KG COLLEGE OF ARTS AND SCIENCE
Autonomous Institution | Affiliated to Bharathiar University
Accredited with A++ Grade by NAAC
ISO 9001:2015 Certified Institution
KGiSL Campus, Saravanampatti, Coimbatore – 641 035

Regulations 2024-25 for Postgraduate Programme

Learning Outcomes Based Curriculum Framework (LOCF) model with

Choice Based Credit System (CBCS)

Programme: M.Sc. Mathematics

Programme Code: MMA

(Applicable for the Students admitted during the academic year 2024 – 25 onwards)

Eligibility

The student should have passed B.Sc. Mathematics/with Computer Application / Applied Mathematics.
(As per the eligibility conditions given by Bharathiar University Ref. BU/R/B3-B4/ Eligibility Condition/2024/9206 dated 24/05/2024).

Program Learning Outcomes (PLOs)

The successful completion of the M.Sc. Mathematics programme shall enable the students to:

PLO1	Hone mathematical reasoning, problem-solving skills and digital literacy which paves way to become a software developer.
PLO2	Explore core mathematics with profound learning that nurtures the research skills.
PLO3	Engage with mathematical softwares which demonstrates a dedication to continuous learning in mathematics.
PLO4	Incorporate collaboration with non-profit organizations and government bodies through internships and industry partnerships.
PLO5	Demonstrate ethical and professional values in providing services in the relevant field including entrepreneurial skills.

M.Sc. Mathematics

Distribution of Credits and Hrs. for all the semesters

Part	Course Category	No. of Courses	Hours		Credits		Total Credits	Semester
III	Core Theory (6 hrs./week)	8	8 X 6	48	8 X 4	32	74	1 – 3
	Core Theory (5 hrs./week)	3	3 X 5	15	3 X 4	12		1,3 ,4
	Core Lab (Embedded)	2	2 X 7	14	2 X5	10		3 ,4
	Core Lab (3 hrs./week)	1	1 X 3	3	1 X 2	2		2
	Elective (5 hrs./week)	2	2 X 5	10	2 X 3	6		1 , 2
	Elective (4 hrs./week)	2	2 X 4	8	2 X 3	6		3 , 4
	Project	1	1 X 10	10	1 X 6	6		4
	Skill Enhancement (SEC)	3	3 X 2	6	3 X 2	6	6	2 - 4
	Internship	-	-	-	1 X 2	2	2	3
IV	Ability Enhancement Compulsory Course (AECC)	4	3 X 2	6	4 X 2	8	8	1 - 4
	Total	**26**		**120**		**90**	**90**	

Consolidated Semester wise and Component wise Hours and Credits Distribution

Semester	Part III		Part IV		Total	
	Hrs.	Credits	Hrs.	Credits	**Hrs.**	**Credits**
1	28	19	2	2	30	**21**
2	28	19	2	2	30	**21**
3	30	24	-	2	30	**26**
4	28	20	2	2	30	**22**
Total	**114**	**82**	**6**	**8**	**120**	**90**

Curriculum

M.Sc. Mathematics

Semester – 1									
Course Code	**Part**	**Course Category**	**Course Name**	**Hrs./ week**	**Examination**				**Credits**
					Duration in hrs.	**Max Marks**			
						CIA	**ESE**	**Total**	
24MMA11C	III	Core – I	Abstract Algebra	6	3	25	75	100	4
24MMA12C	III	Core – II	Real Analysis	6	3	25	75	100	4
24MMA13C	III	Core – III	Ordinary Differential Equations	6	3	25	75	100	4
24MMA14C	III	Core – IV	Mechanics	5	3	25	75	100	4
24MMA1AE	III	Elective – I	Number Theory and Cryptography	5	3	25	75	100	4
24MMA1BE			Differential Geometry						
24MMA1CE			Mathematical Methods						
24QUA1AE	IV	AECC – I	Quantitative Aptitude	2	2	-	50	50	2
Total				**30**				**550**	**22**

