THE GANDHIGRAM RURAL INSTITUTE (DEEMED TO BE UNIVERSITY)
GANDHIGRAM - 624302
(Ministry of Education, Govt. of India)
Accredited by NAAC with 'A' Grade (3rd cycle)

Department of Mathematics

B.Sc. Honour Degree (Mathematics)

Pre-Requisite: Mathematics as a subject of study at the Higher Secondary level.

Revised Syllabus with effect from 2024 – 2025 onwards

CURRICULUM WITH OUTCOME BASED EDUCATION (OBE)

Name of the School	:	School of Sciences
Department	:	Department of Mathematics
Academic Programme offered	:	B.Sc. (Hons.) Mathematics, B.Sc. B.Ed. (4 year integrated) Mathematics, M.Sc. Mathematics and Ph.D. Mathematics

I. VISION :

- Science & Technology Enabled Rural Development through teaching and research in Mathematical Sciences

II. MISSION :

- Proficiency in research and teaching
- Research studies in International standards and to urge the need for practical significance

III. PROGRMME CODE : MAU

IV. PROGRAMME : B. Sc. (Hons.) Mathematics /
B.Sc. B.Ed. (4 year integrated) Mathematics

V. PROGRAMME EDUCATIONAL OBJECTIVES (PEO) OF B.SC. MATHEMATICS:

PEO 1: Demonstrate proficiency in mathematics and allied fields by exhibiting the required knowledge of the mathematical concepts so as to secure appropriate placement and studies.

PEO 2: To develop further career through learning research and extension.

PEO 3: To demonstrate the needed skills for analysis, data interpretation and methodologies as appropriate to the domain of maths.

PEO 4: To address the needs of society by applying the knowledge and leadership so as to seek solutions for society / industry.

PEO 5: Select higher studies in Mathematics and other inter-disciplinary programmes and enable to get employed in private and public sectors

VI. GRADUATE ATTRIBUTES

GA1: Reasoning Ability
GA2: Analytical Ability
GA3: Communication Skill
GA4: Computational Skill

VII. PROGRAMME OUTCOMES (PO)

PO1: Have the potential to face all competitive exams in public and private sectors.

PO2: Possess the ability to do higher studies in premier institutions

PO3: Posses the computational skills to solve related problems in science and engineering

PO4: Have the ability to develop mathematical models related to real life situations

PO5: Identifying and solving problems arising in social science, business and banking based on quantitative techniques.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Acquire skills in basic concepts of algebra, real and complex analysis, number theory, Optimization theory

PSO2: Become proficient in differential and integral calculus and familiar with applications of ODE & PDE.

PSO3: Gain knowledge in 2D and 3D geometrical objects using various metrics and solving mechanical and physical problems through geometrical and graphical way.

PSO4: Analyze numerical and statistical data of population dynamics of real life situations

PSO5: Proficient in soft skills and Computing skills for solving complex mathematical problems.

Name of the Programme	**B.Sc. Mathematics**								
Year of Introduction	1976								
Year of Revision	2024								
Semester-wise Courses and Credit distribution	I	II	III	IV	V	VI	VII	VIII	**Total**
No. of Courses	7	8	7	6	6	6	5	3	**48**
No. of Credits	21	23	23	21	20	24	20	20	**172**

Category	**Course Code**	**Course Title**	**Number of Credits**	**Lecture Hours per week**	**Exam Duration (Hrs.)**	**Marks**		
						C.F.A	**E.S.E**	**Total**
Semester-I								
Core Major-1	24MAUC1101	Classical Algebra	4	4	3	40	60	100
Core Minor-1	24MAUB1101	Programming with Python (Theory)	3	3	3	40	60	100
Core Minor-1 Lab	24MAUB1102	Programming with Python (Practical)	1	2	3	60	40	100
Multi disciplinary	--	Multidisciplinary-I	3	3	3	40	60	100
Ability Enhancement course (AEC)	24ENUA1101	Essential English: Basic	3	3	3	40	60	100
Skill Enhancement Course	24TAUS1101/ 24MLUS1101/ 24HIUS1101	Indian Language (Tamil/Malayalam/Hindi)-I	3	3	3	40	60	100
Value Added Course	24FSUV1001	Environmental Science	2	2	2	50	-	50
Value Added Course	24FAUV1001/ 24GTUV1002	Heritage & Cultural History of India (or) Shanthi Sena	2	2	2	50	-	50
TOTAL			**21**					

Semester-II								
Core Major-2	24MAUC1202	Theory of Equations and Trigonometry	4	4	3	40	60	100
Core Minor-2	24MAUB1206	Object Oriented Programming with C++ (Theory)	3	3	3	40	60	100

Core Minor-2 Lab	24MAUB1207	Object Oriented Programming with C++ (Practical)	1	2	3	60	40	100
Multi disciplinary	--	Multidisciplinary-II	3	3	3	40	60	100
Ability Enhancement course (AEC)	24ENUA1202	Essential English: Intermediate	3	3	3	40	60	100
Skill Enhancement Course	24TAUS1202/ 24MLUS1202/ 24HIUS1202	Indian Language (Tamil/Malayalam/Hindi)-II	3	3	3	40	60	100
Value Added Course	24PEUV1001	Yoga & Fitness	2	2	2	50	-	50
Value Added Course	24GTUV1001	Let us Know Gandhi	2	2	2	50	-	50
Skill Enhancement Course	24TAUS0004/ 24MLUS0004/ 24HIUS0004	Functional Tamil/ Malayalam/Hindi	2	2	2	50	-	50
TOTAL			**23**					

Semester-III								
Core Major-3	24MAUC2103	Calculus - I	4	4	3	40	60	100
Core Major-4	24MAUC2104	Mathematical Statistics	4	4	3	40	60	100
Core Minor-3	24PHUB2101 (or) 24MAUB2111	Physics – I (or) Programming with JAVA (Theory)	3	3	3	40	60	100
Core Minor-3 Lab	24PHUB2102 (or) 24MAUB2112	Physics – I (or) Programming with JAVA (Practical)	1	3	3	60	40	100
			1	2	3	60	40	100
Multi disciplinary	--	Multidisciplinary-III (Online Course)	3	3	3	40	60	100
Ability Enhancement course (AEC)	24ENUA2103	Essential English: Advanced	3	3	3	40	60	100
Skill Enhancement Course	24TAUS2103/ 24MLUS2103/ 24HIUS2103	Indian Language (Tamil/Malayalam/Hindi)-III	3	3	3	40	60	100
Extension	24EXUE2101	Village Placement Programme	2	2	2	50	-	50
TOTAL			**23**					

Semester-IV								
Core Major-5	24MAUC2205	Abstract Algebra	4	4	3	40	60	100
Core Major-6	24MAUC2206	Calculus-II	4	4	3	40	60	100
Core Major-7	24MAUC2207	Sequences and Series	4	4	3	40	60	100
Core Minor-4	24PHUB2203 (or) 24MAUB2213	Physics II (or) Statistical Methods (Theory)	3	3	3	40	60	100
Core Minor-4 Lab	24PHUB2204 (or) 24MAUB2214	Physics II (or) Statistical Methods (Practical)	1	2	3	40	60	100
Ability Enhancement course (AEC)	24MAUA220X	AEC	3	3	3	40	60	100
Extension	24EXUE2202	Community Engagement	2	2	2	50	-	50
TOTAL			21					

Semester-V								
Core Major-8	24MAUC3108	Linear Algebra	4	4	3	40	60	100
Core Major-9	24MAUC3109	Mathematical Analysis	4	4	3	40	60	100
Core Major-10	24MAUC3110	Linear Programming	4	4	3	40	60	100
Core Minor-5	24MAUB3115	Ordinary Differential Equations	4	4	3	40	60	100
Core Major-11	24MAUC3111	Internship	2	2	2	50	-	50
	24MAUE3101	Field Study	2	2	2	50	-	50
TOTAL			20					

Semester-VI								
Core Major-12	24MAUC3212	Complex Analysis	4	4	3	40	60	100
Core Major-13	24MAUC3213	Graph Theory	4	4	3	40	60	100
Core Major-14	24MAUC3214	Mechanics	4	4	3	40	60	100
Core Major-15	24MAUC3215	Numerical Methods	4	4	3	40	60	100
Core Minor-6	24MAUB3216	Transforms and Partial Differential Equations	4	4	3	40	60	100
Core Major-16	24MAUC3216	Project (or)	4	4	3	40	40+20	100
		Operations Research	4	4	3	40	60	100
TOTAL			24					

Semester-VII								
Core Major-17	24MAUC4117	Advanced Algebra	4	4	3	40	60	100
Core Major-18	24MAUC4118	Real Analysis	4	4	3	40	60	100
Core Major-19	24MAUC4119	Advanced Ordinary Differential Equations	4	4	3	40	60	100
Core Minor-7	24MAUB4117	Numerical Analysis	4	4	3	40	60	100
Core Minor-8	24MAUB4118	Discrete Mathematics	4	4	3	40	60	100
TOTAL			**20**					

Semester-VIII								
Core Major-20	24MAUC4220	Partial Differential Equations and Applications	4	4	3	40	60	100
Core Major-21	24MAUC4221	Mathematical Methods	4	4	3	40	60	100
Core Major-22	24MAUC4222	Project	12	12	3	100	100+ 100	300
TOTAL			**20**					

LIST OF ABILITY ENHANCEMENT COURSES:

1. Analytical Geometry (24MAUA2201)
2. Basic Numerical Methods (24MAUA2202)

Semester	I	Course Code	24MAUC1101
Course Title	CLASSICAL ALGEBRA		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Core Course (Major-1)		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing matrices, relations, and sets. (K-1) • Understanding functions and inequalities (K-2). • Applying number theory concepts and Congruence relations to solve problems. (K-3) • Analyzing cardinality of sets (K-4) • Evaluating eigenvalues and eigenvectors of matrices (K-5)		
Course Objective	The course aims to impart fundamental knowledge in sets theory, matrices and number theory.		

Unit	Content	No. of. Hours
I	Basic terminologies – Operations on sets – Family of sets – Power sets – Cartesian product of sets.	13
II	Basic definitions: one-one, onto functions and bijections – Composition of functions – Inverse of a function – Image of subsets under functions – Inverse image of subsets under functions.	13
III	Relation on sets – Types of relations – Equivalence relations – Equivalence classes and partitions of a set – The induction principle – Sets with same cardinality – Finite sets – Countable sets – Comparing cardinality.	13
IV	Types of matrices- Operations on Matrices- Inverse Matrix Solution of simultaneous equations- Rank of a matrix- Homogeneous and Non-homogeneous linear equations- Eigen values and Eigen vectors - Diagonalization- Cayley-Hamilton theorem.	12
V	Prime Numbers and Composite Numbers - Euler's function - Divisibility and Congruence relations - Fermat's theorem - Wilson's theorem.	13

<table>
<tr><td rowspan="3">References</td><td>Text Books:
1. Ajit Kumar, S. Kumaresan, & Bhaba Kumar Sarma, A Foundation Course in Mathematics, Narosa Publishers, New Delhi, 2018.
Unit 1: Chapter 2
Unit 2: Chapter 3
Unit 3: Chapter 4, Chapter 5 (sec 5.1), and Chapter 6.
2. T. K. Manicavachagom Pillay, T. Natarajan, K. S. Ganapathy, Algebra, Vol. 2, S. Viswanathan Publications (India) Pvt. Ltd., Chennai, 2012.
Unit 4: Chapter 2
Unit 5: Chapter 5.</td></tr>
<tr><td>Reference Books:
1. A Shen and NK Vereshchagin, Basic Set Theory, AMS Students Mathematical Library, USA, 2002.
2. Paul R. Halmos, Naive Set Theory, Springer, New York, 1974.
3. David M. Burton, Elementary Number Theory, 7th Edition, McGraw Hill, New Delhi, 2012.
4. S. Arumugam & A. T. Isaac, Modern Algebra, SciTech Publications, India Pvt. Ltd., Chennai, 2003.
5. S. Narayanan & T. K. Manicavachagom Pillay, Modern Algebra, Vol-I, S. Viswanathan Pvt. Ltd., Chennai, 1997.
6. Seymour Lipschutz, Set Theory & Related Topics, Schaum's outlines, 2nd Edition, Tata McGraw Hill, New Delhi, 2005.
7. Arumugam & Issac, Classical Algebra, New gamma Publishing house, Tirunelveli, 2003.
8. S.B. Malik, Basic Number Theory, 2nd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2009.</td></tr>
<tr><td>E-Recourses:
1. http://nptel.ac.in/courses/109104124/
2. https://nptel.ac.in/courses/111/106/111106142/
3. https://nptel.ac.in/courses/111/105/111105112/
4. www.maths.manchester.ac.uk/~avb/0n1_pdf/0N1_All.pdf
5. https://4dspace.mtts.org.in/expository-articles-list.php</td></tr>
<tr><td>Course Outcomes</td><td>On completion of the course students should be able to
CO1: explain the basic concepts of set theory.
CO2: analyze various types of functions.
CO3: identify equivalence relations and cardinality of sets.
CO4: solve problems in matrices.
CO5: explain basic concepts of number theory.</td></tr>
</table>

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	3	2
CO2	3	2	2	2	3
CO3	3	3	2	3	2
CO4	3	1	2	2	2
CO5	3	3	2	2	3

Semester	I	Course Code	24MAUB1101
Course Title	**PROGRAMMING WITH PYTHON (THEORY)**		
No. of. Credits	**3**	No. of. contact hours per week	**3**
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	40%
Category	**Core Course (Minor-1) – Theory**		
Scope of the Course	• Employability • Skill Development		
Cognitive Levels addressed by the course	• Remembering the basic tokens of Python (K1) • Understanding the basic control structures (K2) • Applying functions to compute mathematical results (K3 & K4) • Applying the OOPs concept to solve mathematical problems (K4)		
Course Objective	The course aims to provide basic knowledge in programming with Python.		

Unit	Content	No. of. Hours
I	Python: Identifiers – Keywords – Statements and Expressions - Variables – Operators – Precedence and Associativity – Data Types – Indentation – Comments – Reading Input and Output – Type Conversions.	12
II	Control Flow Statements: The if decision flow statement – The if…else decision flow statement – The if…elif…else decision flow statement – Nested if statement – while loop – for loop – the continue and break statement – catching exceptions using try and except statement.	12
III	Functions: Build in functions – commonly used modules –function definition and calling the function – the return statement and void function – scope and lifetime of variables – default parameter – keyword arguments – *args and **kwargs-command line arguments.	8
IV	Object-Oriented Programming: Classes and Objects- Creating Classes in Python- Creating Objects in Python- The Constructor Method.	8

V	Object-Oriented Programming (continuation): Classes with Multiple Objects- Class Attributes versus Data Attributes Encapsulation- Inheritance- The Polymorphism.	8
References	**Text Book:** 1. S. Gowrishankar and A. Veena, **Introduction to Python Programming**, CRC Press, 2019. Unit 1: Chapter 2 Unit 2: Chapter 3 Unit 3: Chapter 5. Unit 4: Chapter 11 (Section 11.1-11.4) Unit 5: Chapter 11 (Section 11.5-11.9) **Reference Books:** 1. E. Balagurusamy, **Problem Solving and Python Programming,** McGraw Hill Education (India) Private Limited, 2018. 2. Tony Gaddis, **Starting Out with Python,** 4th Edition, Pearson, New York, 2018.	
	E-Recourses: 1. https://nptel.ac.in/courses/106/106/106106212/ 2. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-cs21/	
Course Outcomes	On completion of the course students should be able to CO1: understand the basic structure of python programming. CO2: process data input output using Python. CO3: debug the Python program. CO4: solve decision making problems. CO5: write Python programs to solve complex problems.	

