculus: Area under Plane curve: Cartesian co-ordinates – Area of a closed curve – Areas in polar coordinates – Approximate integration: Trapezoidal rule – Simpson's rule.

**(Chapter 2, Sec 1.1 – 2.2, Pages:112-131)**

### **UNIT III**

Multiple Integrals - definition of double integrals - evaluation of double integrals – double integrals in polar coordinates - Triple integrals –applications of multiple integrals.

**(Chapter 5, Sec 1 – 4, Pages:203 -222)**

### **UNIT IV**

Change of variables – Jacobian – change variables in case of two variables - change variables in case of three variables – transformation from Cartesian to polar coordinates - transformation from Cartesian to spherical polar coordinates.

**(Chapter 6, Sec 1.1 – 2.4, Pages:251-267)**

### **UNIT V**

Beta and Gamma functions – Application of Beta and Gamma Functions in evaluation of Double and Triple Integrals, Improper Integrals.

**(Chapter 7, Sec 2.1 – 6, Pages:278 - 300)**

### **Text Book**

1. S.Narayanan and T.K.Manicavachagom Pillay, *Calculus*, Vol II,S.Viswanathan (Printers & Publishers) PVT. LTD. (Edition-2015).

### **Reference Books**

1. S. Arumugam & A. Thangapandi Issac, *Calculus*, New Gamma Publishing House, Palayamkottai. (2011).
2. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
3. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2010. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd.(Pearson Education), Delhi, 2007.

<b>Semester – II</b>
<b>Part IV Skill Enhancement Course II - Quantitative Aptitude II</b>

<b>Course Code: 23UMASE2</b>	<b>Hrs/week :2</b>	<b>Hrs/Semester : 30</b>	<b>Credits :2</b>
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**Objectives:**

- To bring out the mental ability and skill of the students
- To train the students for competitive and professional examinations

**Course outcomes**

<b>Co No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
Co-1	recall and recognize essential mathematical concepts and formulas.	K1
Co-2	demonstrate understanding of mathematical principles and their application in problem-solving.	K2
Co-3	apply problem-solving strategies to solve practical mathematical problems.	K3
Co-4	analyze and evaluate mathematical problems to determine effective problem-solving strategies.	K4
Co-5	develop new problem-solving techniques for real-world mathematical applications.	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	3	2	2	2	1	2	2	2	2	2
<b>CO-2</b>	3	3	3	2	1	3	3	2	3	3
<b>CO-3</b>	2	3	3	2	1	3	3	3	3	3
<b>CO-4</b>	2	2	3	3	2	3	2	3	3	3
<b>CO-5</b>	2	2	3	3	3	2	2	1	2	2
<b>Ave.</b>	2.4	2.4	2.8	2.4	1.6	2.6	2.4	2.2	2.6	2.6

**Semester – II**

**Part IV Skill Enhancement Course II - Quantitative Aptitude II**

<b>Course Code : 23UMASE2</b>	<b>Hrs/week :2</b>	<b>Hrs/Semester : 30</b>	<b>Credits : 2</b>
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**Unit I**

Percentage– Time and Work

(Chapters 10&15, pages 179-218, 309-330)

**Unit II**

Ratio and Proportion-Chain Rule

(Chapters 12& 14, Pages 248-276, 291-398)

**Unit III**

Problems on Trains – Boats and Streams

(Chapters 18 &19, Pages 361-381)

**Unit IV**

Profit and Loss-Alligation or Mixture

(Chapters 11 &20 , Pages 219-247, 382-387)

**Unit V**

Line Graphs-Pie charts - Bar Diagrams

(Chapters 33,34 &35, Pages 525-549)

**Text Book**

Aggarwal R.S., Arithmetic Subjective and Objective for Competitive Examinations, S.Chand and Company Ltd. , Ram Nagar, New Delhi - 55. Revised Edition 2014

**Reference Books**

1. Aggarwal R.S., Quantitative Aptitude,S.Chand and Company Ltd. , Ram Nagar, New Delhi.
2. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

**Semester – II**

**Part IV Skill Enhancement Course III - Documentation using LaTeX**

<b>Course Code : 23UMASE3</b>	<b>Hrs/week :2</b>	<b>Hrs/ Semester:30</b>	<b>Credits :2</b>
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**Objectives:**

- To give deep knowledge of the LaTeX for Mathematical documentation
- To train the students to use LaTeX skills in documenting and preparing for publications.

**Course Outcome:**

<b>Co No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
Co-1	recall and reproduce basic LaTeX commands and syntax.	K1
Co-2	understand the principles and rules for text and math environments in LaTeX.	K2
Co-3	apply knowledge of LaTeX commands to create well-formatted documents.	K3
Co-4	evaluate the effectiveness of different LaTeX environments and constructs.	K4
Co-5	design and create complex LaTeX documents with advanced features.	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	2	2	3	2	1	3	3	2	2	2
<b>CO-2</b>	3	3	3	2	1	3	3	3	2	2
<b>CO-3</b>	3	3	3	2	1	3	3	3	3	2
<b>CO-4</b>	2	2	2	3	1	2	2	2	3	3
<b>CO-5</b>	2	2	3	2	3	2	2	2	3	3
<b>Ave.</b>	2.4	2.4	2.8	2.2	1.4	2.6	2.6	2.4	2.6	2.4

**Semester - II**

**Part IV Skill Enhancement Course III – Documentation using LaTeX**

<b>Course Code : 23UMASE3</b>	<b>Hrs/week : 2</b>	<b>Hrs/ Semester: 30</b>	<b>Credits : 2</b>
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### Unit I

Typing text : Words, sentences, and paragraphs - Symbols not on the keyboard - Comments and footnotes - Changing font characteristics - Lines, paragraphs, and pages – Spaces – Boxes.

(Chapter 5, Sec 5.1 - 5.9, pages: 61 -

115)

### Unit II

Text environments: Some general rules for displayed text environments - List environments - Style and size environments - Proclamations (theorem-like structures) - Proof environments - Tabular environments - Tabbing environments - Miscellaneous displayed text environments

(Chapter 6, Sec 6.1 to 6.8, pages 117 - 149)

### Unit III

Typing math: Math environments - Spacing rules - Equations - Basic constructs - Arithmetic operations - Delimiters - Operators - Math accents - Stretchable horizontal lines - Formula Gallery

(Chapter 7, Sec 7.1 to 7.9, pages 151 - 186)

### Unit IV

More math: Spacing of symbols Building new symbols - Math alphabets and symbols - Vertical spacing - Tagging and grouping - Generalized fractions - Boxed formulas

(Chapter 8, Sec 8.1 to 8.6, pages 187 - 206)

### Unit V

LaTeX documents: The structure of a document - The preamble - Abstract -Sectioning - Cross-referencing - Bibliographies. (Chapter 10, Sec 10.1 to 10.6, pages 245 - 270)

#### Text Book:

George Gratzner, *More Math into LaTeX*, 4<sup>th</sup> Edition, Springer, 2007.

<https://www.javatpoint.com/latex>

<https://www.overleaf.com/learn/latex/Tutorials>

#### Books for Reference:

1. Helmut Kopka and Patrick W. Daly, *A guide to LaTeX*, Addison-Wesley, Fourth Edition.
2. David R. Wilkins, *Getting started with LaTeX*, Second Edition.

**Practicals:** Typing Text and Tables: Chapter 4.1 - Inserting Figures: Chapter 5.1 - Mathematical Equations: Chapter 6.3- Inserting References: Chapter 7.6 - Preparing an article for mathematical journal

<b>Semester – III</b>			
<b>Part III Core V - Abstract Algebra</b>			
<b>Course Code: 23UMAC31</b>	<b>Hrs/week: 5</b>	<b>Hrs/Semester:75</b>	<b>Credits: 5</b>



## Objectives

- To give an introductory knowledge of the basics abstract systems of Mathematics
- To train the students to generalize the known concepts and to develop analytical thinking.

## Course Outcomes

Co No	Upon completion of this course, students will	Cognitive Level
Co-1	explain the theory behind relations and functions and how functions may relate dissimilar structures to each other.	K1
Co-2	describe and generate the basic algebraic structures such as Groups, Rings, Fields, Integral Domain, Euclidean Domain, etc., and will identify examples of these specific constructs.	K2
Co-3	have a working knowledge of important mathematical concepts such as order of Group, order of an element, generator of a cyclic group, index of a subgroup, characteristic of a Ring, Maximal and Prime Ideals etc.,	K3
Co-4	analyze relationship between abstract algebraic structures with familiar number system such as integers, complex and real numbers	K4
Co-5	critically analyze and construct mathematical arguments that relate to the study of introductory linear algebra. (Proof and Reasoning).	K5

## Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	3	1	3	3	1	2	2
CO-2	3	3	2	3	1	3	3	1	2	2
CO-3	3	3	2	3	2	3	3	1	2	2
CO-4	3	3	2	3	1	3	3	1	2	2
CO-5	3	3	2	3	2	3	3	1	2	2
Ave.	3	3	2	2	1.4	3	3	1	2	2

<b>Semester – III</b>			
<b>Part III Core V - Abstract Algebra</b>			
<b>Course Code: 23UMAC31</b>	<b>Hrs/week:5</b>	<b>Hrs/Semester:75</b>	<b>Credits: 5</b>

### **Unit I**

Relations and Mappings - Relations - Equivalence Relations - Functions – Binary Operations

(Chapter 2, Sec 2.1 - 2.5, pages 2.1 – 2.18)

### **Unit II**

Permutation groups - Sub groups - Cyclic Groups - Order of an Element - Cosets and Lagrange's theorem - Euler's theorem - Fermat's theorem

(Chapter 3, Sec 3.4 - 3.8, pages 3.12 – 3.31)

### **Unit III**

Normal Subgroups and Quotient Groups - Isomorphism - Cayley's theorem - Homomorphism - Automorphism - Fundamental theorems of Homomorphism

(Chapter 3, Sec 3.9 - 3.11, pages 3.31 – 3.50)

### **Unit IV**

Rings - definition and examples – Elementary properties of rings- Isomorphism – Types of rings - Characteristic of a ring - Sub rings

(Chapter 4, Sec 4.1 - 4.6, pages 4.1 – 4.18)

### **Unit V**

Ideals - Quotient Rings - Maximal and Prime Ideal – Homomorphism of rings - Unique factorization domain(U.F.D.) – Euclidean domain

(Chapter 4, Sec 4.7 - 4.10, 4.13- 4.14, pages 4.18 – 4.26, 4.31-4.36)