Semester – 2									
Course Code	**Part**	**Course Category**	**Course Name**	**Hrs. / week**	**Examination**				**Credits**
					Duration in hrs.	**Max Marks**			
						CIA	**ESE**	**Total**	
24MMA21C	III	Core – V	Linear Algebra	6	3	25	75	100	4
24MMA22C	III	Core – VI	Partial Differential Equations	6	3	25	75	100	4
24MMA23C	III	Core – VII	Computer Programming C++ - Theory	6	3	25	75	100	4
24MMA24P	III	Core Lab –I	**Lab :** Computer Programming C++ - Lab	3	3	40	60	100	2
24MMA2AE	III	Elective – II	Fuzzy Logic and Fuzzy Sets	5	3	25	75	100	4
24MMA2BE			Elements of Stochastic Process						
24MMA2CE			Algebraic Geometry						
24MMA25P	III	SEC Lab - I	**Lab:** Computational Mathematics using SageMath	2	3	40	60	100	2
24SOF2AE	IV	AECC - II	Soft Skills	2	2	-	50	50	2
			Total	**30**				**650**	**22**

Semester – 3									
Course Code	**Part**	**Course Category**	**Course Name**	**Hrs. / week**	**Examination**				**Credits**
					Duration in hrs.	**Max Marks**			
						CIA	**ESE**	**Total**	
25MMA31C	III	Core – VIII	Topology	6	3	25	75	100	4
25MMA32C	III	Core – IX	Mathematical Statistics	6	3	25	75	100	4
24MMA33P	III	Core Lab –II (Embedded)	Numerical Analysis	3	3	40	60	100	5
	III		Numerical Analysis using C++ Programming	4					
25MMA34C	III	Core- X	Fluid Dynamics	5	3	25	75	100	4
25MMA3AE/ 25MMA3BE/ 25MMA3CE/	III	Elective –III	Neural Networks / Control Theory / Mathematical Methods	4	4	25	75	100	3
25MMA35S	III	SEC Lab – II	**Lab:** Mathematical Documentation using LaTeX	2	3	40	60	100	2
25MMA37I	III	SEC	Internship / Institutional Training	-	-	50	-	-	2
25MOO3AE	IV	AECC– III	Online Course – MOOC	–	-	-	-	-	2
Total				**30**				**600**	**26**

Semester – 1

Course code	Course Name	Category	Hours / Week	Credits
24MMA11C	Abstract Algebra	Core - I	6	4

Course Objectives

The Course intends to cover

- Various algebraic structures.
- Galois Theory and its application to the solvability of polynomial equations by radicals.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand Sylows' theorem and its applications.	K2
CLO2	Understand the concept of various rings.	K2
CLO3	Apply polynomials over rational fields and splitting fields	K3
CLO4	Analyze Galois theory over the rationals to ensure secure communications and reliable data transmission enhances competency skill of a coder and a cryptographer.	K4
CLO5	Understand the basic concepts of solvability by radicals and finite fields.	K2
K2 - Understand; **K3** - Apply; **K4** - Analyze		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	1	1	1	2
CLO2	3	3	2	1	1
CLO3	2	1	3	2	3
CLO4	2	1	3	3	3
CLO5	1	2	2	3	2
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - I: Abstract Algebra