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	2	3
CO2	3	2	2	2	3
CO3	3	2	3	1	1
CO4	2	3	1	2	2
CO5	3	1	3	2	3

Semester	I	Course Code	24MAUB1102
Course Title	**PROGRAMMING WITH PYTHON (PRACTICAL)**		

No. of. Credits	1	No. of. contact hours per week	2
Category	Core Course (Minor-1) – Practical		
List of Practical			No. of. Hours
	1. Python program to read the marks of five subjects and find the average of them. 2. Python program to read the Richter magnitude value from the user and display the result using if...elif...else statement. 3. Python program to print the sum of the series. 4. Python program to find the largest of three numbers using functions. 5. Python program using functions to find the value of nPr and nCr. 6. Python program using functions to finds the area of a pentagon. 7. Python program using functions to display Pascal's triangle. 8. Python program using functions to print harmonic progression series and its sum till N terms. 9. Python program to simulate a bank account with support for deposit money, withdraw money and show balance operations using class. 10. Python program to verify whether the given three points are colinear or not using class. 11. Python program to determine whether the point lies inside the circle, on the circle or outside the circle using class. 12. Python program to calculate area and perimeter of different shapes using polymorphism. 13. Python program to demonstrate operator overloading. 14. Python program to display the marks details of top five students using inheritance. 15. Program to demonstrate multiple inheritance with method overriding.		32

Semester	II	Course Code	24MAUC1202
Course Title	THEORY OF EQUATIONS AND TRIGONOMETRY		

No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-2)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing the basic concepts of roots of equations. (K-1) • Understanding the various transformation of equations. (K-2) • Applying different methods to analyse the nature of roots of the equation. (K-3) • Evaluating the values of trigonometric functions. (K-5) • Analysing the Hyperbolic functions, Inverse hyperbolic functions, and Logarithm of complex quantities. (K-4)		
Course Objective	The Course aims to learn techniques of solving algebraic and trigonometric equations.		

Unit	Content	No. of. Hours
I	Theory of Equations: Formation of equations - Fundamental Theorem of Algebra - Relations between roots and coefficients – Sum of the powers of the roots-Reciprocal equations.	13
II	Transformation of equations: Removal of terms-Multiple roots-Nature and position of roots-Descarte's Rule- Rolle's Theorem Sturm's Theorem-Cubic Equations-Cardan's method.	13
III	Biquadratic equations: Ferrari's Method-Approximation solutions of numerical equations-Newton's Method-Horner's Method.	12
IV	Trigonometry: Expansion of $cosn\theta$, $sin\, n\theta$ and $tan\, n\theta$–Powers of sines and cosines of θ– Expansions of $sin^n\theta$, $cos^n x$, $sin\, \theta$ and $cos\, \theta$ - Properties and their related problems.	13
V	Hyperbolic functions -Inverse hyperbolic functions- Logarithm of Complex Quantities.	13

References	**Text Books:** 1. Arumugam & Issac, **Set Theory Number System and Theory of Equations**, New Gamma Publishing House, Palayamkottai, 1999. Unit 1: Chapter -5, Section 5.1-5.4 Unit 2: Chapter -5, Section 5.5-5.8

	Unit 3: Chapter -5, Section 5.9-5.10 2. S. Narayanan & T. K. Manicavachagom Pillay, **Trigonometry**, S. Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai, 2001. Unit 4: Chapter III, Sections 1, 2, 4, 5. Unit 5: Chapter IV, Sections 1, 2 (2.1, 2.2, 2.3) & Chapter V, Section 5 (Only).
	Reference Book: 1. Hari Kishan, **Theory of Equations,** Atlantic Publishers and Distributors, 2022. 2. William Snow Burnside, Arthur William Panton, **The Theory of Equations**, Wave Books, 2022.
	E-Recourses: 1. https://www.youtube.com/watch?v=V4fCrkWJ8tc 2. https://www.youtube.com/playlist?list=PLOnJQiDsowoiyJH7qgTXkLjeVOzlVvumh 3. https://cosmolearning.org/courses/trigonometry-complex-numbers/
Course Outcomes	On completion of the course students should be able to CO1: utilize basic concepts of roots and coefficients of equation to solve algebraic equations. CO2: solve various problems in transformation of equations. CO3: apply Newton's and Horner's method to solve various equations. CO4: assess trigonometric functions and related problems. CO5: identify various types of hyperbolic functions.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	3
CO2	3	1	3	2	3
CO3	3	2	2	3	2
CO4	3	2	3	2	2
CO5	3	2	1	3	2

Semester	II	Course Code	24MAUB1206

Course Title	**OBJECT ORIENTED PROGRAMMING WITH C++ (THEORY)**		
No. of. Credits	**3**	No. of. contact hours per week	**3**
New Course/ Revised Course	Revised	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	**Core Course (Minor-3) – Theory**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Identify basic input/output, tokens, operators, and functions through C++. • Create objects and classes. • Constructing relationships between classes and objects. • Use function templates and class templates in a program. • Design Object Oriented Programs using class, inheritance diagrams.		
Course Objective	The Course aims to develop programming skills in C++ and its object-oriented programming concepts.		

Unit	**Content**	**No. of. Hours**
I	Beginning with C++ statements: What is C++ - Applications of C++ - A simple C++ program – More C++ statements - An example with class. Tokens: Keywords - Identifiers and constants - Basic, user defined, Derived data types - Storage classes – Symbolic constants - Type compatibility - Declaration of variables – Dynamic initialization of variables – Reference variables.	10
II	Operator in C++: Scope resolution operators - Member dereferencing operators - Memory management operators - Manipulators - Type cast operator. Functions in C++: The main function - Function prototyping - Call by reference - Return by reference - Inline functions – Default arguments - Constant arguments – Recursion - Function overloading - Math library functions.	10
III	Classes and Objects: C structure - Specifying a class - Defining member functions – A C++ program with class - Making an outside function inline - Nesting of member functions - Private member functions - Arrays within a class – Memory allocation for objects - Static data members - Static member functions - Arrays of objects -	10

	Objects as function arguments - Friendly functions.	
IV	Constructors and Destructors: Constructors – Parameterized constructors - Multiple constructors in a class - Constructors with default arguments - Dynamic initialization of objects - Copy constructor - Dynamic constructors – Destructors. Operator overloading: Defining operator overloading - Overloading unary operators – Overloading binary operators – Overloading binary operators using friends.	9
V	Inheritance: Extending classes - Defining derived classes - Single inheritance – Making a private member inheritable - Multilevel inheritance - Multiple inheritance - Hierarchical inheritance - Hybrid inheritance - Virtual base class - Abstract classes - Constructors in derived classes.	9
References	**Text Book:** 1. E. Balagurusamy, **Object-Oriented Programming with C++**, Seventh edition, McGraw-Hill Education Pvt. Ltd, Chennai, 2018. Unit 1: Chapters: 2.1 - 2.5, 3.1- 3.13. Unit 2: Chapters: 3.14 - 3.19, 4.1 - 4.10 & 4.12. Unit 3: Chapters: 5.1 - 5.15. Unit 4: Chapters: 6.1 - 6.8, 6.11, 7.2 - 7.5. Unit 5: Chapters: 8.1 - 8.11.	
	Reference Books: 1. V. Ravichandran, **Programming with C++**, Second Edition, Tata McGraw - Hill, New Delhi, 2011. 2. H. Schildt, **The complete Reference of C++**, Tata-McGraw-Hill publishing Company Ltd. New Delhi, 2003. 3. P. B. Mahapatra, **Programming in C++**, S. Chand and Company, New Delhi, 2010.	
	E-Recourses: 1. https://archive.nptel.ac.in/courses/106/105/106105151/ 2. https://onlinecourses.nptel.ac.in/noc24_cs44/preview 3. https://onlinecourses.swayam2.ac.in/aic20_sp01/preview 4. https://onlinecourses.nptel.ac.in/noc21_cs38/preview	
Course Outcomes	On completion of the course students should be able to CO1: formulate object-oriented programming concept. CO2: utilize the C++ tokens and operators.	

	CO3: apply C++ class declaration and definition and its objects in software. CO4: design constructors, destructors, and operator overloading. CO5: apply the concept of inheritance in Software problems.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	3	3
CO2	2	2	3	2	2
CO3	0	2	1	2	3
CO4	1	2	2	1	3
CO5	1	3	1	2	2

Semester	II	Course Code	24MAUB1207
Course Title	**OBJECT ORIENTED PROGRAMMING WITH C++ (PRACTICAL)**		
No. of. Credits	**1**	No. of. contact hours per week	**2**
Category	**Core Course (Minor-3) – Practical**		

Unit	Content	No. of. Hours
	1. Compute simple and compound interest values. 2. Compute biggest among three numbers. 3. Display Fibonacci series. 4. List the prime numbers in each range. 5. Print perfect squares in each range. 6. Write a program to solve a quadratic equation and test the nature of roots. 7. Sorting given list of numbers in ascending order. 8. Compute biggest among N integers. 9. Sorting given list of names in alphabetical order. 10. Read and display matrix of any order. 11. Compute factorial of a given number using recursive function. 12. Write a program to swap the values using functions. 13. Write a program to calculate the following functions to 0.0001% accuracy. $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots$ $SUM = 1 + \left(\frac{1}{2}\right)^2 + \left(\frac{1}{3}\right)^3 + \left(\frac{1}{4}\right)^4 + \cdots$	32

	$cosx = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \cdots$ 14. Write a program to calculate variance and SD of N numbers. 15. Write a program to read two matrices and compute matrix multiplication using functions. 16. Prepare employee details using class with array of objects. 17. Program to illustrate objects as function arguments. 18. Program to illustrate parameterized constructors. 19. Program to illustrate multiple constructors in a class. 20. Show by a suitable program: how the unary minus operator is overloaded? 21. Show by a suitable program: how the binary operator is overloaded? 22. Prepare student mark list by using multilevel inheritance. 23. Program to illustrate multiple inheritance. 24. Prepare student mark list by using hybrid inheritance. 25. Prepare student mark list by using the concept of virtual base class.	

Semester	**III**	Course Code	**24MAUC2103**
Course Title	**CALCULUS-I**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	Revised	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	**Core Course (Major-3)**		
Scope of the Course	● Basic Skill		
Cognitive Levels addressed by the course	● Remember the techniques of calculus in Differentiation and Integration (K-1) ● Understand the behaviour of limits of functions on the Real line (K-2) ● Evaluate the derivative of Real valued functions (K-5) ● Applying the derivatives to analyse the properties of functions (K-3 &K-4) ● Evaluate integration of functions (K-5)		
Course Objective	The Course aims to learn the different concepts of differential and integral calculus.		

Unit	Content	No. of. Hours
I	Limits and Continuity: Limits –Limits at Infinity – Continuity- Limits at Infinity	12

II	The Derivative: Tangent Lines and Rates of Change-The Derivative Function-Introduction to Techniques of Differentiation-The Product and Quotient Rules-Derivatives of Trigonometric Functions-The Chain Rule.	13
III	Differentiation (continuation): Implicit Differentiation-Derivatives of Logarithmic Functions-Derivatives of Logarithmic Functions-L'Hôpital's Rule-Indeterminate Forms.	13
IV	Analysis of Functions I: Increase-Decrease- and Concavity-Analysis of Functions II: Relative Extrema- Graphing Polynomials-Analysis of Functions III: Rational Functions, Cusps, and Vertical Tangents-Absolute Maxima and Minima-Rolle's Theorem- Mean-Value Theorem.	14
V	Integration: An Overview of the Area Problem-The Indefinite Integral-The Indefinite Integral-The Definition of Area as a Limit; Sigma Notation-The Definite Integral-The Fundamental Theorem of Calculus.	12
References	**Text Book:** 1. Howard Anton, Irl C. Bivens, Stephen Davis, **Calculus**, 10th Edition, Wiley India Pvt. Ltd. New Delhi, 2002. Unit 1: Chapter 1: Section 1.3 -1.6. Unit 2: Chapter 3: Section 3.2 – 3.6, Unit 3: Chapter 4: Section 4.1- 4.3, 4.5, 4.8 Unit 4: Chapter 5: Section 5.2, 5.3, 5.5, 5.6, 5.8 Unit 5: Chapter 7: Section 7.1-7.3, 7.6, 7.7	
	Reference Books: 1. James Stewart, **Calculus - Early Transcendentals**, 7e, Cengage Learning Pvt. Ltd, New Delhi, 2012. 2. George B. Thomas, JR & Ross L. Finney, **Calculus and Analytic Geometry**, Sixth edition, Narosa Publishing House, New Delhi, 1986. 3. Thomas & Fenny, **Calculus,** 9th Ed. Pearson, USA, 2002. 4. Courant, R., and F. John, **Introduction to Calculus and Analysis**, Volume I, Springer, New York, 1999. 5. Tom. M. Apostol, **Calculus-I**, 2 Edition, John Wiley & Sons.	
	E-Recourses: 1. https://nptel.ac.in/courses/111/104/111104144/ 2. https://onlinecourses.nptel.ac.in/noc21_ma61/course 3. https://nptel.ac.in/courses/111/104/111104144/ 4. https://nptel.ac.in/courses/111/106/111106146/	
Course Outcomes	On completion of the course students should be able to CO1: find limits of functions. CO2: understand the geometry of differentiation and integration. CO3: analyse the characteristics of functions. CO4: compute definite integrals. CO5: solve differentiation and integration of functions involving logarithmic and	

	exponential functions.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	1	1	2	2
CO3	3	3	2	3	2
CO4	2	2	3	1	2
CO5	3	1	2	2	1

Semester	**III**	Course Code	**24MAUC2104**
Course Title	**MATHEMATICAL STATISTICS**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-4)**		
Scope of the Course	• Basic Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the course	• Knowing various statistical techniques (K-1) • Understanding the random variables and distribution function (K-2). • Applying the measures of central tendency (K-3). • Analyzing the theoretical distributions (K-4). • Evaluating the regression & correlation equations (K-5).		
Course Objective	The course aims to impart skills in various statistical methods and its applications		