### **Text Book**

1. S. Arumugam and A. Thangapandi Isaac, Modern Algebra, Scitech Publications (India) Pvt. Ltd., Chennai, 2003, Reprint July 2022

### **Books for Reference**

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

### **Web Resources**

<https://nptel.ac.in>

Semester – III			
Part III Core VI - Differential Equations			
Course Code: 23UMAC32	Hrs/week: 4	Hrs/Semester: 60	Credits: 3

**Objectives:**

- To make the students to understand differential Equations as a powerful tool in solving problems in physical and social sciences.
- To furnish the students the tools necessary to solve ordinary differential equations.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	identify an ordinary differential equation and its order.	K1
CO-2	explain whether a given function is a solution of a given ordinary differential equation.	K2
CO-3	solve first order linear differential equations, find the general solution of second order linear equation	K3
CO-4	identify essential characteristics of ordinary and partial differential equations	K4
CO-5	compute the Laplace transform of a function and inverse Laplace transform of a function, solve a differential equation using Laplace transform, solve a partial differential equation	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	1	1	3	3	2	3	3
CO-2	3	3	2	1	1	3	3	2	2	3
CO-3	3	3	2	1	1	3	3	1	2	3
CO-4	3	3	2	1	1	3	3	1	3	2
CO-5	3	3	2	1	1	3	3	1	2	3
Ave.	3	3	2	1	1	3	3	1.4	2.4	2.8

<b>Semester – III</b>			
<b>Part III Core VI - Differential Equations</b>			
<b>Course Code: 23UMAC32</b>	<b>Hrs/week :4</b>	<b>Hrs/Semester :60</b>	<b>Credits :3</b>

### **Unit I**

Equations of the first order, but of higher degree - Solvable for p, x & y - Clairaut's form – Equations that do not contain x explicitly- Equations that do not contain y explicitly-Equations homogeneous in x and y.

**(Chapter4, Sec 1- 4, pages 60 – 67)**

### **Unit II**

Linear equation with constant coefficients: Complementary function of a linear equation with constant coefficients-Particular Integral-Special methods for finding Particular Integral

**(Chapter 5, Sec 1-4, pages 68-88)**

### **Unit III**

Linear equations with variable coefficients- Special method of evaluating the P.I when X is of the form - Equations reducible to the linear equations-Linear equations of the second order - Complete solution given a known integral - Reduction to the normal form–Change of the independent variable– variation of parameters -Methods of operational factors.

**(Chapter 5, Sec 5 and 6 pages 89-102 &Chapter8,Sec1-5, pages 145- 160)**

### **Unit IV**

Laplace transform - Definition-Sufficient conditions for the existence of Laplace transform-Laplace transform of periodic functions-Some general theorems- the Inverse transforms.

**(Chapter9, Sec 1-6, pages 161-199)**

### **Unit V**

Partial differential equation of first order – Classification of integrals - Derivation of partial differential equations - Lagrange's method of solving the linear equation – Special methods, Standard forms – Charpit's method.

**(Chapter 12, Sec1-4, Sec 5 (5.1-5.4) pages 219-238)**

### **Text Book**

S.Narayanan and T.K.Manickavachagam Pillay, Differential Equations and its applications. Published by: Divya Subramanian for Aanda Book Depot, Edition 2017.

### **Books for Reference**

1. A.R.Vasishtha and Dr.S.K.Sharma, Differential Equations, Krishna Educational Publishers, Seventeenth Edition 2015.
2. Dr.S.Arumugam and A.Thangapandi Issac, Differential Equations and Applications, New Gamma Publishing House, Edition 2011

<b>Semester –III</b>			
<b>Part III - Generic Elective III - Mathematical Statistics</b>			
<b>Course Code : 23UMME31</b>	<b>Hrs/week :4</b>	<b>Hrs/ Semester:60</b>	<b>Credits :3</b>

**Objectives:**

- To understand different statistical concepts which are useful for the economic growth of the country
- To know different types of moments and the shape of the curves

**Course Outcome:**

<b>CO. No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
CO-1	understand the difference between the central moments and general moments, Remember the formula of skewness, understand the regression lines, Understand the uses of index numbers	K1
CO-2	recall the definition of mean, variance, understand the definition of Binomial, Poisson, and Normal distribution	K2
CO-3	find correlation between two variables.,solve problems, apply the rules correctly	K3
CO-4	analyse and apply the formula correctly	K4
CO-5	evaluate the concept correctly and find the solution	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	1	2	2	1	2	1	2	2	2	2
<b>CO-2</b>	2	3	2	2	3	2	2	2	2	2
<b>CO-3</b>	3	2	3	2	2	2	2	2	2	2
<b>CO-4</b>	2	1	1	3	2	2	2	2	2	2
<b>CO-5</b>	2	3	2	2	3	2	2	3	2	2
<b>Ave.</b>	2.	2.2	2.0	2	2.4	1.8	2	2.2	2	2

<b>Semester – III</b>			
<b>Part III - Generic Elective III - Mathematical Statistics</b>			
<b>Course Code : 23UMME31</b>	<b>Hrs/week :4</b>	<b>Hrs/ Semester:60</b>	<b>Credits : 3</b>

**Unit I**

Introduction - Moments - Skewness and Kurtosis

**(Text Book 1: Chapter 4, Sec 4.1- 4.2, pages: 82-94)**

**Unit II**

Correlation - Rank correlation. Regression

**(Text Book 1: Chapter 6, Sec. 6.1- 6.2,6.3 pages: 106-144)**

**Unit III**

Binomial distribution- Poisson distribution.

**(Text Book 1: Chapter13, Sec 13.1 - 13.2, pages: 343 -369)**

**Unit IV**

Normal distribution.

**(Text Book 1: Chapter13, Sec 13.3, pages: 371 -389)**

**Unit V**

Introduction - Uses of Index numbers - Methods of constructing index numbers - Tests of adequacy of index number formulae - The chain index numbers.

**(Text Book 2: chapter 13, Pages: 536-568)**

**Text Books**

1. S.Arumugam and A.ThangapandiIssac; Statistics, New Gamma Publishing House, Palayamkottai, 2011.
  
2. S.P.Gupta; Statistical Methods, Sultan Chand & Sons, Educational Publishers, New Delhi, Forty Third Revised Edition, 2014,

**Books for Reference**

1. H.C.Saxena; Elementary Statistics,S.Chand& Company Ltd., New Delhi, Tenth Edition, 2011.
  
2. J.N.Kapur and Saxena; Mathematical Statistics, S.Chand& Company Pvt Ltd., New Delhi, Twentieth Edition.

Semester – III			
Part III NME I - Mathematics for Competitive Examinations I			
Code :23UMAN31	Hrs/week :2	Hrs/Semester :30	Credits :2

### Objectives

- To train the students appearing for the competitive examinations
- To inculcate the skills in Arithmetic ability

### Course Outcomes

Co No	Upon completion of this course, students will be able to	CL
Co-1	Identify concepts of H.C.F and L.C.M of numbers efficiently.	K1
Co-2	Understand arithmetic operations and simplify algebraic expressions effectively.	K2
Co-3	Apply time and work concepts to optimize work efficiency and schedules.	K3
Co-4	Analyze distances, speeds, and travel times accurately in various scenarios.	K4
Co-5	Evaluate data sets to calculate averages and draw meaningful conclusions.	K5

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	1	1	1	1	3	2	1	3	2
CO-2	1	2	1	1	1	2	2	1	2	2
CO-3	1	1	2	1	1	1	3	1	1	1
CO-4	1	1	1	2	1	1	2	2	2	1
CO-5	1	1	1	1	2	1	1	1	1	3
Ave.	1.2	1.2	1.2	1.2	1.2	1.6	2	1.2	1.8	1.8

<b>Semester – III</b>			
<b>Part III NME I - Mathematics for Competitive Examinations I</b>			
<b>Code :23UMAN31</b>	<b>Hrs/week :2</b>	<b>Hrs/Semester :30</b>	<b>Credits :2</b>

### **Unit I**

H.C.F and L.C.M of Numbers

**(Chapter 2, Pages 22-36)**

### **Unit II**

Simplification

**(Chapters 4, Pages 58-75)**

### **Unit III**

Average

**(Chapter 7, Pages 124-138)**

### **Unit IV**

Time & Work

**(Chapters 11, Pages 206-222)**

### **Unit V**

Time & Distance

**(Chapter 13, Pages 231-243)**

### **Text Book**

Aggarwal R.S., **Objective Arithmetic**(Edition 2004), S.Chand and Company Ltd. , Ram Nagar, New Delhi - 55

### **Books for Reference**

1. Aggarwal R.S., **Arithmetic Subjective and Objective for Competitive Examinations** (Revised Edition 2011), S.Chand and Company Ltd. , Ram Nagar, New Delhi - 55
2. Abhijit Guha, **Quantitative Aptitude for Competitive Examinations**, Tata McGraw-Hill Publishing Company Ltd., New Delhi.



<b>Semester – III</b>			
<b>Part IV Skill Enhancement Course IV– Statistics with R Programming</b>			
<b>Course Code: 23UMASE4</b>	<b>Hrs/week: 2</b>	<b>Hrs/Semester: 30</b>	<b>Credits: 2</b>

**Objectives:**

- Attain a solid understanding of R's fundamental elements, including data structures, functions, and basic operations.
- provide a solid foundation in probability theory, mathematical statistics and R programming

**Course Outcome:**

<b>CO. No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
CO-1	recall the basics of R programming	K1
CO-2	explain how to use R for statistical programming, computation, and graphics.	K2
CO-3	apply functions to measures of dispersion	K3
CO-4	outline standard distributions in R.	K4
CO-5	create Data Frames and develop R programs for the given task	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	3	3	3	1	2	3	3	2	2	2
<b>CO-2</b>	3	3	3	1	2	3	3	2	2	2
<b>CO-3</b>	3	3	3	1	2	3	3	2	2	2
<b>CO-4</b>	3	3	3	1	2	3	3	2	2	2
<b>CO-5</b>	3	3	3	1	2	3	3	2	2	2
<b>Ave.</b>	3	3	3	1	2	3	3	2	2	2

Semester – III			
Part IV Skill Enhancement Course IV- Statistics with R Programming			
Course Code: 23UMASE4	Hrs/week: 2	Hrs/Semester: 30	Credits: 2

#### UNIT I

Introduction to Functions - Important R Data Structures -vectors - Declarations - Common Vector Operations - Using all() and any() - Vectorized Operations - NA and NULL Values.

#### UNIT II

Statistical software and programming language, Data inputting methods, Data accessing and indexing.