Unit	Content	No. of Hours
I	Counting Principle - Another Counting Principle, Sylow's Theorem – 1st, 2nd and 3rd parts of Sylow's Theorems – double coset – the normalizer of a group.	18
II	Direct Products - External and Internal direct Products, Euclidean Rings, A Particular Euclidean Ring, Polynomial rings.	18
III	Polynomials over rational fields – extension fields – roots of polynomials – splitting fields.	18
IV	Roots - more about roots – simple extension – fixed fields – symmetric rational functions – normal extension - Galois group – fundamental theorem of Galois theory.	18
V	Solvability by radicals- Solvable group – the commutator subgroup – Solvability by radicals - Finite fields.	18
	Total Hours.	**90**
Text Book		
1.	I.N. Herstein. (2006). Topics in Algebra (Ed. 2), John Wiley and Sons. Unit I: Chapter 2: Sections 2.5, 2.11, 2.12 Unit II: Chapter 2: Section 2.13 Chapter 3 : Sections 3.7 - 3.9 Unit III: Chapter 3 : Section 3.10 Chapter 5 : Sections 5.1,5.3 Unit IV: Chapter 5 : Sections 5.5,5.6 Unit V: Chapter 5 : Section 5.7 Chapter 7 : Section 7.1	
Reference Books		
1.	Serge Lang. (1993, 2005). Algebra, Addison-Wesley, MA.	
2.	John B. Fraleigh. (1982, 2003). A First Course in Abstract Algebra, Addison Wesley, MA.	
3.	M. Artin. (1991, 2015). Algebra, Prentice-Hall of India, New Delhi.	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/111105112	

Course code	Course Name	Category	Hours / Week	Credits
24MMA12C	Real Analysis	Core - II	6	4

Course Objectives

The Course intends to cover

- Function of a real variable using Riemann Stieltjes integral and gain its properties.
- The validation of convergence theorems along with their practical applications.
- Lebesgue measure, measurable functions, and the Lebesgue integral.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Apply the concepts of continuity, compactness and connectedness of functions in solving related problems.	K3
CLO2	Remember the derivatives of vector valued functions.	K1
CLO3	Apply the Riemann Stieltjes integral and bring its properties and rectifiable curves.	K3
CLO4	Evaluate advanced uniform convergence with related theorems.	K5
CLO5	Evaluate the derivatives of higher order differentiation and determinants.	K5
K1 – Remember; **K3** - Apply; **K5** - Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	1	2	2	3	1
CLO2	3	2	2	1	2
CLO3	1	2	3	1	2
CLO4	1	2	3	1	2
CLO5	2	1	3	2	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - II: Real Analysis

Unit	Content	No. of Hours
I	Limits of functions-Continuous functions-Continuity and Compactness- Continuity and Connectedness- Discontinuities- Monotonic functions- Infinite limits and Limits at Infinity.	18
II	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	18
III	Definition and existence of the integral – Properties of the integral – Integration and differentiation – Integration of vector-valued functions – Rectifiable curves.	18
IV	Uniform convergence-Uniform convergence and continuity – Uniform convergence and integration – Uniform convergence and differentiation – Equi-continuous families of functions – The Stone - Weierstrass theorem.	18
V	Linear transformations –Differentiation - The contraction principle – The inverse function theorem – The implicit function theorem –Determinants – Derivatives of higher order – Differentiation of integrals.	18
	Total Hours.	**90**
Text Book		
1.	W. Rudin (1976, 2013). Principles of Mathematical Analysis, McGraw Hill, New York. Unit I: Chapter 4 : Pg. No. : 83-97 Unit II Chapter 5: Pg. No. : 103-113 Unit III: Chapter 6: Pg. No. : 120-137 Unit V: Chapter 5: Pg. No. : 147-164 Unit V: Chapter 6: Pg. No. : 204-228, 231-237	
Reference Books		
1.	R.G. Bartle, Elements of Real Analysis, John Wily and Sons, New York.	
2.	Walter Rudin. (1986, 2023). Real and Complex Analysis, McGraw-Hill, New York.	
3.	H. L. Roydon (1988), Real Analysis , Macmillan, New York.	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/111101100	

Course code	Course Name	Category	Hours / Week	Credits
24MMA13C	Ordinary Differential Equations	Core - III	6	4