Unit	Content	No. of. Hours
I	Measures of Central Tendency – Measures of Dispersion – Moments, Skewness and Kurtosis.	12
II	Theory of Probability: Definition – Axioms – Addition and Multiplication Theorems –Baye's Theorem on conditional probability and its applications.	13
III	Random variables – Discrete and Continuous – Definition of Probability Mass Function and Density Function – Distribution	13

	Functions – Properties – Mathematical Expectations – Mean, Variance and Moments – Moment Generating Functions – Simple properties.	
IV	Theoretical distributions – Discrete: Binomial Distribution and Poisson distribution – Continuous: Normal Distribution Properties and Applications.	14
V	Curve Fitting by the Method of Least Squares – Correlation – Properties – Regression – Equations of Regression Lines – Angle between Regression Lines – Properties and Applications.	12
References	**Text Book:** S. Arumugam & A. Thangapandi Isaac, **Statistics**, New Gamma Publishing House, Tirunelveli, 2006. Unit 1: Chapter 1: Sections 1.0 -1.4; Chapter 2: Section 2.0-2.5; Chapter 3: Sections: 3.0 - 3.2; Chapter 4: Sections: 4.0 - 4.2. Unit 2: Chapter 11: Sections: 11.0 -11.2. Unit 3: Chapter 12: Sections 12.0 -12.5. Unit 4: Chapter 13: Sections 13.0-13.3. Unit 5: Chapter 5: Section 5.0, 5.1; Chapter 6: Section 6.0 - 6.3	
	Reference Books: 1. J.N. Kapoor & H.C. Saxena, **Mathematical Statistics**, S. Chand & Co Pvt. Ltd., New Delhi, 1994. 2. S. C. Gupta & V. K. Kapoor, **Fundamentals of Mathematical Statistics**, S. Chand & Sons Pvt. Ltd., New Delhi, 1994. 3. A. M. Goon, M. K. Gupta, B. Dasgupta, **Fundamentals of Statistics (Vol. I & II),** World Press, Calcutta, 2008. 4. A.M. Mood, F.A. Graybill, and D.C. Boes, **Introduction to the Theory of Statistics**, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd., Noida, 2017	
	E-Recourses: 1. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma22/ 2. https://nptel.ac.in/courses/108/106/108106106/ 3. https://nptel.ac.in/courses/111106112	
Course Outcomes	On completion of the course students should be able to CO1: analyze the given data by using statistical methods. CO2: explain the basic concepts of probability and related results. CO3: employ probabilistic methods to solve problems arise in different situations. CO4: design curve fitting methods for the given data. CO5: apply regression techniques to real life situations.	

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	3	2
CO2	1	1	2	3	3
CO3	2	2	2	3	3
CO4	1	1	2	3	3
CO5	1	1	2	2	3

Semester	III	Course Code	24MAUB2111
Course Title	PROGRAMMING WITH JAVA (THEORY)		
No. of. Credits	3	No. of. contact hours per week	3
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Ability Enhancement Course (AEC)		
Scope of the Course	• Basic Skil		
Cognitive Levels addressed by the course	• Identify Classes, objects, and methods to define a class, Operators and expressions, Accessing interface variables (K-1). • Understanding decision making with looping and branching using control statements (K-2). • Applying Java applets to create Web pages to contain animated graphics or interactive content (K-3). • Analyzing graphics programming with geometry and statistical data (K-4). • To create geometrical shapes (K-5).		
Course Objective	The Course aims to develop object-oriented programming skills in JAVA and its applications in web page designing, geometry and graphical representation of statistical data.		

Unit	Content	No. of. Hours
I	Overview of java language: Introduction - Simple java program – More of java - An application with two classes - Java program structure - Java tokens - Java statements - Implementing a java program - Java virtual machine - Command line arguments. Constants, Variables, and Data types: Constants – Variables – Data types - Declaration of variables giving values to variables - Scope of variables - Symbolic constants - Type casting - Getting values of	10

	variables - Standard default values.	
II	Operators and Expressions: Arithmetic operators - Relational operators - Logical operators - Assignment operators - Increment and decrement operators - Conditional operators - Bitwise operators - Special operators - Arithmetic expressions - Evaluation of expressions - Precedence of arithmetic operators - Type conversion in expressions - Operator precedence and associativity – Mathematical functions. Decision making and Branching: Decision making with if statement - Simple if statement - The if.... else statement - Nesting of if else statements - The else if ladder - Switch statement – The ?: operator.	10
III	Decision making and Looping: While statement - Do statement - For statement - Jumps in loops - Labeled loops. Classes, Objects, and Methods: Defining a class – Fields declaration – Methods declaration - Creating objects - Accessing class members - Constructors - Method overloading - Static members - Nesting of methods – Inheritance: Extending a class - Overriding methods - Final variables and methods - Final classes - Finalizer methods - Abstract methods and classes - Visibility control. Arrays, Strings, and Vectors: One dimensional arrays - Creating an array - Two-dimensional arrays - Strings - Vectors - Wrapper Classes.	10
IV	Interfaces: Defining interfaces - Extending interfaces - Implementing interfaces - Accessing interface variables. Packages: Java API packages - Using system packages - Naming conventions - Creating packages - Accessing a package -Using a package - Adding a class to a package - Hiding classes.	9
V	Applet programming: Introduction - How applets differ from applications - Preparing to write applet - Building applet code - Applet life cycle - Creating an executable applet - Designing a web page - Applet tag - Adding applet to HTML file - Running the Applet - More about applet tag - Displaying numerical values - Getting input from the user. Graphics programming: Introduction - The graphics class - Lines and rectangles - Circles and ellipses - Drawing arcs - Drawing polygons - Line graphs - Using control loops in applets - Drawing bar charts.	9
References	**Text Book:** 1. E. Balagurusamy, **Programming with Java**, Fifth Edition, McGraw - Hill	

	Education (India) Pvt. Ltd., Chennai, 2017. Unit 1: Chapters 3, 4. Unit 2: Chapters 5, 6. Unit 3: Chapters 7, 8, 9. Unit 4: Chapters 10, 11. Unit 5: Chapters 14, 15.
	Reference Books: 1. H. Sehildt, **JAVA2: The Complete Reference**, Fourth Edition, TMH Publishing Company, New Delhi, 2001. 2. C. Xavier, **Programming with JAVA 2**, SciTech Publications, Chennai, 2000.
	E-Recourses: 1. https://nptel.ac.in/courses/106/105/106105191/ 2. https://onlinecourses.swayam2.ac.in/aic20_sp13/preview 3. Search Tutorials | spoken-tutorial.org
Course Outcomes	On completion of the course students should be able to CO1: create Java programs and implement java tokens. CO2: solve problems using Java operators and expressions. CO3: demonstrate decision making and looping in programs. CO4: critique the concept of interfaces. CO5: apply the applet and graphics programming with geometry and statistical data analysis.

Mapping of Cos with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	4	5
CO2	1	2	2	3	3
CO3	2	2	1	3	2
CO4	3	2	3	2	3
CO5	2	1	2	2	2

Semester	**III**	Course Code	24MAUB2112
Course Title	**PROGRAMMING WITH JAVA (PRACTICAL)**		
No. of. Credits	**1**	No. of. contact hours per week	**2**
Category	**AEC**		
Unit	**Content**		**No. of. Hours**

	1. Write a program to convert the given temperature in Fahrenheit to Celsius and vice versa using Scanner class methods. 2. Write a Java program to determine the sum of Harmonic series for given 'n' by DataInputStream class methods. 3. Write a program to print first n Fibonacci numbers using DataInputStream class. 4. Write a program to perform any five math functions using Scanner class methods. 5. Write a program to solve two linear equations with two unknown using Scanner class methods and verify the result manually. 6. Write a program to illustrate bitwise OR, bitwise AND, and bitwise exclusive OR using Scanner class methods for input and verify result manually. 7. Find biggest among three numbers using Scanner class methods and nested if concept, conditional operator. 8. Prepare EB bill for TNEB slab rates using Scanner class methods else…..if ladder. 9. Prepare grade of a student for given 5 subject marks using Scanner class methods and switch-case. 10. Display any three form of Floyd's triangle for given limit of rows using DataInputStream class methods. 11. Compute the power of 2 using for loop up to the given limit n using Scanner Class method. 12. Write a program to illustrate constructor overloading. 13. Write a program to illustrate inheritances. 14. Write a program to illustrate overriding methods. 15. Write a program to sort a list of given numbers using Scanner class methods. 16. List the factorial values up to the given integer received from Data Input Stream class. 17. Write a program to receive two matrices, compute its product and display all matrices. 18. Write a program to alphabetical ordering of given strings using inputs from Scanner class methods. 19. Use of wrapper class methods to compute compound interest. 20. Illustrate a program to implementing interfaces.	32

	21. Illustrate multiple packages and adding a class to a package in a suitable program. 22. Write an applet program to receive three numeric values from the user and display the largest value on the screen with HTML page. 23. Write an applet program to draw the given image with appropriate HTML page. 24. Write an applet program to draw line graphs for the given data with appropriate HTML page. 25. Write an applet program to draw bar chart for the given data with appropriate HTML page.	

Semester	IV	Course Code	24MAUC2205
Course Title	ABSTRACT ALGEBRA		
No. Of. Credits	4	No. of. Contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Core Course (Major-5)		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing the basic properties of groups, subgroups, rings, ideals, and fields. • Understanding the order of elements in a group, cosets, normal subgroups, and isomorphism of groups as well as rings. • Using Lagrange's theorem to find the properties of subgroups of a group • Testing of isomorphism of groups and rings. • Investigate the properties of permutation groups and special types of rings. • Constructing Cayley Table, subgroups in groups and subrings and ideals in rings.		
Course Objective	The Course aims to provide some knowledge about various algebraic structures.		

Unit	Content	No. of. Hours
I	Groups: Introduction - Definition and examples - Elementary properties of a group – Equivalent definition of a group – Permutation groups.	13
II	Subgroups – Cyclic groups - Order of an element –Cosets and Lagrange's theorem.	14

III	Normal subgroups and quotient groups – Isomorphism - Cayley's Theorem – Homomorphism's.	13
IV	Rings: Definition and examples – Elementary properties of rings – Isomorphism - Type of rings – Characteristic of a ring – Subring.	12
V	Ideals - Quotient rings – Maximal and prime ideals - Homomorphism of rings.	12
References	**Text Book:** S. Arumugam & A. T. Isaac, **Modern Algebra**, SciTech Publications (India) Pvt. Ltd., Chennai, 2003. Unit 1: Chapter 3: Sections 3.0, 3.1, 3.2, 3.3, 3.4 Unit 2: Chapter 3: Sections 3.5, 3.6, 3.7, 3.8 Unit 3: Chapter 3: Sections 3.9, 3.10, 3.11 Unit 4: Chapter 4: Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6 Unit 5: Chapter 4: Sections 4.7, 4.8, 4.9, 4.10	
	Reference Books: 1. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, **Basic Abstract Algebra**, 2nd Edition. Cambridge University Press, New Delhi, 1997 2. John. B. Fraleigh, **A First Course in Abstract Algebra**, 7th edition, Addison-Wesley Publications, US, 2003. 3. S. Narayanan & T. K. Manicavachagom Pillay, **Modern Algebra, Vol. II**, S. Viswanathan Pvt. Ltd., Chennai, 1997. 4. Joseph Gallian, **Contemporary Abstract Algebra**, 9th edition, Chapman and Hall/CRC, 2021.	
	E-Recourses: 1. https://nptel.ac.in/courses/111/106/111106113/ 2. https://nptel.ac.in/courses/111/105/111105112/	
Course Outcomes	On completion of the course students should be able to CO1: analyze the basic properties of groups and subgroups. CO2: identify the types of homomorphism and use them to classify groups. CO3: apply the theorems to study the structure of groups. CO4: outline the basic properties of rings, fields, and integral domains. CO5: utilize the ideals to construct fields and integral domains.	

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	2
CO2	3	1	1	1	2
CO3	3	2	1	1	2
CO4	3	1	1	1	2

CO5	3	2	3	2	2

Semester	IV	Course Code	24MAUC2206
Course Title	CALCULUS-II		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Core Course (Major-6)		
Scope of the Course	• Basic Skill / Advanced Skill		
Cognitive Levels addressed by the course	• Remembering limits and graphs of functions of single variables(K-1) • Understanding the limits and derivatives of functions of several variables (K-2) • Applying partial derivatives to find the maxima & minima of functions of several variables (K-3) • Analyse vector fields and line integrals over higher dimensional space (K-4). • Evaluating double integral and triple integrals by applying Green's and Stokes's Theorem (K-4 &K-5)		
Course Objective	The Course aims to learn the different concepts of differential and integral calculus.		

Unit	Content	No. of. Hours
I	Vector Functions: Vector Functions and Space Curves – Derivatives and Integrals of Vector Functions – Arc Length and Curvature – Functions of Several Variables – Limits and Continuity.	14
II	Partial Derivative: Partial Derivatives – The Chain Rule – Directional Derivatives and the Gradient Vector – Maximum and Minimum Values – Lagrange Multipliers.	14
III	Multiple Integrals: Double Integrals over Rectangles – Iterated Integrals – Double Integrals over General Regions – Triple Integrals.	12
IV	Vector Calculus: Vector Fields – Line Integrals – The Fundamental Theorem of Line Integrals – Green's Theorem.	12
V	Vector Calculus (Continued): Curl and Divergence – Surface Integrals – Stokes' Theorem – The Divergence Theorem.	12
References	**Text Books:** 1. James Stewart, Calculus - **Early Transcendentals**, 7e, Cengage Learning Private Ltd, New Delhi, 2012.	

	Unit 1: Chapter 13: Section 13.1 – 13.3, Chapter 14: Section 14.1, 14.2. Unit 2: Chapter 14: Section 14.3, 14.5 – 14.8. Unit 3: Chapter 15: Section 15.1- 15.3, 15.6, 15.7. Unit 4: Chapter 16: Section 16.1-16.4. Unit 5: Chapter 16: Section 16.5, 16.7-16.9.
	Reference Books: 1. Howard Anton, Irl C. Bivens, Stephen Davis, **Calculus**, 7th Edition, Wiley India Pvt. Ltd., New Delhi 2002. 2. George B. Thomas, JR & Ross L. Finney, **Calculus and Analytic Geometry**, Sixth edition, Narosa Publishing House, New Delhi, 1986. 3. M.D. Weir, J. Hass, F.R. Giordano, **Thomas' Calculus**, 11th Edition, Pearson Education, USA, 2008. 4. Thomas & Fenny, **Calculus**, 9th Ed. Pearson, USA, 2002. Courant, R., and F. John, **Introduction to Calculus and Analysis**, Volume II, Springer, New York, 1999.
	E-Recourses: 1. https://nptel.ac.in/courses/111/104/111104144/ 2. https://nptel.ac.in/courses/111/107/111107108/ 3. https://nptel.ac.in/courses/111/106/111106146/
Course Outcomes	On completion of the course students should be able to CO1: Compute limits, partial derivatives, directional derivatives, gradient of functions of several variables. CO2: Applying partial derivatives to find extremum of functions of several variables. CO3: Compute Double/ Trible integrals. CO4: Construct vector fields on higher dimensional spaces. CO5: Compute Curl, Divergence and surface integrals.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	3	3	1	1
CO3	3	2	1	1	1

CO4	3	3	2	2	2
CO5	3	2	2	2	1

Semester	IV	Course Code	24MAUC2207
Course Title	SEQUENCES AND SERIES		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	60%
Category	Core Course (Major-7)		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Remembering the basic concepts of Real number system(K-1) • Remembering the basic concepts of bounded, monotonic, convergent, divergent, and oscillating sequences (K-1). • Understanding and analysing the algebra of limits, behaviour of monotonic sequences, sub-sequences and limit points (K-2 & K-4). • Applying the Comparison test, Kummer's test, Root test and Condensation test to test the convergences and divergence of series (K-3).		
Course Objective	The Course aims to enhance basic skills in the areas of sequences and series.		