#### UNIT III

Graphics in R, built in functions, diagrammatic representation of data, measures of central tendency.

#### UNIT IV

Measures of dispersion, summaries of a numerical data.

#### UNIT V

Normal distribution, plot to check Normality, plotting probability curves for standard distributions.

#### Text Book

1. Norman Matloff, "The Art of R Programming: A Tour of Statistical Software Design", NoStarch Press, 2011.
2. Sudha G. Plurohit et.al., Statistics Using R, Narosa Publishing House, India, 2008.
3. Michael J. Crawley, "The R Book", John Wiley & Sons Ltd, 2009.

#### Books for Reference

1. Jared P. Lander, "R for Everyone", Pearson Education, Inc., 2014.
2. John Verzani, simple R-Using R for introductory Statistics.
3. P. Dalgaard. Introductory Statistics with R, 2nd Edition. (Springer 2008)

#### Website and e-Learning Source

<http://nptel.ac.in/courses/110106064/>

<http://www.r-project.org>

**Practical List:**

1. Write a Program to Introduce Functions in R
2. Create Examples to Explore Important R Data Structures
3. Implement Declarations in R
4. Demonstrate Common Vector Operations in R
5. Utilize all () and any () Functions in R
6. Implement Vectorized Operations in R
7. Handle NA and NULL Values in R
8. Provide an Overview of Statistical Software and Programming Languages
9. Demonstrate Data Inputting Methods in R
10. Implement Data Accessing and Indexing Techniques in R
11. Create Graphics in R: Basics and Built-in Functions
12. Implement Diagrammatic Representation of Data in R
13. Calculate Measures of Central Tendency in R
14. Compute Measures of Dispersion in R
15. Write a Program to Summarize Numerical Data in R
16. Understand Normal Distribution in R
17. Create Plots to Check Normality in R
18. Generate Probability Curves for Standard Distributions in R

<b>Semester III</b>	
<b>Self Study Course –Foundation of Mathematics</b>	
<b>Code: 23UMASS1</b>	<b>Credits:2</b>

### Objectives

- Understand the foundational principles and methodologies of axiomatic and genetic methods in geometry and set theory
- Apply logical reasoning techniques, such as truth tables and predicate calculus, to analyze and solve mathematical propositions

### Course Outcomes

<b>CO.No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>CL</b>
CO-1	Recall key concepts and theories	K1
CO-2	Understand the significance and implications of methods and theories	K2
CO-3	Apply mathematical principles to solve problems	K3
CO-4	Analyze mathematical arguments and systems	K4
CO-5	Integrate knowledge to construct advanced mathematical solutions	K5

### Relation Matrix

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	2	1	1	1	1	2	1	1	1	1
<b>CO-2</b>	2	2	2	1	1	2	2	1	1	1
<b>CO-3</b>	2	2	2	1	1	3	2	2	1	1
<b>CO-4</b>	2	2	2	2	1	2	2	2	2	1
<b>CO-5</b>	2	2	2	2	2	2	2	2	1	2
<b>Ave.</b>	2.0	1.8	1.8	1.4	1.2	2.2	1.8	1.6	1.2	1.2

<b>Semester III</b>	
<b>Self Study Course - Foundation of Mathematics</b>	
<b>Code: 23IMASS1</b>	<b>Credits: 2</b>

### **Unit I**

The Axiomatic method – Geometry according to Euclid – Euclid’s postulates – Non Euclidean Geometry.

**(Chapter: 1, pages: 1 - 6)**

### **Unit II**

The formal axiomatic method - Description of formal axiomatic method –Analysis of axiomatic method – Consistency of axiomatic method - Completeness of an axiom system – Advantages and Disadvantages of the axiomatic method

**(Chapter: 1, pages:6 - 18)**

### **Unit III**

The Genetic method - The theory of sets – Equivalent sets – Cardinal numbers

**(Chapter: 1, pages: 18 - 25)**

### **Unit IV**

Paradoxes in set theory –Cantor’s Paradox – Russell’s Paradox – Axiomatic set theory – The three schools of thought.

**(Chapter: 1, pages: 25 - 40)**

### **Unit V**

Truth tables method – The Predicate Calculus

**(Chapter: 1, pages: 40 - 44)**

### **Text Book**

1. K.S. Narayanan and K. Narasimhan, A History of Mathematics ,Taj printers, First Edition Reprint 1985.

Semester – IV			
Part III Core VII - Elements of Mathematical Analysis			
Course Code: 23UMAC41	Hrs/week: 5	Hrs/Semester: 75	Credits: 5

### Objectives

- It gives an introductory knowledge of the basic abstract systems and fundamentals of Mathematics
- To train the students to generalize the known concepts and to develop analytical thinking

### Course Outcomes

Co No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	develop the analytical thinking to generalize the known concepts.	K1
CO-2	know the important inequalities necessary to compare the real numbers.	K2
CO-3	explain the difference between a sequence and a series in the mathematical context.	K3
CO-4	able to identify boundedness, monotonic, limit points etc. of a sequence.	K4
CO-5	able to apply various tests to verify the convergence or divergence of a given sequence and also the series.	K5

### Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	3	2	3	2	1	2	2
CO-2	3	3	2	3	2	3	2	1	2	2
CO-3	3	3	3	3	2	3	2	1	2	2
CO-4	3	3	3	3	2	3	2	1	2	2
CO-5	3	3	2	3	2	3	2	1	2	2
Ave.	3	3	2.4	3	2	3	2	1	2	2

<b>Semester – IV</b>			
<b>Part III Core VII - Elements of Mathematical Analysis</b>			
<b>Course Code: 23UMAC41</b>	<b>Hrs/week: 5</b>	<b>Hrs/ Semester:75</b>	<b>Credits: 5</b>

### **Unit I**

Sequences - Bounded Sequences - Monotonic Sequences - Convergent Sequences - Divergent and Oscillating Sequences - The Algebra of Limits- Behaviour of Monotonic Sequences

**(Chapter 3 Sec 3.1 – 3.8, pages 41- 94)**

### **Unit II**

Some Theorems on Limits – Subsequences - Limit points - Cauchy Sequences - Cauchy's General Principle of Convergence of Sequences

**(Chapter 3 Sec 3.9 – 3.12, pages 94- 118)**

### **Unit III**

Series of Positive Terms - Infinite series - Comparison test - Kummer's test - D' Alembert's ratio test - Raabe's test - Gauss's test - Cauchy's Root test – Cauchy's Condensation Test(without proof)

**(Chapter 4 Sec 4.1 - 4.4, pages 129- 169)**

### **Unit IV**

Alternating series – Leibnitz's test - Absolute convergence - Tests for Convergence of Series of Arbitrary Terms – Dirichlet's test – Abel's test

**(Chapter 5 Sec 5.1 - 5.3, pages: 175 – 192)**

### **UNIT V**

Multiplication of Series - Abel's theorem – Merten's Theorem

**(Chapter 5 Sec 5.5, pages: 203 - 211)**

### **Text Book**

1. S. Arumugam, A. Thangapandi Issac and A.Somasundaram, Sequences and Series, Yes Dee Publishing Pvt. Ltd., Chennai, 2019.

### **Books for Reference**

1. Richard R. Goldberg, Methods of Real Analysis: Oxford and IBH Publishing, 2020.
2. Ethan D. Bloch, The Real Numbers and Real Analysis, Springer, 2011.
3. G.M. The fundamentals of Mathematical Analysis, vol I. Pergamon Press, New York, 1965.

Semester –IV			
Part III Core VIII-Vector Calculus			
Course Code :23UMAC42	Hrs/week :4	Hrs/Semester :60	Credits :3

**Objectives:**

1. To master vector calculus fundamentals, including derivatives and operators like  $\nabla$ .
2. To develop advanced problem-solving skills by applying theorems like Gauss's and Stoke's.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	CL
CO-1	Understand vector and scalar point functions and their derivatives, including the gradient operator $\nabla$	K1
CO-2	Apply the $\nabla$ operator and grasp its role in calculating gradients.	K2
CO-3	Comprehend concepts of divergence, curl, and properties of solenoidal and irrotational vectors, including the Laplacian operator.	K3
CO-4	Demonstrate the ability to perform integration of point functions, line integrals, and surface integrals.	K4
CO-5	Evaluate problems involving volume and surface integrals using Gauss's divergence theorem, Green's theorem, and Stoke's theorem	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	1	1	1	1	2	2	1	2	1
CO-2	1	2	1	1	1	2	2	1	2	2
CO-3	1	1	2	1	1	2	3	1	2	1
CO-4	1	1	1	2	1	2	2	2	3	1
CO-5	1	1	1	1	2	1	2	1	2	3
Ave.	1.2	1.2	1.2	1.2	1.2	1.8	2.2	1.2	2.2	1.6



Semester –IV			
Part III – Core VIII-Vector Calculus			
Course Code :23UMAC42	Hrs/week :4	Hrs/Semester :60	Credits :3

### Unit I

Vector point functions – Scalar point functions – Derivative of a vector and derivative of sum of vectors – Derivative of product of a scalar and vector point function – The vector operator  $\nabla$  - Gradient.

### Unit II

Divergence – Curl, solenoidal, irrotational vectors –Laplacian operator.

### Unit III

Integration of point function – Line integral – Surface integral.

### Unit IV

Volume Integral – Gauss divergence theorem (Statement without Proof ) – Problems.

### Unit V

Green's theorem and Stoke's theorem (Statement without Proof ) – Problems.

### Text Books

1. DuraiPandian P and Laxmi Duraipandian, Vector Analysis, Emerald Publishers, Edition 2005.

### Books for Reference

1. Arumugam S. and Thangapandi Isaac A, *Analytical Geometry of Three Dimensions and Vector Calculus*, New Gamma Publishing House, Edition 2014,
2. Piskunov N, *Differential and Integral Calculus*, Vol II, CBS Publishers and Distributors.