Unit	Content	No. of. Hours
I	Axioms and Properties of Real Numbers: The field axioms – The order axioms – Bounded sets, LUB and GLB – The completeness axiom (existence of LUB's) – Dual of the completeness axiom (existence of GLB's) – Archimedean property – Bracket function – Density of the rationals – Monotone sequences – Theorem on nested intervals – Dedekind cut property – Square roots – Absolute value.	14
II	Sequences: Sequences – Limit points of a sequence – Limit- liminf and limsup– Convergent sequences – Non-convergent sequences.	13
III	Sequences (Continued): Cauchy's general principle of convergence – Algebra of Sequences – Some important Theorems – Monotonic Sequences.	13
IV	Infinite Series: Introduction – Positive term series – Comparison tests for positive term series – Cauchy's root test – D'Alembert's	12

	ratio test - Raabe's test.	
V	Infinite Series (Continued): Logarithmic test – Integral test – Gauss's test – Series with arbitrary terms – Rearrangement of terms.	12
References	**Text Books:** 1. Sterling K. Berberian, **A First Course in Real Analysis**, Springer Verlag, New York, 1994. Unit 1: Chapter 1 & Chapter 2. 2. S C Malik, Savitha Arora, **Mathematical Analysis** (Fifth Edition), New Age International Publishers, 2017. Unit 2: Chapter 3 (sec 1 to 5) Unit 3: Chapter 3 (sec 6 to 9) Unit 4: Chapter 4 (sec 1 to 6) Unit 5: Chapter 4 (sec 7 to 11)	
	Reference Books: 1. R. G. Bartle & D.R. Sherbert, **An Introduction to Real Analysis**, John Wiley & Sons, New York, 1982. 2. N. P. Bali, **Real Analysis**, An imprint of Laxmi Publications Pvt. Ltd., New Delhi, 2005. 3. Richard R. Goldberg, **Methods of Real Analysis**, Oxford & IBH Publishing CO. PVT. LTD., New Delhi, 1970. 4. S. K. Mapa, **Introduction to Real Analysis**, 8th Edition, Sarat Book House, Kolkata, 2014. 5. Kenneth A. Ross, **Elementary Analysis**, The Theory of Calculus, Springer-Verlag,1980. 6. Ajith Kumar and S. Kumaresan, **A Basic Course in Real Analysis**, CRC Press, Boca Raton, 2015.	
	E-Recourses: 1. http://nptel.ac.in/courses/109104124/ 2. https://nptel.ac.in/courses/111/106/111106142/ 3. https://nptel.ac.in/courses/111/105/111105112/ 4. https://nptel.ac.in/courses/111/106/111106053/ 5. https://nptel.ac.in/courses/111/101/111101134/ 6. www.maths.manchester.ac.uk/~avb/0n1_pdf/0N1_All.pdf	
Course Outcomes	On completion of the course students should be able to CO1: find LUB/ GLB of sets of real numbers. CO2: analyse the behaviour of sequences. CO3: compute the limit of convergent sequences. CO4: applying various test to test the convergence of series. CO5: compute the limit of convergent series.	

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	2
CO2	3	2	2	2	1
CO3	3	2	3	2	1
CO4	3	2	2	1	2
CO5	3	3	2	2	1

Semester	**IV**	Course Code	24MAUB2213
Course Title	**STATISTICAL METHODS (THEORY)**		
No. of. Credits	**3**	No. of. contact hours per week	**3**
New Course/ Revised Course	Revised	If revised, Percentage of Revision effected (Minimum 20%)	30%
Category	**Core Course (Minor-4)- Theory**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Remember the concept of attributes, hypothesis and sampling distributionsχ^2 test and goodness of fit (K-1). • Understand the methods the techniques of analysis and variance, statistical inference (K-2) • Apply the technique of analysis of variance for some statistical problems(K-3). • Analyze the variance and coding of data by using χ^2 test (K-4). • Evaluate the significance for large samples and small samples (K-5) • Create statistical models for real world situations and solve them using these techniques (K-6)		
Course Objective	The Course aims to impart deep knowledge about statistical methods.		

Unit	Content	No. of. Hours
I	Association of Attributes: Introduction - Difference between correlation and association - Notation and Terminology - Consistency of data - association and dissociation - methods of studying association - Miscellaneous illustrations.	10
II	Statistical inference-Tests of hypotheses: Introduction-standard error and sampling distribution-estimation.	10

III	Statistical inference- Tests of hypotheses (continued): test of significance for large samples Test of significance for small samples.	9
IV	χ^2test and goodness of fit: Introduction-χ^2 defined-conditions for applying χ^2 test-Yates' corrections-Uses of χ^2 test-additive property of χ^2- Chi-square for specified value of population variance.	9
V	Analysis of variance-assumptions in analysis of variance-technique of analysis of variance-coding of data-analysis of variance in two-way classification model.	10
References	**Text Book:** S.P. Gupta, **Statistical Methods**, Sultan Chand & Sons, New Delhi, 2001. Unit I: Page number 477-499. Unit II: Page number 881-901. Unit III: Page number 901-929. Unit IV: Page number 953-972. Unit V: Page number 1009-1038.	
	Reference Books: 1. S. C. Gupta and V. K. Kapoor, **Fundamentals of Mathematical Statistics**, Sultan Chand & Sons, New Delhi, 1994. 2. J. N. Kapoor and H. C. Saxena, **Mathematical Statistics**, Sultan Chand & Sons, New Delhi, 1994. 3. S. Arumugam & A. Thangapandi Isaac, **Statistics**, New Gamma Publishing House, Tirunelveli, 2006.	
	E-Recourses: 1. https://nptel.ac.in/courses/111105041/ 2. https://nptel.ac.in/courses/111105090/	
Course Outcomes	On completion of the course students should be able to CO1: analyze the concept about the methods of attributes. CO2: compute standard error and sampling distribution. CO3: predict the occurrence of null and alternative hypotheses. CO4: analyze the given data using Chi-square test. CO5: estimate the variance and coding of data.	

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	3	3
CO2	2	2	3	2	2

CO3	1	2	1	2	3
CO4	1	2	2	1	3
CO5	1	2	2	3	3

Semester	IV	Course Code	24MAUB2214
Course Title	**STATISTICAL METHODS (PRACTICAL)**		
No. of. Credits	**1**	No. of. contact hours per week	**2**
Category	**Core Course (Minor-4) -Practical**		
List of Practical			**No. of. Hours**
	1. Drawing bar charts, Pie diagrams, Histograms, Pictograms, 3-D bars, and other related diagrams. 2. Drawing graphs of frequency curves, frequency polygons, Normal probability curve, cumulative distribution curves, probability curves for different distributions. 3. Computation of Mean, Variance, Skewness and Moments, Kurtosis measures. 4. Computation of Moment generating functions, characteristic functions, cumulants and related measures. 5. Computation of Covariance, Correlation Coefficient, Equations of Regression lines and curves. 6. Curve fitting for the given statistical data.		32

Semester	IV	Course Code	24MAUA2201
Course Title	**ANALYTICAL GEOMETRY**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Ability Enhancement Course**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Understanding the representation of basic curves in polar coordinates (K-2) • Analysing the Conics and properties (K-3)		

<table>
<tr><td></td><td colspan="2">

- Analysing equations of a circle on a sphere and intersection of two spheres (K-3).
- Remembering the basic concepts of Cartesian coordinates and apply them in finding Directions cosines (K-1 & K-3)
- Evaluating the angle between two planes and length of perpendicular from a point on the plane (K-5).

</td></tr>
<tr><td>Course Objective</td><td colspan="2">The Course aims to study the various properties of geometrical figures in two dimensions and three dimensions.</td></tr>
<tr><td>Unit</td><td>Content</td><td>No. of. Hours</td></tr>
<tr><td>I</td><td>Polar Equations: Representation of basic curves in polar coordinates. General equation of Conic: Tracing the Conic - Properties and its applications.</td><td>13</td></tr>
<tr><td>II</td><td>Rectangular Cartesian co-ordinates: Direction cosines of a line: Co-ordinates – Projections – Direction Cosines.</td><td>13</td></tr>
<tr><td>III</td><td>The Plane: Equations of Plane – Angle between planes – Length of perpendicular from a point on the plane.</td><td>13</td></tr>
<tr><td>IV</td><td>The Straight Line: Equation of the straight line – coplanar lines – skew lines – intersection of three planes.</td><td>13</td></tr>
<tr><td>V</td><td>The Sphere: Equation of Sphere – Equation of a circle on a sphere – intersection of two spheres.</td><td>12</td></tr>
<tr><td rowspan="3">References</td><td colspan="2">Text Books:
1. T. Natarajan & T. K. Manicavachagom Pillay, Analytical Geometry 2D, S. Viswanathan Pvt. Ltd., Chennai, 2001.
Unit 1: Chapter IX (Sections: 1 - 9), X (Sections: 1- 8).
2. T. Natarajan & T. K. Manicavachagom Pillay, Analytical Geometry 3D, S. Viswanathan Pvt. Ltd., Chennai, 2001.
Unit 2: Chapter I.
Unit 3: Chapter II.
Unit 4: Chapter III.
Unit 5: Chapter IV.</td></tr>
<tr><td colspan="2">Reference Books:
1. P R Vittal, Analytical Geometry 2D and 3D, Pearson, 2013 Copy right.
2. George B. Thomas, JR & Ross L. Finney, Calculus and Analytic Geometry, Sixth edition, Narosa Publishing House, New Delhi, 1986.
3. S. Arumugam & Issac, Analytical Geometry 3D and Vector Calculus, New Gamma Publications, Palayamkottai, 1997.</td></tr>
<tr><td colspan="2">E-Recourses:
1. https://nptel.ac.in/Aeronautical/Applied%20Mathematics-1/index.php</td></tr>
</table>

	2. https://freevideolectures.com/course/2776/ma-141-analytic-geometry-and-calculus-i 3. https://cosmolearning.org/courses/mah-by-fives-trigonometry-502/ 4. https://cosmolearning.org/courses/pre-calculus-6-9-trigonometry-review/
Course Outcomes	On completion of the course students should be able to CO1: discuss conics in polar co-ordinates. CO2: outline planes and its properties as 3-dimensional objects. CO3: apply the concepts of skew lines and spheres in geometrical problems. CO4: solve problems related to geometry of two dimension and three dimensions.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	2
CO2	3	2	3	1	1
CO3	3	3	2	2	1
CO4	2	3	3	1	2

Semester	IV	Course Code	24MAUA2202
Course Title	BASIC NUMERICAL METHODS		
No. of. Credits	3	No. of. contact hours per week	3
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Ability Enhancement Course		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing forward interpolation and backward interpolation (K-1). • Understanding Numerical Differentiation through Newton's formula, Gauss's formula (K-2). • Applying Taylor's series method - Euler's method - Modified Euler to solve ODE (K-3). • Evaluate the Solution to Simultaneous Linear Equation (K-5).		
Course Objective	The course aims to develop efficient algorithms for solving problems.		
Unit	**Content**		**No. of. Hours**
I	Interpolation: Differences - relation between differences and derivatives - differences of polynomial - Newton's formula for forward interpolation - Backward interpolation–Central		11

	differences - Gauss's forward formula - backward formula and Stirling's interpolation formula.	
II	Numerical Differentiation: Newton's formula, Gauss's formula for first and second derivatives. Numerical Integration: General quadrature formula - Trapezoidal rule – Simpson's rule- Weddle's rule. Curve Fitting: Principles of least squares - Fitting a straight line - A parabola and exponential curve.	10
III	Numerical Algebra and Transcendental Equation: Finding approximate values of the roots Iteration method - Bisection method - Newton Raphson method –Regula Falsi method.	9
IV	Solution to Simultaneous Linear Equation: Back substitution - Gauss elimination method, Gauss - Jordon method. Iterative methods: Gauss - Jacobi's iteration method – Gauss-Seidel iterative method.	9
V	Numerical Solution of Ordinary Differential Equations: Taylor's series method - Euler's method - Modified Euler's method -Runge-Kutta method of second and fourth order.	9
References	**Text Book:** 1. P. Kandasamy, K. Thilagavathy & K. Gunavathi, **Numerical Methods**, S. Chand & Company Ltd., New Delhi, 2012. Unit 1: Chapters 5, 6, 7 Unit 2: Chapters 1, 9 Unit 3: Chapter 3 Unit 4: Chapter 4 Unit 5: Chapter 11	
	Reference Books: 1. S. S. Sastry, **Introductory Methods of Numerical Analysis**, Fifth Edition, PHI Learning Pvt. Ltd., New Delhi, 2015. 2. A. Singaravelu, **Numerical Methods**, Meenakshi Publications, Chennai, 1992. 3. S. Arumugam, **Numerical Methods,** 2nd edition, Scitech Publications (India) Pvt Ltd., Chennai, 2010.	
Course outcomes	On completion of the course students should be able to CO1: solve the interpolation problems. CO2: identify the basic concept of numerical differentiation and integration, principle of least squares. CO3: analyze the different aspects of numerical solution of algebraic and Transcendental equations. CO4: evaluate the solutions of simultaneous linear equations. CO5: discuss the role and application of numerical solution of ordinary differential	

	equations.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	3	2
CO2	2	3	2	2	3
CO3	1	3	2	3	1
CO4	1	3	2	3	2
CO5	2	3	1	3	1

Semester	**V**	Course Code	**24MAUC3108**
Course Title	**LINEAR ALGEBRA**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-8)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Recognizing the basic properties of vector spaces, inner product spaces. • Interpreting the concepts of linear algebra from a geometric point of view. • Solving simultaneous linear equations, finding eigenvalues and eigenvectors, the inverse of a matrix by using Cayley Hamilton Theorem. • Examining the linear independence and orthogonality of a set of vectors. • Constructing linearly independent sets, basis, subspaces, linear transformations in a vector space.		
Course Objective	The course aims to introduce the fundamentals of vector spaces.		
Unit	**Content**		**No. of. Hours**
I	Vector Spaces: Introduction - Definition and examples – Subspaces.		12
II	Linear transformation – Span of a set – Linear independence.		13
III	Basis and dimension- Rank and nullity - Matrix of a linear transformation.		14