Semester – IV			
Part III Generic Elective IV - Industrial Statistics( Industry Module)			
Course Code: 23UMME41	Hrs/week: 4	Hrs/Semester: 60	Credits: 3

**Objectives:**

- To understand different testing hypothesis and their applications for the development of the business
- To create awareness about the uses of basic statistical concepts in their day-to-day life

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand the difference between the various charts and test	K1
CO-2	understand to use the	K2
CO-3	find the applications of the chart	K3
CO-4	Analyze and interpret mathematical patterns, enhancing the ability to recognize and solve complex algebraic problems.	K4
CO-5	Synthesize, demonstrate the problem solving skills	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
<b>CO-1</b>	3	2	3	1	2	1	2	2	2	2
<b>CO-2</b>	2	3	1	2	3	2	2	2	2	2
<b>CO-3</b>	2	2	3	2	2	2	2	2	2	2
<b>CO-4</b>	2	1	2	3	3	3	2	2	2	2
<b>CO-5</b>	2	3	2	2	3	2	2	2	3	2
<b>Ave.</b>	2.2	2.2	2.2	2	2.6	2	2	2	2.2	2

<b>Semester – IV</b>			
<b>Part III Generic Elective IV - Industrial Statistics( Industry Module)</b>			
<b>Course Code: 23UMME41</b>	<b>Hrs/week: 4</b>	<b>Hrs/Semester: 60</b>	<b>Credits: 3</b>

### **Unit I**

Statistical Quality Control - Definition, Advantages, Process control - Control chart, Mean chart, Range chart

**(Text Book1: Vol.2, Chapter 7, Pages 1051-1074)**

### **Unit II**

Control chart for standard Deviation, Control chart for C, Control chart for P ,np-chart

**(Text Book1: Vol.2, Chapter 7, Pages1082-1091)**

### **Unit III**

Testing of hypothesis - Null and Alternate Hypothesis. Type I and Type II errors - Critical region, level of significance - Test of significance for large samples - Testing a single proportion - Difference of proportions - testing a single mean - Difference of means.

**(Text Book1: Vol.2, Chapter 3, Pages882 – 909)**

### **Unit IV**

Tests based on t - distribution - Single mean - Difference of means - Tests based on F distribution - Variance ratio test - Test based on chi square distribution - Independence - Goodness of fit. (excluding the test for correlation)

**(Text Book1: Chapter 3- 4, Pages 910 – 920, 954 – 970, 1006-1009)**

### **Unit V**

Analysis of Variance - One way and two way classified data - Basis of experimental design - simple problems.

#### **Text Books**

1. Gupta S.P., Statistical Method , 44-th edition Sultan Chand & Sons Publishers-New Delhi.

2. Arumugam S. and Issac A., Statistics, New Gamma publishing House. Palayamkottai, 2016.

#### **Books for Reference**

1. Gupta S.C., Kapoor V.K., Fundamentals of mathematical Statistics , Eleventh edition, Sultan Chand & Sons, Educational Publishers, New Delhi

2. Sancheti D.C, Kapoor V.K., Statistics,Sultan Chand& Sons, Educational Publishers, New Delhi

Semester – IV			
Part III NME II - Mathematics for Competitive Examinations II			
Code :23UMAN41	Hrs/week :2	Hrs/Semester :30	Credits :2

### Objectives

- Master square roots, cube roots, numerical operations, and problem-solving techniques.
- Utilize concepts like simple and compound interest, along with age-related problems, in real-life scenarios for financial planning and decision-making.

### Course Outcomes

CO No	Upon completion of this course, students will be able to	CL
CO-1	Identify square roots and cube roots effectively.	K1
CO-2	Describe numerical problems efficiently.	K2
CO-3	Solve age-related problems.	K3
CO-4	Analyze simple interest accurately.	K4
CO-5	Develop compound interest concepts in financial calculations.	K5

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	1	1	3	1	1	3	2
CO-2	1	3	2	1	1	1	1	3	1	1
CO-3	1	2	1	3	1	1	1	1	3	1
CO-4	1	2	1	3	1	1	1	1	3	1
CO-5	1	1	2	3	2	1	1	3	1	3
Ave.	1.2	2	1.4	2	1.2	1.4	1	2	2.2	1.6

<b>Semester – IV</b>			
<b>Part III NME II -Mathematics for Competitive Examinations II</b>			
<b>Code :23UMAN41</b>	<b>Hrs/week :2</b>	<b>Hrs/Semester:30</b>	<b>Credits :2</b>

### **Unit I**

Square Root and Cube Root

**(Chapter 5, Pages 76-95)**

### **Unit II**

Problems on Numbers

**(Chapter 16, Pages 267-278)**

### **Unit III**

Problems on Ages

**(Chapters 17, Pages 279-285)**

### **Unit IV**

Simple Interest

**(Chapter 18, Pages 286-298)**

### **Unit V**

Compound Interest

**(Chapter 19, Pages 299-312)**

### **Text Book**

Aggarwal R.S., **Objective Arithmetic**(Edition 2004), S.Chand and Company Ltd. , Ram Nagar, New Delhi - 55.

### **Books for Reference**

1. Aggarwal R.S., **Arithmetic Subjective and Objective for Competitive Examinations** (Revised Edition 2011), S.Chand and Company Ltd. , Ram Nagar, New Delhi - 55.
2. Abhijit Guha, **Quantitative Aptitude for Competitive Examinations**, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Semester – IV			
Part IV Skill Enhancement Course V– Introduction to Data Science			
Course Code: 23UMASE5	Hrs/week: 2	Hrs/Semester: 30	Credits: 2

**Objectives:**

- Gain a basic understanding of data science concepts and techniques.
- Proficiently utilize data science tasks, including data manipulation and statistical analysis, and derive actionable insights from real-world datasets.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Describe the basic principles of data science	K1
CO-2	Perform data manipulation and data analysis	K2
CO-3	Visualize data effectively using algorithms	K3
CO-4	Apply basic statistical techniques to analyze data	K4
CO-5	create data Frames and develop programs for the given task	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	1	3	3	3	2	2	2
CO-2	3	3	3	1	3	3	3	2	2	2
CO-3	3	3	3	1	3	3	3	2	2	2
CO-4	3	3	3	1	3	3	3	2	2	2
CO-5	3	3	3	1	3	3	3	2	2	2
Ave.	3	3	3	1	3	3	3	2	2	2

Semester – IV			
Part IV Skill Enhancement Course V– Introduction to Data Science			
Course Code: 23UMASE5	Hrs/week: 2	Hrs/Semester: 30	Credits: 2

### UNIT I

Introduction, Toolboxes: Python, fundamental libraries for data Scientists. Integrated development environment (IDE).

### UNIT II

Data operations: Reading, selecting, filtering, manipulating, sorting, grouping, rearranging, ranking, and plotting. Descriptive statistics, data preparation. Exploratory Data Analysis data summarization, data distribution, measuring asymmetry. Sample and estimated mean, variance and standard score.

### UNIT III

Regression analysis: linear regression simple linear regression, multiple & Polynomial regression.

### UNIT IV

Supervised Learning: First step, learning curves, training-validation and test. Learning models generalities, support vector machines

### UNIT V

Unsupervised learning: clustering, similarity and distances, quality measures of clustering.

### Text Book

1. Laura Igual and SantiSeguí, Introduction to Data Science a Python approach to concepts, Techniques and Applications, Springer, 2017

### Books for Reference

1. Data Analysis with Python A Modern Approach, David Taieb, Packt Publishing, ISBN: 9781789950069
2. Python Data Analysis, Second Ed., Armando Fandango, Packt Publishing, ISBN: 9781787127487

### Website and e-Learning Source

<http://nptel.ac.in/courses/110106064/>

<https://www.datacamp.com/>

**Practical List:**

1. Implementation of Python Basic Libraries such as Statistics, Math, Numpy and Scipy
2. Implementation of Python Libraries for ML application such as Pandas and Matplotlib.
3. Creation and loading different datasets in Python and compute Mean, Median, Mode, Variance, Standard Deviation using datasets.
4. Compute reshaping the data, filtering the data, merging the data and handling the missing values in datasets.
5. Compute the Simple Linear Regression and plot the graph.
6. Implementation of Naviebayes classifier algorithm and plot the graph.
7. Implementation of SVM classification and plot the graph.
8. Implementation of k-means clustering.
9. Implementation of hierarchical clustering.
10. Performance analysis on a specific dataset.



Semester – IV			
Part IV- Skill Enhancement Course II -Computing Mathematics with Geogebra			
Course Code: 23UMAA41	Hrs/week: 1	Hrs/Semester: 15	Credits: 1

**Objectives:**

- To analyze and compare the effectiveness of GeoGebra's drawing, construction, and graphic tools for various mathematical tasks
- To evaluate the suitability of GeoGebra in enhancing students' understanding of mathematical concepts compared to traditional methods

**Course Outcomes:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Know the difference between drawing, construction, and graphic tools.	K1
CO-2	Describe the features of GeoGebra that aid in algebraic input	K2
CO-3	Use GeoGebra tools effectively, including drawing, construction, and graphic tools.	K3
CO-4	Analyse instructional materials integrating mathematical concepts using GeoGebra.	K4
CO-5	Evaluate the effectiveness of GeoGebra in problem-solving and propose improvements.	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	1	1	2	1	2	1	1
CO-2	2	2	2	1	1	2	1	2	1	1
CO-3	2	2	2	1	1	1	1	2	1	1
CO-4	2	2	1	2	1	1	1	1	2	1
CO-5	2	2	1	1	1	1	1	1	2	1
Ave.	2	2	1.4	1.2	1	1.4	1	1.6	1.4	1

<b>Semester – IV</b>			
<b>Part IV- Skill Enhancement Course II -Computing Mathematics with Geogebra</b>			
<b>Course Code: 23UMAA41</b>	<b>Hrs/week: 1</b>	<b>Hrs/Semester: 15</b>	<b>Credits: 1</b>

### **Unit I**

Installation and Introduction of GeoGebra: Installing GeoGebra, Save the Accompanying Files. Drawing versus Geometric Construction: Drawing Geometric Figures and Other Objects, Saving GeoGebra Files, Drawings, Constructions and Drag Test ,Rectangle Construction , Equilateral Triangle Construction

### **Unit II**

Basic Algebraic Input, Commands and Functions : Constructing Tangents to a Circle, Exploring Parameters of a Quadratic Polynomial, Using Sliders to Modify Parameters , Library of Functions. Export of Pictures to the Clipboard: Exporting Pictures to the Clipboard, Inserting Pictures into a Text Processing Document

### **Unit III**

Inserting Pictures into the Graphics View: Drawing Tool for Symmetric Figures, Resizing and Reflecting a Picture, Distorting a Picture, Exploring Properties of Reflection. Inserting Text into the Graphics View: Coordinates of Reflected Points, Rotation of a Polygon

### **Unit IV**

Combining Spreadsheet View & Graphics View: Record to Spreadsheet, Relative Copy and Linear Equations, Best Fit Line, Exploring Basic Statistics

### **Unit V**

Creating Static Instructional Materials: Saving Pictures as Files, Inserting Pictures into a Text Processing Document. Creating Dynamic Worksheets: GeoGebra Tube and User Forum, Creating Dynamic Worksheets , Enhancing Dynamic Worksheets, Providing Dynamic Worksheets to Students

### **Text book:**

1. Judith and Markus Hohenwarter, Introduction to GeoGebra, Creative Commons Attribution-Noncommercial-Share Alike see <http://creativecommons.org/licenses/by-nc-sa/3.0/>, 2011 Edition

### **Books for Reference**

1. Jonas Hall and Thomos Lingerjard, Mathematical Modeling: Applications with GeoGebra, First Edition, John Wiley & Sons, New Jersey, 2017.
2. Lingguo Bu and Robert Schoen, Model-Centered Learning: Pathways to Mathematical Understanding Using GeoGebra, Sense Publishers, The Netherlands, 2011.