IV	Inner product spaces: Introduction - Definition and examples – Orthogonality –Orthogonal Complement.	12
V	Elementary transformations - Rank of a matrix – Simultaneous linear equations – Characteristic equation and Cayley Hamilton Theorem – Eigen values and eigen vectors.	13
References	**Text Book:** 1. S. Arumugam & A. T. Isaac, **Modern Algebra**, SciTech Publications (India) Pvt. Ltd., Chennai, 2003. Unit 1: Chapter 5: Sections 5.0, 5.1, 5.2. Unit 2: Chapter 5: Sections 5.3, 5.4, 5.5. Unit 3: Chapter 5: Sections 5.6, 5.7, 5.8. Unit 4: Chapter 6: Sections 6.0, 6.1, 6.2, 6.3. Unit 5: Chapter 7: Sections 7.4, 7.5, 7.6, 7.7, 7.8.	
	Reference Books: 1. S. Narayanan & T. K. Manicavachagom Pillay, **Modern Algebra**, Vo1 III, S. Viswanathan Pvt. Ltd., Chennai, 1997. 2. S. Kumaresan, **Linear Algebra: A Geometric Approach**, Prentice Hall of India, 2006. 3. Vivek Sahai & Vikas Bist, **Linear Algebra**, Narosa Publishing House, New Delhi, 2002. 4. Gilbert Strang, **Introduction to Linear Algebra**, Wellesley-Cambridge Press, 2022.	
	E-Recourses: 1. https://onlinecourses.nptel.ac.in/noc18_ma13 2. https://nptel.ac.in/courses/111106135	
Course Outcomes	On completion of the course students should be able to CO1: explain the basic properties of vector spaces. CO2: identify the concepts of linear algebra in geometric point of view. CO3: form linear transformations as matrix form and vice versa. CO4: apply the tools of linear algebra to solve the system of equations. CO5: construct orthonormal bases of inner product spaces	

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	3
CO2	3	2	3	2	3
CO3	3	2	2	1	3
CO4	3	3	2	1	3

CO5	3	3	2	2	3

Semester	**V**	Course Code	**24MAUC3109**
Course Title	**MATHEMATICAL ANALYSIS**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-9)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Understanding metric spaces by remembering basic concepts of sets and functions (K-1 & K-2). • Analysing properties of open, closed, connected and compact sets in metric spaces (K-4). • Applying the property of compact sets to study uniformly continuous (K-3). • Constructing everywhere discontinuous functions on the real line (K-6) • Computing the definite integrals of functions (K-6)		
Course Objective	The Course aims to impart concepts about sets with metric and related properties.		

Unit	**Content**	**No. of. Hours**
I	Limit of a function on the real line- Metric spaces- Limits in metric spaces- Functions continuous at a point on the real line - Functions continuous on a metric space.	14
II	Open sets- Closed sets- Discontinuous function on R- More about open sets.	12
III	Connected sets- Bounded sets and totally bounded sets- Complete metric spaces- Compact metric spaces.	14
IV	Continuous functions on compact metric spaces- Continuity of the inverse function, Uniform continuity.	11
V	Definition of the Riemann integral- Existence of the Riemann integral- Properties of the Riemann integral- Derivatives- Rolle's theorem- The law of the mean- Fundamental theorem of calculus- Improper integrals.	13
References	**Text Book:** 1. Richard R. Goldberg, **Methods of Real Analysis**, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 1970.	

	Unit 1: Section 4.1-4.3, 5.1-5.3. Unit 2: Section 5.4-5.6, 6.1. Unit 3: Section 6.2-6.5. Unit 4: Section 6.4-6.8. Unit 5: Section 7.2-7.9.
	Reference Books: 1. N. P. Bali, **Real Analysis**, An imprint of Laxmi Publications Pvt. Ltd., New Delhi, 2005. 2. Sterling K. Berberian, **A First Course in Real Analysis**, Springer, New York, 2004. 3. S. Arumugam & A. Thangapandi Isaac, **Modern Analysis**, New Gamma Publishing House, Palayamkottai, 2002. 4. Robert G. Bartle and Donald R. Sherbert, **Introduction to Real Analysis**, John Wiley & Sons, New Delhi, 1982. 5. S. C. Malik & Savita Arora, **Mathematical Analysis**, New Age International LTD., New Delhi, 1992.
	E-Recourses: 1. https://nptel.ac.in/courses/111/106/111106142/ 2. https://www.youtube.com/watch?v=md5UCR7mcIY&list=PLbMVogVj5nJSxFihV-ec4A3z_FOGPRCo-
Course Outcomes	On completion of the course students should be able to CO1: understand the geometrical view of metric spaces with different metrics. CO2: identify open, closed, connected and compact sets and its properties in metric spaces. CO3: construct continuous and discontinuous functions on metric spaces. CO4: distinguish continuous and uniformly continuous functions CO5: evaluate integration of bounded functions.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	2	1
CO2	3	3	3	1	2
CO3	3	3	3	1	1
CO4	3	1	3	2	1
CO5	3	2	3	1	1

Semester	V	Course Code	24MAUC3110
Course Title	LINEAR PROGRAMMING		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	30%
Category	Core Course (Major-10)		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing the basic concepts of mathematical formulation of LPP and solving the linear programming problems using graphical method, simplex method, Big M method and two-phase method. • Understanding the concept of duality in Linear Programming, General Primal-Dual pair, formulating a dual problem and dual simplex method. • Applying the North-West Corner rule and Vogel's approximation method to find an initial basic feasible solution. • Evaluating the processing 'n' jobs through two machines, processing 'n' jobs through k machines and processing 2 jobs through k machines. • Analyzing the two-person zero-sum games, the MAXIMIN-MINIMAX principle, graphical solution of $2 \times n$ and $m \times 2$ games and dominance property.		
Course Objective	The Course aims to impart the basic concepts and applications of linear programming.		

Unit	Content	No. of. Hours
I	Solving Linear Programming Problems: Graphical Solution Method –Insights into the simplex method – Use of artificial variables: Big M Method - Two Phase Method.	13
II	Writing of Dual Linear Programming Problem: General Primal - Dual Pair –Formulating a Dual Problem - Duality and Simplex Method - Dual Simplex Method.	13
III	Transportation Problem (TP): General structure of TP – Methods for Finding Initial Basic Feasible Solution – Optimality Test - MODI Method - Unbalanced Transportation Problems. Modern Formulation of an Assignment Problems (AP): Methods of solving an AP – Hungarian Method –The Travelling Salesman Problem.	13
IV	Operations Scheduling: Problem of Sequencing – Basic Terminology and Assumptions – Gantt Chart – Criteria and Objective for Scheduling – Methods of Scheduling – Single Processor Scheduling – Flow shop scheduling – Processing of Two jobs through 'm' machines – Personnel scheduling – Rooting	13

	problems and sequencing – Problems of complex sequencing.	
V	Decision Theory – Decision making under conflict (Competitive Game) – Two-Person Zero-Sum Games – Solution of Two Person Zero Sum Game – Arithmetic method for $n \times n$ game - Dominance Property.	12
References	**Text Book:** 1. Kanti Swarup, P. K. Gupta & Man Mohan, **Operations Research**, Eighteenth Edition, Sultan Chand & Sons, New Delhi, 2015. Unit 1: Chapter 3: Sections 3.1 – 3.5 Unit 2: Chapter 5: Sections 5.1 - 5.3, 5.5, 5.8. Unit 3: Chapter 7: Sections 7.9, 7.10 - 2, 7.14, 7.15 Chapter 8: Sections 11.2, 11.3, 11.7. Chapter 9: Section 9.6 Unit 4: Chapter 10: Sections 10.1 - 10.11. Unit 5: Chapter 19: Sections 19.9 – 19.12.	
	Reference Books: 1. P. K. Gupta & D. S. Hira, **Operations Research**, S. Chand & Company Ltd., New Delhi, 2013. 2. J. K. Sharma, **Operations Research theory and its applications**, 2nd Edition, Macmillan, New Delhi, 2006. 3. R. Panneerselvam, **Operations Research**, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.	
	E-Recourses: 2. https://nptel.ac.in/courses/112106134/ 3. https://nptel.ac.in/courses/111105039/ 4. https://nptel.ac.in/courses/110/106/110106062/	
Course Outcomes	On completion of the course students should be able to CO1: formulate a linear programming problem and solve them graphically and simplex method. CO2: explain the concepts of duality programming. CO3: analyze the different aspects of transportation problems and also assignment problems. CO4: develop, organize, evaluate short, long-term processes, and solve problems. CO5: utilize the acquired knowledge of basics in game theory.	

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	2	3
CO2	3	2	3	1	3
CO3	3	2	2	3	1
CO4	3	2	3	2	1
CO5	3	2	1	3	2

Semester	**V**	Course Code	**24MAUB3115**
Course Title	**ORDINARY DIFFERENTIAL EQUATIONS**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Minor-5)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Remembering the different types of differential equations (K-1) • Understanding the initial/ Boundary value problems and existence of solutions (K-2) • Applying various methods to solve first/second order differential equations (K-3) • Analyse the conditions for the existence of solutions of differential equations (K-4) • Construct solutions of differential equations by applying Laplace Transforms (K-3 & K-6)		
Course Objective	The Course aims to introduce the basic concepts of differential equations and the Laplace Transform.		

Unit	Content	No. of. Hours
I	Differential Equations and Their Solutions: Classification of Differential Equations; Their Origin and Application – Solutions – Initial-Value Problems- Boundary-value Problems, and Existence of Solutions.	13
II	First-Order Equations for which Exact Solutions Are Obtainable: Exact Differential Equations and Integrating Factors – Separable Equations and Equations Reducible to This Form – Linear Equations and Bernoulli Equations.	14

III	Explicit Methods of Solving Higher-Order Linear Differential Equations: Basic Theory of Linear Differential Equations – The Homogeneous Linear Equations with Constant Coefficients – The Method of Undetermined Coefficients.	12
IV	Explicit Methods of Solving Higher-Order Linear Differential Equations (Continued): Variation of Parameters – The Cauchy-Euler Equation – Statements and Proofs of Theorem on the Second-Order Homogeneous Linear Equation.	13
V	The Laplace Transform: Definition, Existence, and Basic Properties of the Laplace Transformation (Theorems without Proof) – The Inverse Transform and the Convolution (Theorems without Proof) – Laplace Transform Solution of Linear Differential Equations with Constant Coefficients.	12
References	**Text Book:** 1. Shepley L. Ross, **Differential Equations**, Third Edition, Wiley India Pvt. Ltd., New Delhi, 2004. Unit 1: Chapter 1 Unit 2: Chapter 2: Section 2.1-2.3. Unit 3: Chapter 4: Section 4.1 – 4.3. Unit 4: Chapter 4: Section 4.4 – 4.6. Unit 5: Chapter 9. Section 9.1 - 9.3.	
	Reference Books: 1. William E. Boyce, Richard C. Diprima, **Elementary Differential Equations and Boundary Value Problems**, 9th Ed., Wiley India Pvt. Ltd., New Delhi, 2017. 2. Richard Bronson, Gabriel Costa, **Schaum's Outline of Differential Equations**, 4th Edition (Schaum's Outlines), USA, 2014. 3. Braun, M. **Differential Equations and Their Applications**, 4th Ed., Springer, USA, 2011. 4. Kreyszig, E., **Advanced Engineering Mathematics**, 10th edition. John Wiley & Sons, USA, 2010. 5. M. D. Raisinghania**, Advanced Differential Equations**, S. Chand Publications, New Delhi 2004.	
	E-Recourses: 1. https://onlinecourses.nptel.ac.in/noc21_ma09/course 2. https://onlinecourses.nptel.ac.in/noc21_ma69/course 3. https://nptel.ac.in/courses/122/107/122107037/ 4. https://nptel.ac.in/courses/111/106/111106100/ 5. https://nptel.ac.in/courses/111/108/111108081/	
Course Outcomes	On completion of the course students should be able to CO1: solve boundary/initial value problems. CO2: determine solutions of second order linear homogeneous, non-homogeneous differential equations with constant coefficients. CO3: determine solutions of Cauchy- Euler equation. CO4: determine the conditions for the existence of solutions of second order differential equations.	

	CO5: estimate the solutions by applying Laplace transform methods.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	2
CO2	3	3	2	2	1
CO3	2	3	2	1	2
CO4	3	3	3	1	1
CO5	3	3	2	2	1

Semester	**V**	Course Code	**24MAUC3111**
Course Title	**INTERNSHIP**		
Category	**Core Course (Major -11)**		

Semester	**VI**	Course Code	**24MAUC3212**
Course Title	**COMPLEX ANALYSIS**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	Revised	If revised, Percentage of Revision effected (Minimum 20%)	60%
Category	**Core Course (Major-12)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Understanding analytic, harmonic, and conformal mapping (K-1). • Understanding bilinear transformations –Cross Ratio-Fixed points of bilinear transformations (K-1). • Applying Cauchy's Theorem and Cauchy's Integral formula to evaluate integral of complex functions (K-3). • Identifying singular points of complex functions using Laurent's series and classifying the singular points (K-4). • Evaluating indefinite integrals of complex functions using Residue Theorem (K-5).		
Course Objective	The Course aims to introduce the concepts of complex numbers and analytic functions.		

Unit	Content	No. of. Hours
I	Complex numbers – sums and products –moduli –complex conjugates – exponential forms – products and quotients in exponential form – roots of complex number – examples – regions in complex plane – analytic functions – functions of a complex variable – mappings – mappings by the exponential function – limits – theorems on limits – limits involving the point at infinity – continuity – derivatives – differentiation formulas – Cauchy-Riemann equations – sufficient condition for differentiability.	13
II	Polar coordinates – analytic functions – examples – harmonic functions – mapping by elementary functions – linear transformation – the transformation $w = 1/z$ – mapping by $1/z$ – linear fractional transformations – an implicit form – mappings of the upper half plane.	12
III	Integrals – derivatives of function $w(t)$ – Definite Integrals of functions $w(t)$– Contours – Contour Integrals – examples – upper bounds for moduli of contour integrals – Cauchy-Goursat Theorem (without proof) – simply and multiply connected domains (theorems without proof) – Cauchy integral formula – derivatives of analytic functions – Liouville's Theorem and the Fundamental Theorem of Algebra – maximum modulus principle.	13
IV	Series – convergence of sequences and series (theorems without proof) – Taylor series – examples – Laurent series – examples – residues – Cauchy's Residue Theorem – using a single residue – the three types of isolated singular points.	15
V	Residues at Poles – examples – zeros of analytic functions – zeros and poles – evaluation of improper integrals – example –improper integrals from fourier analysis – Jordan's lemma – definite integrals involving sines and cosines.	11
References	**Text Book:** 1. R. V. Churchill & J.W. Brown, **Complex Variables and Applications**, 7th Edition, McGraw Hill, Singapore, 1990. Unit 1: Chapter 1 (Sections 1, 4-10), Chapter 2 (Sections 11-21) Unit 2: Chapter 2 (Sections 22-25), Chapter 8 (Sections 83-88) Unit 3: Chapter 4 (Sections 36-41, 44, 46-50) Unit 4: Chapter 5 (Sections 51-56, 62-65) Unit 5: Chapter 6 (Sections 66-69), Chapter 7 (Sections 71-74, 78)	

	Reference Books: 1. L. Ahlfors, **Complex Analysis**, McGraw-Hill International Edition, 1979. 2. John B. Conway, **Functions of One Complex Variable**, Springer, ISE, 1973. 3. S. Arumugam, A. Thangapandi Isaac & A. Somasundaram, **Complex Analysis**, SciTech Publications India, Pvt. Ltd., Chennai, 2002. 4. S. Narayanan & T.K. Manicavachagom Pillay, **Complex Analysis**, S. Viswanathan Publishers, Chennai, 1997. 5. S. Ponnusamy, **Foundations of Complex Analysis**, 2ndEdition, Narosa Publication, New Delhi, 2005.
	E-Recourses: 1. https://nptel.ac.in/courses/111107056/s 2. https://cosmolearning.org/courses/advanced-complex-analysis-i/
Course Outcomes	On completion of the course students should be able to CO1: outline the basic concepts of analytic function and its properties. CO2: explain about complex valued functions, conformal and bilinear transformation. CO3: compare the integration of complex valued function with real valued function. CO4: predict the series of analytic function. CO5: apply the integration of complex function to find residues.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	3	3	3	1	1
CO3	3	2	3	2	1
CO4	3	3	3	1	1
CO5	3	3	3	1	1

Semester	**VI**	Course Code	**24MAUC3213**
Course Title	**GRAPH THEORY**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--

<table>
<tr><td>Category</td><td colspan="2">Core Course (Major-13)</td></tr>
<tr><td>Scope of the Course</td><td colspan="2">● Basic Skill</td></tr>
<tr><td>Cognitive Levels addressed by the course</td><td colspan="2">● Knowing about graphs and subgraphs (K-1)
● Analysing about degree sequences and connectedness (K-3)
● Finding chromatic number and index for various graphs (K-2)</td></tr>
<tr><td>Course Objective</td><td colspan="2">The Course aims to acquire knowledge of fundamentals of graphs and its applications.</td></tr>
<tr><td>Unit</td><td>Content</td><td>No. of. Hours</td></tr>
<tr><td>I</td><td>Graphs and Subgraphs: Introduction – Definition and examples –Degree – Subgraphs – Isomorphism –Ramsey Numbers– Independent sets and coverings –Intersection graphs and line graphs – Matrices – Operations on graphs.</td><td>14</td></tr>
<tr><td>II</td><td>Degree Sequences: Introduction – Degree sequences –Graphic sequences - Connectedness: Introduction –Walks, trails, and paths– Connectedness and components – Blocks –Connectivity.</td><td>12</td></tr>
<tr><td>III</td><td>Eulerian and Hamiltonian graphs: Introduction – Eulerian Graphs – Hamiltonian graphs – Trees: Introduction –Characterization of trees–Centre of a tree.</td><td>13</td></tr>
<tr><td>IV</td><td>Matchings: Introduction – Matchings – Matchings in bipartite graphs – Planarity: Introduction - Definition and properties.</td><td>12</td></tr>
<tr><td>V</td><td>Colourability: Introduction – Chromatic number and chromatic index – Directed graphs: Introduction – Definitions and basic properties – paths and connections.</td><td>13</td></tr>
<tr><td rowspan="2">References</td><td colspan="2">Text Book:
1. S. Arumugam & S. Ramachandran, Invitation to Graph Theory, SciTech Publications (India) Pvt. Ltd., Chennai, 2001.
Unit 1: Chapter 2: Sections 2.0 – 2.9
Unit 2: Chapter 3: Sections 3.0 – 3.2 & Chapter 4: Section 4.0 – 4.4
Unit 3: Chapter 5: Sections 5.0 – 5. 2 & Chapter 6: Section 6.0 – 6.2
Unit 4: Chapter 7: Sections 7.0 – 7.2 & Chapter 8: Section 8.0, 8.1
Unit 5: Chapter 9: Sections 9.0, 9.1 & Chapter 10: Section 10.0 – 10.3</td></tr>
<tr><td colspan="2">Reference Books:
1. J.A. Bondy & U.S.R. Murty, Graph Theory with Applications, Elsevier, New York, 1976.
2. S.A. Choudam, A First course in Graph Theory, Macmillian India Ltd., New Delhi, 2007.</td></tr>
</table>

	3. J. Clark & D.A. Holton, **A First Look at Graph Theory**, Allied Publishers, New Delhi, 1995.
	E-Recourses: 1. https://nptel.ac.in/courses/111/106/111106102/ 2. https://nptel.ac.in/courses/111/106/111106050/
Course Outcomes	On completion of the course students should be able to CO1: explain the different models of a graph. CO2: outline various parameters of graphs. CO3: analyze various properties of graphs. CO4: apply graph theoretic methods to solve different real-life problems. CO5: demonstrate various graph structures in network models.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	3
CO2	2	3	3	3	1
CO3	3	2	2	2	1
CO4	1	1	2	3	3
CO5	3	2	1	2	3

Semester	VI	Course Code	24MAUC3214
Course Title	**MECHANICS**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-14)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing about forces, velocity, acceleration, moments, couples, friction etc., in trigonometrically and geometrically (K-1). • Understanding Newton's laws of motion and equilibrium of forces acting on a rigid body (K-2). • Applying geometrical concepts in parallel forces, moments, and couples in physics problems (K-3). • Analyses for Newton's laws of motion and projectiles (K-4). • Create new problems in motion under action of central forces (K-6).		

Course Objective	The Course aims to learn the application of geometric and trigonometric properties in equilibrium and motion of particles.	
Unit	**Content**	**No. of. Hours**
I	Forces acting at a point: Basic concepts and principles – Parallelogram of forces - Triangle of forces - Lami's theorem and applications – Resolution of a force - Condition of equilibrium. Parallel forces and moments: Like and unlike parallel forces - Moment of a force - Related problems.	14
II	Equilibrium of three forces acting on a rigid body: Three coplanar forces – Two trigonometrical theorems – Related problems. Friction: Definitions - Laws of friction - Angle of friction - Cone of friction - Properties and related problems.	12
III	Kinematics: Motion in a straight line under uniform acceleration - Newton's laws of motion. Projectiles: Definitions - Path of a projectile - Properties and related problems.	14
IV	Impulse and Impact: Collision of elastic bodies – Direct and oblique impact – Loss of kinetic energy – Related properties and problems.	12
V	Central orbits: Motion under the action of central forces - Differentiation of a vector – Velocity and acceleration in polar coordinates - Properties and related problems - Differential equation of central orbit - Pedal equation of central orbit - Velocities in a central orbit - Law of forces - Properties and related problems.	12
References	**Text Books:** 1. M. K. Venkataraman, **Statics**, Agasthiar Publications, Trichy, 2016. Unit 1: Chapters 2, 3. Unit 2: Chapters 5, 7. 2. M. K. Venkataraman, **Dynamics**, Agasthiar Publications, Trichy, 2018. Unit 3: Chapter 3: Section 3.22, Chapter 4: Section 4.3, Chapter 6: Sections 6.1 - 6.11. Unit 4: Chapter 8. Unit 5: Chapter 11.	
	Reference Books: 1. T. K. Manicavachagom Pillay, **Statics**, S. Viswanathan & Co., Chennai, 1980. 2. S. Narayanan, **Dynamics**, S. Chand & Co., New Delhi, 1980. 3. A. V. Dharmapadam, **Statics**, Ananda Book Depot, Chennai, 2019. 4. A. V. Dharmapadam, **Dynamics**, Ananda Book Depot, Chennai, 2019.	
Course Outcomes	On completion of the course students should be able to CO1: apply geometrical concepts in parallel forces, moments, and couples. CO2: evaluate static equilibrium of three forces acting on a rigid body and friction. CO3: explain Newton's laws of motion and projectiles. CO4: analyze the effects of collision of elastic bodies.	

	CO5: predict the motion under action of central forces.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	3	3
CO2	2	2	3	2	2
CO3	3	2	1	2	3
CO4	3	2	2	1	3
CO5	1	3	1	2	2

Semester	VI	Course Code	24MAUC3215
Course Title	NUMERICAL METHODS		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Core Course (Major-15)		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Applying various methods to solve algebraic and transcendental equations (K-3). • Understanding the concepts of interpolations (K-2). • Knowing the various techniques for numerical differentiation (K-1) • Finding the numerical solutions of system of linear equations (K-2) • Applying the various methods to find approximate solutions of differential equations (K-3).		
Course Objective	The Course aims to develop efficient algorithms for solving problems in Science, Engineering and Technology.		

Unit	Content	No. of. Hours
I	Errors in Numerical Calculations: Errors and their computations - A general error formula - Error in a series Approximation. Solution of Algebraic and Transcendental equations: The Bisection method – The Method of False position - Iteration method - Newton - Raphson method.	12
II	Interpolation: Finite differences - Forward Differences – Backward Differences - Central Differences - Symbolic Relations and	13

	Separation of Symbols. Newton's Formulae for Interpolation - Gauss's central difference formulae - Stirling's formula - Interpolation with unevenly spaced points: Lagrange's interpolation formula - Lagrange's Inverse Interpolation.	
III	Numerical Differentiation: Derivatives using Newton's Forward Difference Formula – Derivatives using Newton's Backward Difference Formula - Derivatives using Stirling's Formula - Maxima and Minima of Tabulated Function. Numerical Integration: - Trapezoidal Rule - Simpson's 1/3 Rule - Simpson's 3/8 Rule - Romberg Integration.	13
IV	Numerical Solutions of System of Linear Equations: Gauss elimination method - Gauss - Jordan method – Modification of the Gauss Method to compute the Inverse - Jacobi's method - Gauss - Seidel method.	13
V	Numerical Solutions of Ordinary Differential Equations: Solution by Taylor's series - Picard's method of successive approximations – Euler's Method – Modified Euler's Method – Runge - Kutta Methods - Milne's Predictor -Corrector Method.	13
References	**Text Book:** 1. S. S. Sastry, **Introductory Methods of Numerical Analysis**, Fifth Edition, PHI Learning Pvt. Ltd., New Delhi, 2015. Unit 1: Chapter 1: Section 1.3 to 1.5, Chapter 2: Section 2.1 to 2.5 Unit 2: Chapter 3: Section 3.3.1 to 3.3.4, 3.6, 3.7.1, 3.7.2, 3.9.1 Unit 3: Chapter 6: Section 6.2, 6.3, 6.4.1, 6.4.2, 6.4.3, 6.4.6 Unit 4: Chapter 7: Section 7.5.1, 7.5.3, 7.5.4, 7.6. Unit 5: Chapter 8: Section 8.2, 8.3, 8.4, 8.4.2, 8.5, 8.6.2	
	Reference Books: 1. Gerald & Wheatly, **Applied Numerical Analysis**, Sixth Edition, Pearson Education Pvt. Ltd., New Delhi, 2002. 2. S. Arumugam, A. Thangapandi Isaac & A. Somasundaram, **Numerical Methods**, SciTech Publications Pvt. Ltd., Chennai, 2001. 3. V. N. Vedamurthy & N. Ch. S. N. Iyengar, **Numerical Methods**, Vikas Publishing House Pvt. Ltd. New Delhi, 2000.	
	E-Recourses: 1. https://nptel.ac.in/courses/111/107/111107105/	
Course Outcomes	On completion of the course students should be able to CO1: solve the interpolation problems. CO2: identify the basic concept of numerical differentiation and integration, principle of least squares.	

	CO3: analyze the different aspects of numerical solution of algebraic and Transcendental equations. CO4: evaluate the solutions of simultaneous linear equations. CO5: discuss the role and application of numerical solution of ordinary differential equations.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	2
CO2	3	2	1	2	1
CO3	2	1	3	2	3
CO4	3	2	1	3	2
CO5	2	3	2	2	1

Semester	**VI**	Course Code	**24MAUB3216**
Course Title	**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**		
No. of. Credits	**4**	No. of. contact hours per week	**4**
New Course/ Revised Course	New Course	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Minor - 6)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Remembering the classification of partial differential equations (PDEs) and basic concepts of Fourier series and transforms (K-1) • Understanding the general solutions of PDEs and convergence of Fourier series (K-2) • Applying various methods to solve linear and nonlinear PDEs (K-3) • Analyse Fourier series and Fourier transforms for various functions (K-4) • Construct solutions of PDEs by applying Lagrange's linear equation and the method of separation of variables (K-3 & K-6)		

Course Objective	The Course aims to introduce the fundamental concepts of partial differential equations (PDEs), Fourier series and transforms.	
Unit	**Content**	**No. of. Hours**
I	Introduction to Partial Differential Equations: Formation of Partial Differential Equations – Elimination of Arbitrary Constants – Elimination of Arbitrary Functions – Solutions of Partial Differential Equations – Procedure to Find General Solution – Procedure to Find Singular Solution – Complete Solutions of First Order Non-linear P.D.E.S – Equations Reducible to Standard Types– Transformation.	13
II	General Solutions of Partial Differential Equations: Lagrange's Linear Equation – Solution of the Simultaneous Equations $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$. Linear P.D.E.S. of Higher Order with Constant Coefficients - Complementary Function for a Non-Homogeneous Linear Equation - Solution of P.D.E.S. by the Method of Separation of Variables.	14
III	Introduction to Fourier Series: Dirichlet's Conditions – Euler's Formulas – Definition of Fourier Series and Some Important Concepts – Fourier Series for Even and Odd Functions and the Corresponding Theorems – Convergence of Fourier Series at Specific Points.	12
IV	Half-Range Fourier Series: Related Theorems – Root-Mean Square Value of a Function – Parseval's Theorem – Harmonic Analysis – Complex Form of Fourier Series.	13
V	Introduction to Fourier Transforms: Fourier Integral Theorem – Fourier Transforms – Alternative Form of Fourier Complex Integral Formula – Relationship between Fourier Transform and Laplace Transform – Properties of Fourier Transforms.	12
References	**Text Book:** 1. T Veerarajan, **Transforms and Partial Differential Equations**, Third Edition, McGraw Hill India Pvt. Ltd., Chennai, 2016. Unit 1: Chapter 1: Sections 1.1-1.9. Unit 2: Chapter 1: Sections 1.10-1.15 Unit 3: Chapter 2: Sections 2.1 – 2.8. Unit 4: Chapter 2: Sections 2.9 – 2.12. Unit 5: Chapter 4: Sections 4.1 – 4.6.	