### **Web Resources**

1. <http://hostel.ufabc.edu.br/~daniel.miranda/wp-content/uploads/GeoGebraManual.pdf>
2. <https://www.geogebra.org/m/ZMXBaxRY>
3. [https://youtu.be/KdXKW6IP\\_Qc](https://youtu.be/KdXKW6IP_Qc)
4. <https://youtu.be/S8pQW5DmQXO>

Semester –V			
Part III Core IX - Linear Algebra			
Course Code: 23UMAC51	Hrs/week: 6	Hrs/Semester: 90	Credits: 6

### Objectives

- To extend the knowledge in Abstract Algebra and develop analytical thinking.
- To equip the students with the ideas of Linear Algebra to pursue their higher studies.

### Course Outcomes

CO.No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	know all the definitions in Linear Algebra	K1
CO-2	analyze and construct mathematical arguments that relate to the study of linear algebra. (proof and reasoning).	K2
CO-3	solve systems of linear equations.	K3
CO-4	work within vector spaces and to distill vector space properties	K4
CO-5	understand the concept of Inner Product Spaces and Bilinear Transforms	K5

### Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	3	3	3	3	1	2	2
CO-2	3	3	3	3	3	3	3	1	2	2
CO-3	3	3	2	3	3	3	3	1	2	2
CO-4	3	3	3	3	3	3	3	1	2	2
CO-5	3	3	3	3	3	3	3	1	2	2
Ave.	3	3	2.6	3	3	3	3	1	2	2

Semester –V			
Part III		Core IX - Linear Algebra	
Course Code: 23UMAC51	Hrs/week : 6	Hrs/Semester : 90	Credits :6

### Unit I

Vector Spaces - Elementary Properties - Subspaces - Quotient Spaces - Direct Sum  
 - Linear Span of a Set - Linear Dependence and Independence  
 (Chapter 5, Sec 5.1, 5.2, 5.4, 5.5, Pages 5.1-5.10, 5.14-5.19)

### Unit II

Basis - Dimension - Any Two Bases of a Finite Dimensional Vector Space having the  
 Same Number of Elements – Theorems on Dimension  
 (Chapter 5, Sec 5.3, 5.6, Pages 5.10-5.13, 5.19-5.26)

### Unit III

Linear Transformations - Vector Space of Linear Transformations - Rank And  
 Nullity Theorem – Matrix of Linear Transformations  
 (Chapter 5, Sec 5.7, 5.8, Pages 5.26-5.30)

### Unit IV

Inner Product Spaces – Norm – Schwartz Inequality – Triangular Inequality - Gram  
 Schmidt Orthogonalisation Process - Orthogonal Complement  
 (Chapter 6, Pages 6.1-6.9)

### Unit V

Bilinear Forms – Quadratic Forms – Reduction of Quadratic Form to the Diagonal  
 Form – Computation of Matrix Operations with Sage  
 (Chapter 8, Sec 8.1, 8.2, 8.3, Pages 8.1-8.7)

### Text Book

1. S. Arumugam and A. Thangapandi Isaac, Modern Algebra, Scitech Publications  
 (India) Pvt. Ltd., Chennai, 2003, Reprint July 2022

### Books for Reference

1. R.D. Sharma and Ritu Jain, Theory and Problems of Linear Algebra, IK International Publishing House Pvt. Ltd., New Delhi
2. Gilbert Strang, Introduction to Linear Algebra, 5<sup>th</sup> Edition, Wellesley- Cambridge Press, 2023

### Web Resources:

1. [http://fe.math.kobe-u.ac.jp/icms2010-dvd/SAGE/www.sagemath.org/doc/tutorial/tour\\_linalg.html](http://fe.math.kobe-u.ac.jp/icms2010-dvd/SAGE/www.sagemath.org/doc/tutorial/tour_linalg.html)

Semester – V			
Part III Core X- Real Analysis			
Course Code: 23UMAC52	Hrs/week: 6	Hrs/Semester: 90	Credits: 5

**Objectives:**

- To introduce the basic concepts in Analysis and to enable the students to understand fundamental ideas and theorems on Metric spaces
- To develop the application of the concepts.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	describe the basic theory of metric spaces	K1
CO-2	explain the concepts of modern analysis, such as open sets, closed sets, completeness, connectedness and compactness in metric spaces	K2
CO-3	write simple proofs on their own and study rigorous proofs	K3
CO-4	analyze connectedness and continuity, compactness and continuity	K4
CO-5	compare the different concepts for each metric space	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	1	1	3	3	2	3	3
CO-2	3	3	2	1	1	3	3	2	2	3
CO-3	3	3	2	1	1	3	3	1	2	3
CO-4	3	3	2	1	1	3	3	1	3	2
CO-5	3	3	2	1	1	3	3	1	2	3
Ave.	3	3	2	1	1	3	3	1.4	2.4	2.8

Semester – V			
Part III Core X -Real Analysis			
CourseCode : 23UMAC52	Hrs / Week: 6	Hrs / Semester: 90	Credits: 5

### Unit I

Metric spaces - Bounded sets - open ball - open sets – subspace -diameter of a set - interior of a set.

(Chapter 2, Sec 2.1-2.7, pages 19-63).

### Unit II

Closed sets - closure - limit point - dense sets

(Chapter 2, Sec 2.7-2.11, pages 64-84).

### Unit III

Complete metric space - Cantor's intersection theorem - Baire's Category Theorem

(Chapter 3, Sec 3.1-3.3, pages 87-106).

### Unit IV

Connectedness - equivalent conditions - connected subsets of  $\mathbb{R}$  - connectedness and continuity - continuous image of a connected set is connected - Intermediate mean value theorem

(Chapter 5, Sec 5.1-5.4, pages 145-156).

### Unit V

Compactness - definition of open cover - compact metric space – Heine Borel theorem - compactness and continuity - continuous image of a compact set is compact - uniform continuity – Continuous function on a compact metric space is uniformly continuous

– equivalent characterizations of compactness–compactness and continuity.

(Chapter 6, Sec: 6.1-6.4, pages: 158-184).

### Text Book

1. S.Arumugam A.Thangapandi Issac and A.Somasundaram, Modern Analysis, Yes Dee Publishing Pvt.Ltd, Edition 2019.

### Books for Reference

1. Richard R Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co, New Delhi, Reprint 1973.

2. Robert G.Bartle and Donald R.Sherbert, Introduction to Real Analysis,Wiley India Edition, Fourth Edition, Reprint 2017.

Semester – V			
Part III Core XI - Operations Research			
Course Code: 23UMAC53	Hrs/week: 6	Hrs/Semester: 90	Credits: 5

**Objectives:**

- To introduce the various techniques of operations research
- To apply Mathematical theories to Commerce and Business and Management

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Understand the basis of mathematical steps to be followed for a linear programming problem, remember the definition of linear equation, find the graphical solution,	K1
CO-2	.understand the algorithms of transportation problem, Assignment problem, etc	K2
CO-3	.apply the steps correctly and find optimal solution	K3
CO-4	Analyze and interpret the patterns, enhance the ability to recognize the different patterns.	K4
CO-5	Identify the different patterns and evaluate them correctly	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	3	1	2	1	2	2	2	2
CO-2	2	3	1	2	3	2	2	2	2	2
CO-3	2	2	3	2	2	2	2	2	2	2
CO-4	2	1	2	3	3	3	2	2	2	2
CO-5	2	3	2	2	3	2	2	2	3	2
Ave.	2.2	2.2	2.2	2	2.6	2	2	2	2.2	2

<b>Semester – V</b>			
<b>Part III Core XI - Operations Research</b>			
<b>CourseCode :23UMAC53</b>	<b>Hrs/week : 6</b>	<b>Hrs/Semester :90</b>	<b>Credits : 5</b>

### **Unit I**

Introduction - Linear programming problem - Mathematical formulation of the problem - Introduction - Graphical Solution method - General linear programming problem - Canonical and standard forms of L.P.P. -Introduction - The Simplex algorithm  
**(Chapter 2, Sec 2.1 - 2.3, Chapter 3, Sec 3.1, 3.2, 3.4, 3.5, Chapter 4, Sec 4.1, 4.3, pages 39 - 40, 65 - 76, 79 - 84, 87 - 89, 99 - 106)**

### **Unit II**

Use of artificial variables - Two phase method - Big - M method (Method of penalties) - Introduction - General primal - dual pair -Formulating a dual problem - Primal - Dual pair in matrix form -Duality and Simplex method- Dual simplex method  
**(Chapter 4, Sec 4.4, Chapter 5, Sec5.1 – 5.4, 5.7, 5.9, pages 106 - 114, 129 - 134, 138 - 142, 148 - 150)**

### **Unit III**

Transportation problem: Introduction-LP formulation of the Transportationproblem- Solutions of a Transportation Problem - Finding an initial basic feasible solution - Test for optimality - Degeneracy in Transportation Problem - Transportation Algorithm (MODI Method).

**(Chapter 10, Sec 10.1, 10.2, 10.8 – 10.13, pages 247, 248, 252 – 266, 269 - 273)**

### **Unit IV**

Assignment problem: Introduction - Mathematical formulation of the problem - Solution methods of assignment problem-Special cases in assignment problems.

**(Chapter 11, Sec 11.1 - 11.4, pages 295 – 315)**

### **Unit V**

Sequencing problem:Introduction - Problems of sequencing - Basic terms used in sequencing - Processing n jobs through Two machines -Processing n jobs through k machines, Processing 2 jobs through k machines

**(Chapter 12, Sections 12.1 - 12.6, pages 327 – 342)**

### **Text Book**

1.Kantiswarup, P.K. Gupta, and Manmohan: *Operations Research*, Sultan Chand & Sons, Educational Publishers, New Delhi, Reprint 2013.

### **Books for Reference**

- 1.Prem Kumar Gupta and Hira D.S:*Operations Research*, Sultan Chand & Sons, Educational Publishers, New Delhi -2 .
- 2.Billy E Gillet: *Introduction to Operations Research*, Tata McGraw Hill publishing Company, New Delhi.



<b>SEMESTER – V</b>			
<b>Part III Core XII - Mathematical Modelling</b>			
<b>Course Code : 23UMAC54</b>	<b>Hrs / Week: 6</b>	<b>Hrs / Semester: 90</b>	<b>Credits: 5</b>

**Objectives:**

- To study the mathematical models through ODE and difference equations and train the students to develop mathematical models in real life problems.
- Enable students to proficiently apply mathematical modelling techniques to diverse real-world scenarios, fostering analytical thinking, problem-solving skills, and a deep understanding of mathematical concepts

**Course Outcomes**

<b>CO. No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
CO-1	Comprehend and apply foundational principles of mathematical modelling, distinguishing between linear and non-linear growth and decay models.	K1
CO-2	Analyze and synthesize mathematical models for dynamic systems, utilizing compartmental models to represent real-world scenarios.	K2
CO-3	Evaluate and interpret mathematical models in diverse fields such as economics, medicine, and planetary motions, demonstrating practical applications of modelling.	K3
CO-4	Formulate and solve advanced mathematical problems using linear differential equations and difference equations, showcasing proficiency in mathematical modelling.	K4
CO-5	Create, assess, and integrate complex mathematical models, demonstrating high-level critical thinking and problem-solving skills across various domains, including probability theory.	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	3	2	2	2	2	3	2	3	3	3
<b>CO-2</b>	2	2	2	2	3	2	3	2	3	2
<b>CO-3</b>	3	2	2	2	2	3	2	2	2	3
<b>CO-4</b>	3	3	2	2	2	3	3	3	2	2
<b>CO-5</b>	3	2	2	2	2	3	2	2	3	3
<b>Ave.</b>	2.8	2.2	2	2.0	2.2	2.8	2.1	2.4	2.6	2.6

<b>SEMESTER – V</b>			
<b>Part III Core XII- Mathematical Modelling</b>			
<b>Course Code : 23UMAC54</b>	<b>Hrs / Week: 6</b>	<b>Hrs / Semester: 90</b>	<b>Credits: 5</b>

### **Unit I**

Linear Growth and Decay Models – Non-Linear Growth and Decay Models – Compartment Models.

### **Unit II**

Dynamic problems – Geometrical problems - Population Dynamics – Epidemics – Compartment Models.

### **Unit III**

Economics – Medicine Arms Race, Battles and International Trade – Dynamics. Planetary Motions – Circular Motion and Motion of Satellites

### **Unit IV**

Mathematical Modelling through Linear Differential Equations of Second Order – Miscellaneous Mathematical Models. Simple Models.

### **Unit V**

Basic Theory of Linear Difference Equations with Constant Coefficients – Economics and Finance – Population Dynamics and Genetics – Probability Theory

### **Text Book**

J.N. Kapur, Mathematical Modelling, Wiley Eastern Limited, NewDelhi,1988.

### **Books for Reference**

1. J.N. Kapur, Mathematical Models in biology and Medicine, EWP, New Delhi,1985.
2. Keshet, L. E., "Mathematical Models in Biology", SIAM
3. Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer.
4. Frank R. Giordano, William Price Fox, Maurice D. Weir, A First Course in Mathematical Modelling, 4th Ed., Charlie Van Wagner.

Semester – V			
Part III Discipline Specific Elective I- Transformation Techniques			
Course Code: 23UMAE51	Hrs/week: 4	Hrs/Semester: 60	Credits: 3

**Objectives:**

- To develop the knowledge of Transforms.
- To solve problems in Fourier Transforms and Z- transforms.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Understand the concepts of Fourier Transforms and their properties.	K1
CO-2	Apply Fourier Transforms to analyze signals and systems, demonstrating an understanding of their properties.	K2
CO-3	Analyze and apply the properties of Infinite Fourier Cosine and Sine Transforms.	K3
CO-4	Evaluate Finite Fourier Transforms for signal processing and analysis, demonstrating proficiency in their application.	K4
CO-5	Generate discrete-time signals and systems by understanding the principles of Z-transforms and their properties	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	1	1	2	1	2	1	1
CO-2	2	2	2	1	1	2	1	2	1	1
CO-3	2	2	2	1	1	1	1	2	1	1
CO-4	2	2	1	2	1	1	1	1	2	1
CO-5	2	2	1	1	1	1	1	1	2	1
Ave.	2	2	1.4	1.2	1	1.4	1	1.6	1.4	1

Semester – V			
Part III Discipline Specific Elective I- Transformation Techniques			
Course Code: 23UMAE51	Hrs/week: 4	Hrs/Semester: 60	Credits: 3

### Unit I

Fourier Transforms – Properties of Fourier Transforms.

### Unit II

Infinite Fourier Cosine and Sine Transforms – Properties.

### Unit III

Finite Fourier Transforms.

### Unit IV

Z -transforms – Properties.

### Unit V

Inverse Transforms - Introduction to difference equations and find solution using inverse Z transforms

### Text Book

Singaravelu .A– Engineering Mathematics (vol III) – Meenakshi Agency, Chennai(2019).

### Books for Reference

1. Muthu Kumaraswamy. R - Transforms and Partial Differential Equation Equations –Yes Dee Publications – Second Edition(2019).
2. A. Gangatharan, Engineering Mathematics (volume I) – Prentice Hall of India Pvt. Ltd. (2007).

Semester – V			
Part III Discipline Specific Elective I- Numerical Methods			
Course Code: 23UMAE52	Hrs/week: 4	Hrs/Semester: 60	Credits: 3

**Objectives:**

- To inspire the students with modern computational methods to carry out the problems.
- To enable students develop their calculation skills

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand the difference operators difference between the difference operators ,Newton interpolation formulae, predictor – corrector formulae, remember all formulae	K1
CO-2	.understand the Trapezoidal rule, Simpson’s two formulae, solve problems	K2
CO-3	.apply the the formulae correctly and find the solution	K3
CO-4	Analyze the interpolation formulae.	K4
CO-5	Synthesize, the different formulae to evaluate situation	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	3	1	2	1	2	2	2	2
CO-2	2	3	1	2	3	2	2	2	2	2
CO-3	2	2	3	2	2	2	2	2	2	2
CO-4	2	1	2	3	3	3	2	2	2	2
CO-5	2	3	2	2	3	2	2	2	3	2
Ave.	2.2	2.2	2.2	2	2.6	2	2	2	2.2	2

<b>Semester –V</b>			
<b>Part III Discipline Specific Elective I - Numerical Methods</b>			
<b>Course Code: 23UMAE52</b>	<b>Hrs/week: 4</b>	<b>Hrs/Semester: 60</b>	<b>Credits: 3</b>

**Unit I**

Difference operators-Other difference operators- Difference equation –Linear difference equation

**(Chapter 3, Sec 3.1, 3.2, 3.3 ,3.4, 3.5)**

**Unit II**

Newton’s interpolation formula-Lagrange’s interpolation formulae-Divided difference-Divided difference formula-Inverse interpolation

**(Chapter 4, Sec 4.1, 4.3 ,4.4 4.5, 4.6)**

**Unit III**

Derivatives using Newton’s forward difference formula-Derivatives using Newton’s backward difference formula-Derivatives using Newton’s central difference formula-Maxima and minima of the interpolating Polynomial

**(Chapter5)**

**Unit IV**

Numerical integration - Newton’s Cote’s quadrature formula - trapezoidal rule - Simpson’s one third rule - Simpson’s three eight rule - Wedley’s rule

**(Chapter6)**

**Unit V**

Numerical solution of differential equations - Taylor’s series method - Picard’s method - Euler’s Method - Runge kutta method - Predictor and corrector formulae.

**(Chapter7)**

**Text Book**

1. S.Arumugam and Issac, **Numerical Analysis**, edition 13 ,New Gamma Publishing House, Palayamkottai.Tamil Nadu

<b>Semester V</b>	
<b>Self Study Course –Vedic Mathematics</b>	
<b>Code: 23UMASS2</b>	<b>Credits:2</b>

**Objectives:**

- To develop proficiency in applying Vedic Mathematics techniques to solve mathematical problems across various domains.
- To enhance critical thinking and analytical skills through the exploration and evaluation of Vedic Mathematics principles and their applications.

**Course Outcomes:**

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	Identify the historical significance and basic principles of Vedic Mathematics	K1
CO-2	Describe various Vedic Mathematics techniques and their applications in arithmetic and algebra.	K2
CO-3	Apply Vedic Mathematics methods to solve arithmetic, algebraic, and geometric problems effectively.	K3
CO-4	Analyze and evaluate complex mathematical problems using Vedic Mathematics principles.	K4
CO-5	Propose and justify innovative approaches to problem-solving based on Vedic Mathematics concepts	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
<b>CO-1</b>	2	1	1	1	1	2	1	1	1	1
<b>CO-2</b>	2	2	2	1	1	2	2	1	1	1
<b>CO-3</b>	2	2	2	1	1	3	2	2	1	1
<b>CO-4</b>	2	2	2	2	1	2	2	2	2	1
<b>CO-5</b>	2	2	2	2	2	2	2	2	1	2
<b>Ave.</b>	2.0	1.8	1.8	1.4	1.2	2.2	1.8	1.6	1.2	1.2

<b>Semester V</b>	
<b>Self Study Course – Vedic Mathematics</b>	
<b>Code: 23UMASS2</b>	<b>Credits:2</b>

**Unit: I**

Introduction and Basics - History and Overview of Vedic Mathematics - Parikarma or Circumambulation

**Unit: II**

Basic Operations and Techniques- The 16 Sutras - The Sub-Sutras - EkadhikenaPurvena (By one more than the previous one) -NikhilamNavatashcaramamDashatah (All from 9 and the last from 10)

**Unit: III**

Multiplication and Division- UrdhvaTiryagbhyam (Vertically and Crosswise) - ParavartyaYojayet (Transpose and Apply)- ShunyamSaamyasamuccaye (When the sum is the same, that sum is zero)

**Unit: IV**

Squaring, Cubing, Square Root, and Cube Root- AntyayorDasake'pi (The ultimate and twice the penultimate) - EkanyunenaPurvena (One less than the one before) - Gunita Sutra- Varga Sutra -YavatGunam (As many as is the entity)

**Unit: V**

Algebra and Geometry Basics: Paravartya Sutra - HesanyankenaCharamena (The remainders by the last digit) - Vargank (Special Multiplication)