	Reference Books: 1. I. N. Snedden, **Elements of Partial Differential Equations**, Dover, 2006. 2. M. D. Raisinghania, **Ordinary and Partial Differential Equations**, S. Chand & Company Pvt. Ltd., New Delhi 2016. 3. V. Sundarapandian, **Ordinary and Partial Differential Equations: With Laplace Transforms, Fourier Series and Applications**, McGraw Hill Education Pvt. Ltd., Chennai 2013. 4. Spiegel, Murray R, **Fourier Analysis with Applications to Boundary Value Problems,** McGraw Hill Education Pvt. Ltd., Chennai 2004.
	E-Recourses: 1. https://nptel.ac.in/courses/111106046 2. https://nptel.ac.in/courses/111108144 3. https://nptel.ac.in/courses/111108152
Course Outcomes	On completion of the course, students should be able to CO1: formulate PDEs by eliminating arbitrary constants and functions. CO2: determine solutions for both linear and nonlinear PDEs. CO3: find the Fourier series expansion for various functions. CO4: determine the half-range cosine and sine series for specific functions. CO5: compute the Fourier transform and inverse Fourier transform for given functions.

Mapping of COs with Pos

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	3
CO2	3	3	3	2	3
CO3	1	1	3	2	3
CO4	2	3	2	3	2
CO5	3	2	1	3	3

Semester	VI	Course Code	24MAUC3216
Course Title	OPERATIONS RESEARCH		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected	50%

		(Minimum 20%)	
Category	**Core Course (Major-16)**		
Scope of the Course	• Basic Skill		
Cognitive Levels addressed by the course	• Knowing the basic concepts of decision analysis, decision-making process, decision-making environment, decision under uncertainty and decision under risk (K-1). • Understanding the queuing theory, operating characteristics of a queuing system, probability distributions in queuing systems and classification of queuing models (K-2). • Applying the Economic Order Quantity (EOQ) to solve the inventory problems (K-3). • Evaluating the problems of replacement of equipment/asset that deteriorates gradually, replacement of equipment that fails suddenly (K-5). • Analyzing the critical path analysis and probability considerations in PERT (K-4).		
Course Objective	The Course aims to impart mathematical modelling skills through operations research techniques.		
Unit	**Content**		**No. of. Hours**
I	Scheduling Techniques: Advantages and limitations in network- Basic Components of network – Logical Sequencing – Rules of Network Construction – Critical Path Analysis – Program evaluation and review technique.		13
II	Decision Theory: Introduction – Decision Making Problem – Decision Making Process – Decision Making under certainty – Decision Making under Uncertainty – Decision Making under Risk.		13
III	Queuing Theory: Queuing System – Operating Characteristics of a Queuing System – Probability Distributions in Queuing System – Transient state and Steady States of the system- Classification of Queuing Models — Poisson Queuing system (Model I, II, and III only).		13
IV	Replacement Decisions: Replacement policy for equipment that deteriorates Gradually – Replacement policy for equipment that breaks down/ fails Suddenly.		12
V	Inventory Management - Deterministic: Types of Inventories – Reasons for Carrying Inventories - The inventory decisions – Cost Associated with Inventories – Factors Affecting Inventory Control – The Concept of Economic Order Quantity (EOQ) – EOQ model with replenishment – EOQ model with planned Shortages.		13

References	**Text Book:** 1. Kanti Swarup, P. K. Gupta & Man Mohan, **Operations Research**, Eighteenth Thoroughly Revised Edition, Sultan Chand & Sons, New Delhi, 2015. Unit 1: Chapter 13: Sections 13.1 – 13.4, 13.6 - 13.13. Unit 2: Chapter 19: Sections 19.1, 19.3 – 19.6 Unit 3: Chapter 20: Sections 20.1, 20.3, 20.6, 20.8 – 20.10 (First Three Models only). Unit 4: Chapter 21: Sections 21. 5 and 21.6. Unit 5: Chapter 22: Sections 22.1-22.3, 22.5,22.6,22.8, 22.12, 22.13
	Reference Books: 1. P. K. Gupta & D. S. Hira, **Operations Research**, S. Chand and Company Ltd., New Delhi, 2013. 2. J. K. Sharma, **Operations Research theory and Its Applications**, 2ndEdition, Macmillan India Limited, 2003.
	E-Recourses: 1. https://nptel.ac.in/courses/112106134/ 2. https://nptel.ac.in/courses/111105039/
Course Outcomes	On completion of the course students should be able to. CO1: critique the role and application of PERT/CPM for project scheduling CO2: demonstrate knowledge of the major concepts of decision theory and decision-making process. CO3: identify the basic analysis of queuing systems. CO4: identify the system reliability and specific types of replacement theory CO5: apply the basic various inventory models in real life problems.

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	3	2
CO2	3	2	2	2	0
CO3	2	2	2	1	3
CO4	3	2	2	3	1
CO5	2	3	2	2	1

Semester	**VII**	Course Code	**24MAUC4117**
Course Title	**ADVANCED ALGEBRA**		
No. of Credits	4	No. of contact hours per week	4

New Course/ Revised Course	New Course	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-17)**		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	• Recognizing some advances of theory of groups (K1 Remember) • Understanding automorphism group of a group, class equation of a group and the structure of finite abelian groups (K2-Understanding) • Applying Sylow's Theorem to study the properties of groups. Using class equation to find the conjugacy classes in symmetric groups (K3-Applying) • Examining the irreducibility of a polynomial (K4-Analyse) • Investigating the structure of two isomorphic algebraic structures like groups, rings, fields (K5-Evaluate) • Formulating some special types of rings, ideals (K6-Create)		
Course Objective	The course aims to provide deep knowledge about groups and rings.		

Unit	**Content**	**No. of. Hours**
I	A counting principle - Normal subgroups and quotient groups – Homomorphisms – Cauchy's theorem for abelian groups - Sylow's theorem for abelian groups - Correspondence theorem for groups – First isomorphism theorem	14
II	Automorphisms – Inner automorphisms - Automorphism group of cyclic groups - Cayley's theorem – Applications - Permutation groups	12
III	Another counting principle: Conjugate class - Class equation of a group – Applications - Cauchy's theorem - Sylow's theorems - Direct product of groups - Finite abelian groups.	13
IV	Ideals and quotient rings – More ideals and quotient rings: Maximal ideals - Euclidean rings - G.C.D - Unique Factorization Theorem - A particular Euclidean ring - Fermat's theorem	12
V	Polynomial rings - Division Algorithm- Polynomials over the rational field- Gauss' Lemma - Eisenstein Criterion - Polynomial rings over commutative rings – Unique Factorization Domain.	13

References

Text Book:

I. N. Herstein, **Topics in Algebra**, 2nd edition, John Wiley & Sons, Singapore, 2006.

Unit 1: Chapter 2: Sections 2.5, 2.6, 2.7
Unit 2: Chapter 2: Sections 2.8, 2.9, 2.10
Unit 3: Chapter 2: Sections 2.11, 2.12, 2.13, 2.14
Unit 4: Chapter 3: Sections 3.4, 3.5, 3.7, 3.8,
Unit 5: Chapter 3: Sections 3.9, 3.10, 3.11

Reference Books:

1. John. B. Fraleigh, **A First Course in Abstract Algebra**, 7th Edition, Addison-Wesley,

	New Delhi, 2003. 2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul, **Basic Abstract Algebra**, Cambridge University Press, USA, 1986. 3. Charles Lanski, **Concepts in Abstract Algebra**, AMS, USA, 2010. 4. M. Artin, **Algebra**, Prentice-Hall of India, New Delhi, 1991. 5. D. S. Dummit & R. M. Foote, **Abstract Algebra,** John Wiley, New York, 1999.
	E-Recourses: 1. https://onlinecourses.nptel.ac.in/noc18_ma15 2. https://onlinecourses.nptel.ac.in/noc18_ma16
Course Outcomes	On completion of the course students should be able to CO1: explain advances of the theory of groups. CO2: use Sylow's theorems in the study of finite groups. CO3: classify finite abelian groups using direct products CO4: formulate some special types of rings and their properties. CO5: check the irreducibility of polynomials.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	3
CO2	3	1	2	1	3
CO3	3	2	1	1	2
CO4	3	3	1	1	3
CO5	3	3	2	1	3

Semester	**VII**	Course Code	**24MAUC4118**
Course Title	**REAL ANALYSIS**		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-18)**		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	• Understanding the geometry of metric spaces and identifying open, closed, connected and compact sets in metric spaces (K-2) • Evaluating the limit of a sequence/series by analysing the convergence of the sequence/series (K-4) • Applying open & closed set to study continuous and discontinuous functions (K-3) • Identifying differentiable functions and evaluate its derivatives (K-5)		

<table>
<tr><td>Course Objective</td><td colspan="2">The course aims to impart the advanced concepts in real analysis.</td></tr>
<tr><td>Unit</td><td>Content</td><td>No. of. Hours</td></tr>
<tr><td>I</td><td>Basic Topology: Finite - Countable and Uncountable sets - Metric spaces - Compact sets - Perfect sets - Connected sets.</td><td>13</td></tr>
<tr><td>II</td><td>Numerical Sequences and Series: Convergent sequences – Subsequences - Cauchy sequences - Upper and lower limits - Some special sequences</td><td>13</td></tr>
<tr><td>III</td><td>Series - The number e - The root and ratio tests – Power series - Summation by parts - Absolute convergence - Addition and multiplication of series - Rearrangements.</td><td>14</td></tr>
<tr><td>IV</td><td>Continuity: Limits of functions - Continuous functions - Continuity and compactness - Continuity and connectedness - Monotonic functions - Infinite limits and limits at infinity.</td><td>11</td></tr>
<tr><td>V</td><td>Differentiation: The derivative of a real function - Mean value theorems - The continuity of derivatives - L’Hospital’s rule - Derivatives of Higher order - Taylor’s theorem - Differentiation of vector valued functions.</td><td>13</td></tr>
<tr><td rowspan="3">References</td><td colspan="2">Text Book:
1. Walter Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw – Hill International Book Company, Singapore, 1982.
Unit 1: Chapter-2
Unit 2: Chpater-3
Unit 3: Chpater-3 (Sections 1-5)
Unit 4: Chpater-4 (Sections 6-14)
Unit 5: Chpater-5</td></tr>
<tr><td colspan="2">Reference Books:
1. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw- Hill, New Delhi, 2004.
3. R. G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, New York, 1982.
4. Kenneth A. Ross, Elementary Analysis: The theory of Calculus, Springer, New York, 2004.
5. N. L. Carothers, Real Analysis, Cambridge University Press, UK, 2000.
6. S. C. Malik, Mathematical Analysis, Willey Eastern Ltd., New Delhi, 1985.</td></tr>
<tr><td colspan="2">E-Recourses:
1. http://nptel.ac.in/courses/109104124/
2. http://nptel.ac.in/courses/111101100/</td></tr>
<tr><td>Course Outcomes</td><td colspan="2">On completion of the course students should be able to
CO1: Discuss various axioms and properties of real and complex numbers.
CO2: Identify the topological properties of sets in metric spaces.
CO3: Compute the limits of convergent sequences/series.
CO4: Identify the topological properties of functions defined on metric spaces.
CO5: Evaluate the derivative of real valued functions.</td></tr>
</table>

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	2	3	1	2
CO3	3	3	2	2	2
CO4	3	3	2	1	2
CO5	3	3	2	1	2

Semester	**VII**	Course Code	**24MAUC4119**
Course Title	**Advanced Ordinary Differential Equations**		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-19)**		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	• Identify various basic concepts on differentiation (K-1) • Use to model differential systems (K-2) • To develop approximation methods and fixed point theorems to get solutions of differential equations (K-3) • Extend the results to higher order differential calculus (K-4)		
Course Objective	The Course aims to study in-depth concepts and applications of ordinary differential equations.		

Unit	**Content**	**No. of. Hours**
I	Existence and Uniqueness of Solutions: Introduction - Successive approximations - Picard's theorem - Continuation and dependence of initial conditions – Existence of Solutions in the large – Existence and Uniqueness for Systems - Fixed point method.	13
II	Differential Equations of Higher Order: Introduction – Higher order Equations – Linear Dependence and Wronskian – Basic Theory for linear Equations – Homogeneous Linear Equations with Constant Coefficients – Equations with Variable coefficients – Method of Variation of Parameters .	12
III	Systems of linear differential equations: Introduction - Systems of first order equations - Existence and uniqueness theorem - Fundamental matrix – Non - homogeneous linear systems - Linear systems with constant coefficients - Linear systems with periodic coefficients – Variation of Parameters.	13

IV	Solution in Power Series: Introduction – Second – order Linear Equations with Ordinary Points – Legendre Equations and Legendre Polynomials – Second – Order Equations with Regular Singular Points – Bessel's Functions.	13
V	Boundary value problem: Introduction - Strum Liouville problem - Green's function - Applications of boundary value problems - Picard's theorem.	13
References	**Text Book:** 1. S. G. Deo, V. Raghavendra, Rasmita Kar & V. Lakshmikantham, **Text book of Ordinary Differential Equations**, Third Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2016 Unit 1: Chapter 2: Sections 2.1 to 2.9 Unit 2: Chapter 4: Sections 4.1 to 4.2, 4.4 to 4.8 Unit 3: Chapter 5: Sections 5.1 to 5.9 Unit 4: Chapter 6: Sections 6.1 to 6.5 Unit 5: Chapter 8: Sections 8.1 to 8.5	
	Reference Books: 1. M.E. Taylor**, Introduction to Differential Equations**, AMS Indian Edition, 2011. 2. Earl. A. Coddington, **An Introduction to Ordinary Differential Equations**, PHI Learning Pvt. Ltd., New Delhi, 2013. 3. G. F. Simmons, S. G. Krantz, **Differential Equations: Theory, Technique and Practice**, Tata McGraw Hill Book Company, New Delhi, India, 2007. 4. M. Barun, **Differential Equations and Their Applications**, 4th Edition, Springer,1993.	
	E-Recourses: 1. https://onlinecourses.nptel.ac.in/noc18_ma10 2. https://nptel.ac.in/courses/111/107/111107111/	
Course Outcomes	On completion of the course students should be able to CO1: analyze the existence and uniqueness of solutions of Differential Equations. CO2: solve higher order ODE using various techniques. CO3: analyze the existence and uniqueness of solutions of system of Differential Equations. CO4: solve differential equations using power series method. CO5: solve boundary value problems.	

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	3
CO2	2	3	2	2	2
CO3	1	2	1	2	3
CO4	1	2	2	1	3
CO5	1	2	2	2	2

Semester	VII	Course Code	24MAUB4117
Course Title	NUMERICAL ANALYSIS		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	Core Course (Minor-7)		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	• Knowing various numerical methods to solve transcendental and polynomial equations (K1) • Understanding interpolation and curve fitting (K2) • Applying algorithms numerically (K3) • Applying numerical methods to evaluate differentiation and integration (K5)		
Course Objective	The Course aims to develop skills to solve mathematical problems in an effective and efficient manner using different numerical techniques.		