**Text Book**

1. Jagadguru Swami Sri Bharati Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Indological Publishers, 1981 .



Semester –VI			
Part III Core XIII - Complex Analysis			
Course Code: 23UMAC61	Hrs/week:6	Hrs/Semester:90	Credits: 5

### Objectives

- To expose students to more complex theories of study
- To sharpen analytical thinking and their problem solving capacity

### Course Outcomes

Co No	Upon successful completion of this course students will be able to:	Cognitive Level
Co-1	compute sums, products, quotients, conjugate, modulus, and argument of complex numbers.	K1
Co-2	understand the significance of differentiability for complex functions and be familiar with the Cauchy-Riemann equations.	K2
Co-3	evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem.	K3
Co-4	know the condition(s) for a complex variable function to be analytic and/or harmonic.	K4
Co-5	compute the Taylor and Laurent expansions of simple functions, determining the nature of the singularities and calculating residues and use the Cauchy Residue theorem to evaluate integrals and sum series.	K5

### Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	2	1	3	3	2	2	2
CO-2	3	3	3	2	1	3	3	2	2	2
CO-3	3	3	3	2	1	3	3	2	2	2
CO-4	3	3	3	2	1	3	3	2	2	2
CO-5	3	3	3	2	1	3	3	2	2	2
Ave.	3	3	3	2	1	3	3	2	2	2

<b>Semester –VI</b>			
<b>Part III Core XIII- Complex Analysis</b>			
<b>Course Code: 23UMAC61</b>	<b>Hrs/week:6</b>	<b>Hrs/Semester:90</b>	<b>Credits: 5</b>

### **Unit I**

Complex Numbers- Conjugation and Modulus – Inequalities –Square Root – Geometrical Representation of Complex Numbers – nth Roots of Complex numbers - Circles and Straight lines – Regions in the Complex Plane - Extended Complex Plane - Continuous Functions- Differentiability - The Cauchy - Riemann Equations- Analytic Functions.

(Chapter 1 Sec 1.0 – 1.9, Chapter 2 Sec 2.4, 2.5, 2.6 & 2.7, pages 1- 21, 30 - 50)

### **Unit II**

Harmonic functions - Conformal Mapping – Elementary Transformations -Bilinear Transformations - Cross Ratio –Fixed Points of Bilinear Transformations – Some Special Bilinear Transformation.

(Chapter 2 Sec 2.8 - 2.9, Chapter 3, pages 50 - 100)

### **Unit III**

Complex Integration- Definite Integral - Cauchy's Theorem - Cauchy's Integral Formula - Higher derivatives

(Chapter 6, Sec 6.0 – 6.4, pages 132-172)

### **Unit IV**

Series Expansions - Taylor's series - Laurent's series - Zeros of Analytic Functions – Singularities

(Chapter 7, Sec 7.0 – 7.4, pages 173 - 208)

### **Unit V**

Calculus of Residues - Residues - Cauchy's Residue Theorem - Evaluation of Definite Integrals

(Chapter 8, Sec 8.0 – 8.3, pages 209 -255)

### **Text Book**

1. S. Arumugam, A.ThangapandiIssac, A. Somasundaram,Complex Analysis, SciTech publications(India) Pvt.Ltd, 2022

### **Books for Reference**

1. Complex Variables and Application, Seventh Edition by James Ward Brown and Ruel V. Churchill, Mc-Graw Hill Book Co., International Edition, 2009

2. Theodore W. Gamelan, Complex Analysis, Springer Verlag, 2008

Semester – VI			
Part III-Core XIV-Graph Theory			
Course Code: 23UMAC62	Hrs/week: 6	Hrs/Semester:90	Credits: 5

**Objectives:**

- To learn basic concepts in graph theory.
- To translate situations to diagrammatic representations and to develop problem solving skills.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	describe the basics of graphs and identify induced subgraphs, paths, cycles, independent sets and coverings in graphs	K1
CO-2	explain whether the graphs are Hamiltonian and/or Eulerian	K2
CO-3	solve problems involving vertex and edge connectivity, planarity and crossing numbers, calculate the crossing and outer planarity	K3
CO-4	identify trees and planar graphs and analyse their properties	K4
CO-5	evaluate the chromatic number and chromatic index of a graph	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	1	1	3	3	2	3	3
CO-2	3	3	2	1	1	3	3	2	2	3
CO-3	3	3	2	1	1	3	3	1	2	3
CO-4	3	3	2	1	1	3	3	1	3	2
CO-5	3	3	2	1	1	3	3	1	2	3
Ave.	3	3	2	1	1	3	3	1.4	2.4	2.8

<b>Semester VI</b>			
<b>Part III Core XIV - Graph Theory</b>			
<b>Course Code :23UMAC62</b>	<b>Hrs / Week : 6</b>	<b>Hrs / Semester: 90</b>	<b>Credits: 5</b>

### **Unit I**

Graphs and sub graphs:

Introduction - Definition and examples - Degrees - Sub graphs –Isomorphism - independent sets and coverings - intersection graphs - Line graphs - Matrices - Operation on graphs

**(Chapter 2, Sec 2.1-2.4, 2.6-2.9, pages 5-28).**

### **Unit II**

Degree Sequences:

Introduction –Degree sequences - Graphic Sequence

Connectedness: -

Introduction-walks - trails and paths - Connectedness and components - blocks - connectivity.

**(Chapters 3 and 4 Sec 3.1-3.2, 4.1-4.4, pages 29-47).**

### **Unit III**

Eulerian and Hamiltonian graphs:

Introduction - Eulerian graphs - Hamiltonian graphs - Trees – introduction - Characterization of trees - Centre of a tree.

**(Chapters 5 and 6, Sec 5.1-5.2, 6.1-6.2, pages 48-65).**

### **Unit IV**

Planarity:

Definition and properties, Characterization of planar graphs – thickness, crossing and outer planarity

**(Chapter- 8, Sec 8.1-8.3, pages 73-84).**

### **Unit V**

Colourability:

Chromatic number and Chromatic index - The five colour theorem –Chromatic polynomials.

Directed graphs:

Introduction, Definition and Basic properties, Paths and connectedness, Digraphs and Matrices, Tournaments

**(Chapter- 9, Sec 9.1-9.4, pages: 85-114).**

### **Text Book**

S. Arumugam, S. Ramachandran - *Invitation to Graph theory*, Scitech Publications (India) Pvt. Ltd., Chennai, Reprint July 2022.

### **Books for Reference**

1. Parthasarathy K.R., *Basic Graph Theory*, Tata McGraw Hill Publishing Company Limited,

New Delhi

2. John Clark and Derek Allan Holton, *A First Look at Graph Theory*, World Scientific Publishing Co. Pvt. Ltd., Singapore, Reprint 2013.

Semester VI			
Part III Core XV - Mechanics			
Course Code : 23UMAC63	Hrs/week:6	Hrs/Semester:90	Credits :5

### Objectives

- To provide basic knowledge of the behavior of objects in motion
- To develop a working knowledge to handle the practical problems

### Course Outcome:

CO.No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand the basic definitions triangular law, lami's theorem, recall the definitions parallel forces, remember the conditions for equilibrium	K1
CO-2	understand the two types of impact, the simple harmonic motion, identify the types of friction law	K2
CO-3	distinguish between parallel and non parallel forces, apply friction laws in problems, use Lami's theorem in solving problems	K3
CO-4	apply friction laws in problems, determine the simple harmonic motion.	K4
CO-5	Prove the theorems, evaluate the problems	K5

### Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	1	2	2	1	2	1	2	2	2	2
CO-2	2	3	2	2	3	2	2	2	2	2
CO-3	3	2	3	2	2	2	2	2	2	2
CO-4	2	1	1	3	2	2	2	2	2	2
CO-5	2	3	2	2	3	2	2	3	2	2
Ave.	2.	2.2	2.0	2	2.4	1.8	2	2.2	2	2

<b>Semester VI</b>			
<b>Part III Core XV - Mechanics</b>			
<b>Course Code :23UMAC63</b>	<b>Hrs/week :6</b>	<b>Hrs/Semester :90</b>	<b>Credits :5</b>

### **Unit I**

Lami's theorem, Parallel forces and moments - Resultant of Two like and unlike parallel forces, moment of a force - t Varignon's theorem - moment of force about an axis couples.

**(Text Book 1: Chapter 3,4, pages 52-96)**

### **Unit II**

Equilibrium of three forces acting on rigid body subjected to any three forces - three coplanar forces theorem, Two Trigonometrical theorems, problems.

**(Text Book 1: Chapter5, pages 98-142)**

### **Unit III**

Frictions - Laws of friction - angle of friction - cone of friction - Equilibrium of particle on a rough inclined plane under a Force.

**(Text Book 1: Chapter7, pages 206-262)**

### **Unit IV**

Fundamental laws of impact - impact of a smooth sphere on a fixed smooth plane - direct impact of smooth elastic spheres.

**(Text Book2: Chapter 8, pages 215-261)**

### **Unit V**

Definition - Geometrical representation of S.H.M.'s –Composition of S.H.M.'s of the same period and in the same line - Composition of S.H.M.'s of the same period and in two perpendicular directions.

**(Text Book2: Chapter 10, pages 309-355)**

### **Text Books**

1. Venkatraman,M.K. Statics, Agasthiar Book House, Tiruchirapalli, Aug 2011.
- 2.Venkatraman M.K, Dynamics, Agasthiar Book house, Tiruchirapalli, 16<sup>th</sup> Edition, Jan 2014.

### **Books for Reference**

1. Duraipandian P., Mechanics, S.Chand and Company Ltd.
- 2.Bali N.P., Dynamics, Laxmi Publication, Delhi.

<b>SEMESTER- VI</b>			
<b>Part III Discipline Specific Elective II - Programming Language with C++</b>			
<b>Course Code: 23UMAE61</b>	<b>Hrs / week : 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits : 3</b>

**Objectives:**

- Equip students with a solid understanding of OOP concepts like classes, objects, inheritance, and polymorphism using C++.
- Enhance students' ability to analyze problems and design efficient solutions through hands-on experience with C++ programming.