Unit	Content	No. of. Hours
I	Transcendental and polynomial equations: Rate of convergence Secant Method-Regula Falsi Method-Netwon Raphson Method- Muller Method and Chebyshev Method. Polynomial equations: Descartes' Rule of Signs-Iterative Methods: Birge-Vieta method, Bairstow's method Direct Method: Graeffe's root squaring method.	13
II	Interpolation and curve fitting: Lagrangian polynomials - Divided differences - Interpolation with cubic spline – Least square approximation of functions.	13
III	Numerical differentiation and integration: Numerical differentiation derivatives using Newton's forward and backward formula -Derivatives using Stirling's formula - Trapezoidal rule - Simpson's 1/3rd rule - 3/8 rule -Weddles's rule - Errors in quadrature formula.	13
IV	Numerical solution of ordinary differential equations: The Taylor series method – Picard's method - Euler and modified Euler methods – Runge - Kutta methods - Milne's method - The Adams - Moulton method.	13
V	Numerical solution of ordinary differential equations: The Taylor series method – Picard's method - Euler and modified Euler methods – Runge - Kutta methods - Milne's method - The Adams - Moulton method.	12
References	**Text Books:** 1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, **Numerical Methods for Scientific** and Engineering Computation, New Age International (p) Limited Publishers, New Delhi, Sixth Edition 2012. Unit 1: Chapter 2: Sections 2.5,2.9	

	2. Curtis. F. Gerald, Patrick & O. Wheatley, **Applied Numerical Analysis**, 5th Edition, Pearson Education, New Delhi, 2005 Unit 2: Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.7. 3. V. N. Vedamurthy & N. Ch. S. N. Iyengar**, Numerical Methods**, Vikas Publishing House, Pvt. Ltd., Noida, 2000. Unit 3: Chapter 9: Sections 9.1 to 9.4, 9.6 to 9.12. Unit 4: Chapter 11: Sections 11.4 to 11.20. Unit 5: Chapter 12: Sections 12.1 to 12.9.
	Reference Books: 1. R. L. Burden & J. Douglas Faires**, Numerical Analysis,** Thompson Books, USA, 2005. 2. P. Kandasamy, K. Thilagavathy & K. Gunavathi**, Numerical Methods**, S. Chand & company PVT. LTD.
	E-Recourses: 1. http://nptel.ac.in/courses/111107105/
Course Outcomes	On completion of the course students should be able to CO1: Apply different methods to solve the system of equations CO2: Realize the nature of different curves along with specified properties CO3: Utilize various types of integrals to solve many complicated problems CO4: Outline the methods to solve higher order differential equations CO5: Discuss various types of partial differential equations.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	2
CO2	3	3	3	3	2
CO3	2	2	3	3	3
CO4	3	3	2	3	1
CO5	1	2	3	3	3

Semester	**VII**	Course Code	**24MAUB4118**
Course Title	**DISCRETE MATHEMATICS**		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Minor-8)**		

Scope of the Course	Advanced Skill	
Cognitive Levels addressed by the course	• Knowing the concepts of basic principles to solve the counting problems (K1) • Understanding the permutation and combinatorial problem (K2) • Applying Inclusion-exclusion principle to real life problems. (K3) • Evaluating number theoretical problems by using number theoretic functions (K5)	
Course Objective	The Course aims to impart various concepts about permutations, combinations and theory of numbers.	
Unit	**Content**	**No. of. Hours**
I	Four basic counting principles - Permutations of sets -Combinations (subsets) of sets -Permutations of multi sets -Combinations of multi sets - Pigeonhole principle: simple form - strong form - Pascal's triangle - The binomial theorem - Unimodality of binomial coefficients - The multinomial theorem - Newton's binomial theorem.	14
II	The inclusion – exclusion principle – Combinations with repetition - Derangements – Permutations with forbidden positions – Some number sequences – Generating functions – Exponential generating functions – Solving linear homogeneous recurrence relations and non-homogeneous recurrence relations.	13
III	Divisibility theory in the integers: Early number theory -The division algorithm - The greatest common divisor - The Euclidean algorithm -The Diophantine equation. Primes and their distributions: The fundamental theorem of arithmetic -The sieve of Eratosthenes -The Goldbach conjecture.	13
IV	The theory of congruence: Basic properties of congruence - Linear congruence and the Chinese Reminder Theorem -Fermat's Theorem: Fermat's little theorem and pseudoprimes - Wilson's theorem - The Fermat-Kraitchik factorization method.	12
V	Number theoretic functions: The sum and number of divisors - The Mobius inversion formula. Euler's generalization of Fermat's theorem: Euler's Phi function-Euler's theorem - Some properties of Phi function. Primitive roots: The order of an integer modulo n - Primitive roots for primes - Composite numbers having primitive roots.	12
References	**Text Books:** 1. Richard A. Brualdi, **Introductory Combinatorics,** 5th edition, Pearson Education Inc, England, 2010. Unit 1: Chapter 2: Sections 2.1 - 2.5. Chapter 3: Sections 3.1, 3.2. Chapter 5: Sections 5.1 – 5.5. Unit 2: Chapter 6: Sections 6.1 - 6.4. Chapter 7: Sections 7.1 -7.5. 2. David M. Burton, **Elementary Number Theory**, 6th Edition, Tata McGraw Hill, New Delhi, 2006. Unit 3: Chapter 2: Sections 2.1 - 2.5, Chapter 3: Sections 3.2 - 3.3. Unit 4: Chapter 4: Sections 4.2, 4.4, Chapter 5: Sections 5.2 - 5.4. Unit5: Chapter 6: Sections 6.1, 6.2, Chapter 7: Sections 7.2, 7.3, Chapter 8: Sections 8.1 - 8.3.	

	Reference Books: 1. C. Berg, **Principles of Combinatorics**, Academic Press, New York, 1971. 2. S. Lipschutz & M. Lipson, **Discrete Mathematics**, Tata McGraw-Hill Publishing Company, New Delhi, 2006. 3. J. Truss, **Discrete Mathematics for Computer Scientists**, Pearson Education Limited, England, 1999. 4. Tom. M. Apostol, **Introduction to Analytic Number Theory**, Springer, New Delhi, 1993. 5. Thomas Koshy, **Elementary Number Theory**, Elsevier, California, 2005. 6. N. Robbins, **Beginning Number Theory**, 2nd Edition, Narosa Publishing House, New Delhi, 2007.
	E-Recourses: 1. https://www.tutorialspoint.com/discrete_mathematics/ 2. home.iitk.ac.in/~arlal/book/mth202.pdf
Course Outcomes	On completion of the course students should be able to CO1: Outline the ideas of permutations, combinations, and its properties CO2: Apply the permutations and combinations to solve problems CO3: Predict the concepts of divisibility and related algorithms CO4: Analyse the properties of congruence relations CO5: Explain the number theoretic functions

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	1	2	1	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**VIII**	Course Code	**24MAUC4220**
Course Title	**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-20)**		
Scope of the Course	Advanced Skill		

<table>
<tr><td>Cognitive Levels addressed by the course</td><td colspan="2">• Identify various basic concepts on Partial Differential Equations (K1)
• To study second order P.D.E and its Classifications (K2)
• To study the results to Laplace's Equation, Wave Equation & Heat Equation(K4)</td></tr>
<tr><td>Course Objective</td><td colspan="2">The Course aims to study in-depth concepts and applications of partial differential equations.</td></tr>
<tr><td>Unit</td><td>Content</td><td>No. of. Hours</td></tr>
<tr><td>I</td><td>First Order P.D.E: Curves and Surfaces - Genesis of First Order P.D.E. - Classification of Integrals - Linear Equations of the First Order - Pfaffian Differential Equations - Compatible Systems - Charpit's Method - Jacobi's Method.</td><td>13</td></tr>
<tr><td>II</td><td>Linear Integral Surfaces Through a Given Curve - Quasi-Linear Equations - Non-linear First Order P.D.E. Second Order P.D.E.: Genesis of Second Order P.D.E. - Classification of Second Order P.D.E.</td><td>12</td></tr>
<tr><td>III</td><td>Wave Equation: One-Dimensional Wave Equation - Vibrations of an Infinite String - Vibrations of a Semi-infinite String - Vibrations of a String of Finite Length (Method of separation of variables).</td><td>13</td></tr>
<tr><td>IV</td><td>Laplace's Equation: Boundary Value Problems - Maximum and Minimum Principles - The Cauchy Problem - The Dirichlet Problem for the Upper Half Plane - The Neumann Problem for the Upper Half Plane - The Dirichlet Interior Problem for a Circle - The Dirichlet Exterior Problem for a Circle - The Neumann Problem for a Circle - The Dirichlet Problem for a Rectangle - Harnack's Theorem .</td><td>13</td></tr>
<tr><td>V</td><td>Heat Equation: Heat Conduction Problem - Heat Conduction - Infinite Rod Case - Heat Conduction Finite Rod Case - Duhamel's Principle - Wave Equation - Heat Conduction Equation.</td><td>13</td></tr>
<tr><td rowspan="3">References</td><td colspan="2">Text Book:
1. T. Amarnath, An Elementary Course in Partial Differential Equations, 2nd Ed, Narosa Publishing Company, 2010.
Unit 1: Chapter 1: Sections 1.1 to 1.8
Unit 2: Chapter 1, 2: Sections 1.9 to 1.11 & 2.1,2.2
Unit 3: Chapter 2: Sections 2.3.1 to 2.3.5
Unit 4: Chapter 2: Sections 2.4.1 to 2.4.10
Unit 5: Chapter 2: Sections 2.5 to 2.6</td></tr>
<tr><td colspan="2">Reference Books:
1. I. N. Snedden, Elements of Partial Differential Equations, Dover, 2006.
2. F. Treves, Basic Linear Partial Differential Equations, Dover, 2006.
3. A.K. Nandakumaran and P.S. Datti, Partial Differential Equations, Classical Theory with a Modern Touch, Cambridge University Press, 2020</td></tr>
<tr><td colspan="2">E-Recourses:
1. https://onlinecourses.nptel.ac.in/noc18_ma10
2. https://nptel.ac.in/courses/111/107/111107111/</td></tr>
<tr><td>Course Outcomes</td><td colspan="2">On completion of the course students should be able to
CO1: solve different types of first order partial differential equations.</td></tr>
</table>

	CO2: classify and solve second order partial differential equations. CO3: solve wave equations using different techniques. CO4: solve different forms of Laplace equations. CO5: solve heat equations and apply in real life problems.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	1	3	2	2	3
CO3	3	2	1	3	2
CO4	2	1	2	3	3
CO5	3	3	2	2	3

Semester	**VIII**	Course Code	**24MAUC4221**
Course Title	**MATHEMATICAL METHODS**		
No. of. Credits	4	No. of. contact hours per week	4
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-21)**		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	• Knowing different methods for solving integral equations (K1) • Understanding the concepts of Fourier transformations (K2) • Applying various techniques to evaluate extreme value problems (K5)		
Course Objective	The Course aims to learn various techniques in integral equations and calculus of variations		

Unit	Content	No. of. Hours
I	Integral equations: Types of integral equations - conversion of ordinary differential equation into integral equation - Method of converting initial value problem into a Volterra integral equation - Boundary value problem - Method of converting a boundary value problem into a Fredholm integral equation – Solution of Homogeneous Fredholm integral equation of the second kind with separable kernels - Problems - Characteristic values and functions - Solutions of Fredholm integral equation of the second kind with separable kernels – Problems.	13

II	Method of successive approximations : Introduction - Iterated kernels or functions - Resolvent (or reciprocal) kernel - Solution of Fredholm integral equation of the second kind by successive substitutions - Solution of Volterra integral equation of the second kind by successive approximations - Reciprocal functions Neumann series -Solutions of Volterra integral equation of the second kind when its kernel is of some particular form - Solution of Volterra equation of the second kind by reducing to differential equation.	13
III	Singular integral equations - The solution of Abel's integral equation - Some general form of Abel's singular integral equation - Problem- Applications of integral equation and Green's functions to ordinary differential equation – Green's function- Conversion of a boundary value problem into Fredholm's integral equation - Some special cases - Examples based on construction of Green's functions and problems.	13
IV	Fourier Transforms - Definition- Inversion theorem - Fourier sine and cosine transform - Fourier transforms of derivatives - Convolution theorem - Parsevel's relation for Fourier transform and problems on self-reciprocal.	13
V	Functionals – Euler's equation – Solutions of Euler's equation – Geodesics – Isoperimetric problems – Several dependent variables – Functionals involving higher order derivatives.	12
References	**Text Books:** 1. M. D. Raisinghania, **Integral Equations and boundary value Problems**, Third Revised Edition, S. Chand & Company Ltd. New Delhi, 2010. Unit I: Chapter 2 Sections 2.1 to 2.6 and Chapter 3 Sections 3.1 to 3.3 Unit 2: Chapter 5 Sections 5.1 to 5.15 Unit 3: Chapter 8, Section 8.1 to 8.6, Chapter 11 Section 11.1 to 11.8 2. I. N. Sneddon, **The use of Integral Transform**, Tata McGraw Hill, New Delhi, 1974. Unit 4: 3. B.S. Grewal, **Higher Engineering Mathematics**, 39th edition, Khanna publishers, New Delhi, 2016. Unit 5: Chapter 33.1-33.8	
	Reference Books: 1. J. K. Goyal & K. P. Gupta, **Laplace and Fourier Transforms,** 12th Edition, Pragati Prakashan Meerukt, 2000. 2. W. V. Lovitt, **Linear Integral equations,** Dover Publications, New York, 1950. 3. F.B. Hildebrand, "**Methods of Applied Mathematics**", Prentice-Hall of India Pvt., New Delhi, 1968. 4. A.S. Gupta, "**Calculus of Variations with Application**", Prentice-Hall of India, New Delhi, 2005.	
	E-Recourses: 1. http://nptel.ac.in/courses/111107103/ 2. https://onlinecourses.nptel.ac.in/noc18_ma12 3. http://nptel.ac.in/courses/111107103/	

Course Outcomes	On completion of the course students should be able to CO1: Apply the various concepts of integral equations in various problems CO2: Discuss the solutions of various integral equations CO3: Assess various theorems with proof techniques that will motivate to develop further CO4: Create different functions based on applications CO5: Apply different transformation techniques in solving problems.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	3
CO2	3	3	3	2	3
CO3	1	1	3	2	3
CO4	2	3	2	3	2
CO5	3	2	1	3	3

Semester	**VIII**	Course Code	**24MAUC4222**
Course Title	**PROJECT REPORT**		
No. of. Credits	12	No. of. contact hours per week	12
New Course/ Revised Course	--	If revised, Percentage of Revision effected (Minimum 20%)	--
Category	**Core Course (Major-22)**		