**Course outcome:**

<b>CO No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>CL</b>
CO-1	Understand the fundamentals of C++ programming, including basic program construction, preprocessor directives, variable types, and input/output operations using cin and cout.	K1
CO-2	Apply programming concepts such as arithmetic operators, type conversion, manipulators, and library functions to construct C++ programs effectively.	K2
CO-3	Develop proficiency in function usage, including passing arguments, returning values, working with reference arguments, and understanding function overloading and recursion.	K3
CO-4	Analyze the concepts of objects and classes, including constructors, object usage as function arguments, structures, memory management, and static class data.	K4
CO-5	Demonstrate proficiency in advanced programming topics such as inheritance, polymorphism, containership, pointers, memory management, virtual functions, and file I/O operations.	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	3	2	1	1	1	2	2	1	2	1
<b>CO-2</b>	1	3	1	1	1	2	2	1	2	2
<b>CO-3</b>	2	2	3	1	1	2	3	1	2	1
<b>CO-4</b>	2	2	2	3	2	2	2	2	3	1
<b>CO-5</b>	2	2	2	2	3	1	2	1	2	3
<b>Ave.</b>	2.0	2.2	1.8	1.8	1.8	1.8	2.2	1.2	2.2	1.6

<b>SEMESTER- VI</b>			
<b>Part III Discipline Specific Elective II – Programming with C++</b>			
<b>Course Code: 23UMAE61</b>	<b>Hrs / week : 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits : 3</b>

### **Unit I**

The Big Picture: Why Do Need Object-Oriented Programming- Characteristics of Object-Oriented Languages - C++ and C-Laying the Groundwork. C++ Programming Basics: Basic Program Construction - Output Using cout - Preprocessor Directives – Comments - Integer Variables- Character Variables - Input with cin- Type float- Manipulators-Variable type Summary-Type conversion-Arithmetic Operators-Library Functions.

### **Unit II**

Function: Simple Functions - Passing Arguments to Functions -Returning Values from Functions - Reference Arguments - Overloaded Functions - Recursion-Inline Functions - Default Arguments- Variables and Storage Classes - Returning by Reference.

Objects and Classes: A Simple Class - C++ Objects as Physical Objects - C++ Objects as Data Types-Constructors - Objects as Function Arguments -Returning Objects from unction- Structures and Classes-Classes, Object, and Memory-Static Class Data

### **Unit III**

Arrays: Array Fundamentals - Array as Class Member Data - Array of Objects - String. Operator Overloading: Overloading Unary Operators - Overloading Binary Operators- Data Conversion- Pitfalls of Operator Overloading and Conversion.

### **Unit IV**

Inheritance Derived Class and Base Class - Derived Class Constructors - Overriding Member Functions-Inheritance in the English Distance Class - Class Hierarchies-Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance-Ambiguity in Multiple Inheritance - Containership: Classes with Classes - inheritance and Program Development.

Pointers: Addresses and Pointers - Pointer Variables - Pointers and Array - Pointers and Functions - Pointers and Strings - Memory Management: new and delete - Pointers to Objects - A Linked List Example - Pointers to Pointers - Debugging Pointers.

### **Unit V:**

Virtual Functions: Virtual Functions - Friend Functions - Static Functions - assignment and Copy Initialization -The this Pointer.

Streams and Files: Streams -String I/O -Character I/O - Object I/O -I/O with Multiple Objects-File Pointers - Disk I/O with Member Functions -File Pointers -Error Handling - Redirection - - Printer Output - Overloading the Extraction And Insertion Operators.

**Self Learning:** Command Line Arguments

### **Text Book:**

1. Robert Lafore, Object-Oriented Programming in C++, Pearson and Dorling Kindersley Publications. Fourth Edition 2011

### **Books for Reference:**

1. E.Balagurusamy, Object-Oriented Programming with C++, Tata McGraw Hill. 8th Edition 2020.
2. D.Ravichandran, Programming with C++, Tata McGraw-Hill. Second Edition. 2010.
3. K.R. Venugopal Rajkumar Ravishankar. Mastering C++, Tata McGraw Hill. Second Edition 2017.



<b>SEMESTER – VI</b>			
<b>Part III Discipline Specific Elective II- Introduction to Python Programming</b>			
<b>Course Code :23UMAE62</b>	<b>Hrs / Week: 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits: 3</b>

**Objectives:**

- To acquire Programming skills and Object Oriented Skills in Python
- To develop the ability to write database applications in Python.

**Course Outcomes**

<b>CO. No.</b>	<b>Upon completion of this course, students will be able to</b>	<b>Cognitive Level</b>
CO-1	recall and identify Python operators	K1
CO-2	comprehend the concepts of Python objects	K2
CO-3	apply Python programming concepts such as error handling	K3
CO-4	analyze problem scenarios to determine the appropriate use of Python constructs like conditionals	K4
CO-5	evaluate Python code to identify errors and create new programs	K5

**Relation Matrix**

<b>Course Outcomes</b>	<b>Programme Outcomes (PO)</b>					<b>Programme Specific Outcomes (PSO)</b>				
	<b>PO-1</b>	<b>PO-2</b>	<b>PO-3</b>	<b>PO-4</b>	<b>PO-5</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	<b>PSO-4</b>	<b>PSO-5</b>
<b>CO-1</b>	3	2	2	2	2	3	2	3	3	1
<b>CO-2</b>	3	2	2	2	3	2	3	2	3	2
<b>CO-3</b>	3	2	2	2	2	3	2	2	2	1
<b>CO-4</b>	3	3	2	2	2	2	3	3	2	2
<b>CO-5</b>	3	2	2	2	2	3	2	2	3	2
<b>Ave.</b>	3	2.2	2	2.0	2.2	2.6	2.1	2.4	2.6	1.8

<b>SEMESTER – VI</b>			
<b>Part III Skill Enhancement Course II- Introduction to Python Programming</b>			
<b>Course Code :23UMAE62</b>	<b>Hrs / Week: 4</b>	<b>Hrs / Semester: 60</b>	<b>Credits: 3</b>

### **Unit I**

Introduction to Python – Operators – Variables and Assignment – Numbers and Strings – Errors and Exceptions – Python Basics

**(Chapter II Sec 2.1 - 2.16, Chapter III Sec 3.1 -3.6)**

### **Unit II**

Python Objects – Internal Types – Standard Type Operators – Standard Type- Built-in Functions

**(Chapter IV, Sec 4.1 – 4.5)**

### **Unit III**

Introduction to Numbers – Integers – Complex Numbers – Built-in and Factory Functions – Other Numeric Types

**(Chapter V, Sec 5.1 – 5.7)**

### **Unit IV**

Strings – Strings and Operators – Built-in Functions – String Built-in Methods –Lists – List Type Built-in Methods – Tuples – Tuple Operators and Built-in Functions

**(Chapter VI, Sec 6.2 – 6.6, 6.11 -6.17)**

### **Unit V**

Conditionals and Loops – if, else if – Conditional Expressions – while, for, break, pass Statements

**(Chapter VIII, Sec 8.1 – 8.10)**

### **Text Book**

1. Wesley J.Chun, Core Python Programming, Pearson Education, Second Edition, 2012.
2. Web Resources: 1.<https://www.tutorialspoint.com/python/index.htm>  
2.<https://youtu.be/kqtD5dpn9C8>  
3. [https://youtu.be/\\_uQrJ0TkZlc](https://youtu.be/_uQrJ0TkZlc)

### **Books for Reference**

1. Charles Dierbach, Introduction to Computer Science Using Python, Wiley, 2015
2. Jeeve Jose & P. SojanLal, Introduction to Computing and Problem Solving with Python, Khanna Publishers, New Delhi, 2016.

Semester – VI			
Part IV Skill Enhancement Course VI– Introduction to Machine Learning(Web Tools in Mathematics)			
Course Code: 23UMASE6	Hrs/week: 2	Hrs/Semester: 30	Credits: 2

**Objectives:**

- Expertise in machine learning for data-driven decision-making across diverse domains.
- Proficiency in scalable machine learning technologies for effective handling of complex datasets and solution deployment.

**Course Outcome:**

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	recall fundamental data structures used in programming	K1
CO-2	explain diverse types of learning methodologies	K2
CO-3	apply learning concepts to practical machine learning tasks.	K3
CO-4	analyze datasets using cluster analysis	K4
CO-5	evaluate the utility of tree-based and probabilistic models in machine learning	K5

**Relation Matrix**

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	1	3	3	3	2	2	2
CO-2	3	3	3	1	3	3	3	2	2	2
CO-3	3	3	3	1	3	3	3	2	2	2
CO-4	3	3	3	1	3	3	3	2	2	2
CO-5	3	3	3	1	3	3	3	2	2	2
Ave.	3	3	3	1	3	3	3	2	2	2

<b>Semester – VI</b>			
<b>Part IV Skill Enhancement Course VI– Introduction to Machine Learning(Web Tools in Mathematics)</b>			
<b>Course Code: 23UMASE6</b>	<b>Hrs/week: 2</b>	<b>Hrs/Semester: 30</b>	<b>Credits: 2</b>

### **UNIT I**

Introducing Machine Learning: The origins of machine learning - uses and abuses of machine learning - How machines learn - Machine learning in practice.

### **UNIT II**

Managing and Understanding Data: Machine learning with R - Managing data with R - Exploring and understanding data.

### **UNIT III**

Machine Learning Theory and Practice: Machine Learning Types - Groups of Machine Learning Algorithms - Regression Analysis - Correlation Analysis.

### **UNIT IV**

Support Vector Machine SVM - Decision Trees - The Naive Bayes Method - Cluster Analysis.

### **UNIT V**

Scalable Machine Learning and Related Technologies: Distributed Processing and Storage - The Hadoop Ecosystem - Machine Learning in R with Spark - Machine Learning in R with H<sub>2</sub>O.

### **Text Book**

1. Brett Lantz, Machine Learning with R - Second Edition, Packt Publisher, 2015.
2. KarthikRamasubramanian and Abhishek Singh, Machine Learning Using R, Apress Berkeley, CA 2019.

### **Book for Reference**

1. KarthikRamasubramanian and Abhishek Singh, Machine Learning Using R, Apress Berkeley, CA 2017.

### **Website and e-Learning Source**

<https://www.kaggle.com/search?q=machine+learning>

<https://www.coursera.org/search?isNewUser=true&query=machine+learning>

**Practical List:**

1. Practice creating and manipulating data structures in R.
2. Learn data management techniques for effective dataset exploration.
3. Master data visualization methods to communicate insights clearly.
4. Gain hands-on experience in simulating and visualizing probability distributions.
5. Perform correlation analysis to uncover relationships between variables.
6. Implement regression analysis for predictive modeling tasks.
7. Develop decision tree models for decision-making tasks.
8. Apply clustering algorithms to discover patterns in data.
9. Build and train artificial neural networks for complex problem-solving.
10. Explore scalable machine learning techniques using R with Spark and H2O.