Course Objectives

The Course intends to cover

- The theory and methods of ordinary differential equations.
- The methods taught and implement to work associated problems, including proving results of suitable accessibility.
- The Existence and Uniqueness Theorem and its ramifications.
- Problems arising from many applications such as mathematical models of physical or engineering processes.
- The application of the methods of undetermined coefficients and variation of parameters.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Analyze the basic theory of linear ODEs, for which exact solutions may be obtained to calculate the flow of electricity and thermodynamics concept.	K4
CLO2	Analyze ODEs and system of ODE concepts that can be solved using the process of modeling to handle different situations of population problems, falling objects and mixing problems.	K4
CLO3	Apply the obtained solutions in terms of the physical quantities involved in the original problem under reference.	K3
CLO4	Evaluate particular integral solutions to differential equations with given boundary conditions or initial conditions.	K5
CLO5	Evaluate the convergence of successive approximations.	K5
K3- Apply; **K4** - Analyze; **K5** - Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	2	3	3	2
CLO2	3	3	3	2	1
CLO3	2	3	3	2	2
CLO4	2	3	3	3	3
CLO5	2	3	3	2	1
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - III: Ordinary Differential Equations

Unit	Content	No. of Hours
I	The second order homogeneous equations – Initial value problems – Linear dependence and independence - A formula for the Wronskian – The non-homogeneous equation of order two.	18
II	Homogeneous and non–homogeneous equations of order n – Initial value problems – Annihilator method to solve a non–homogeneous equation – Algebra of constant coefficient operators.	18
III	Initial value problems for the homogeneous equation- Solutions of the homogeneous equation – The Wronskian and linear independence –Reduction of the order of a homogeneous equation - Homogeneous equation with analytic coefficients – The Legendre equation.	18
IV	Euler equation - Second order equations with regular singular points – Exceptional cases – Bessel equation.	18
V	Equation with variables separated– Exact equations – The method of successive approximations – The Lipschitz condition –Convergence of the successive approximations.	18
	Total Hours.	**90**
Text Book		
1.	E.A. Coddington. (2023). An Introduction to Ordinary Differential Equations, Prentice Hall of India Ltd., New Delhi. Unit I : Chapter II Sections : 2.1 – 2.6 Unit II : Chapter II Sections : 2.8 – 2.12 Unit III : Chapter III Sections : 3.2 – 3.8 Unit IV : Chapter II Sections : 4.2 – 4.7 Unit V : Chapter IV Sections : 5.1 – 5.6	
Reference Books		
1.	S.C. Deo, Lakshminathan.V. Raghavendra.V. (2017). Textbook of Ordinary Differential Equation, Tata McGraw Hill, New Delhi.	
2.	P. Hartman, Ordinary Differential Equations, Wiley, New York.	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/111107111	

Course code	Course Name	Category	Hours / Week	Credits
24MMA14C	Mechanics	Core – IV	5	4

Course Objectives

The Course intends to cover

- A solid foundation for understanding basic principles of mechanics and some classical problems.
- Lagrangian and Hamiltonian formulations of classical mechanics thoroughly.
- The importance and consequences of canonical transformations.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Analyze Lagrange's equation using elementary calculus	K4
CLO2	Analyze Hamilton-Jacobi theory in identifying conserved quantities for a mechanical system, even when the problem is not solvable.	K4
CLO3	Apply canonical transformation in Keplers' problem.	K3
CLO4	Apply techniques like least action principles and calculus of variations on to understand the motion of objects.	K3
CLO5	Evaluate differential forms and generating functions which is used in checking the numerical models that gives valuable insights to rock mechanics.	K5
K3 - Apply; **K4** – Analyze; **K5** - Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	1	1	2	2
CLO2	2	1	1	3	2
CLO3	1	1	1	2	1
CLO4	2	1	1	2	2
CLO5	2	2	2	3	2
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - IV: Mechanics

Unit	Content	No. of Hours
I	The mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and momentum.	15
II	Derivations of Lagrange's equations- Examples –Integrals of the motion.	15
III	Hamilton's principle – Hamilton's equations.	15
IV	Hamilton's principle function –The Hamilton - Jacobi equation – Separability.	15
V	Differential forms and generating functions – Lagrange and Poisson brackets.	15
	Total Hours.	**75**
Text Book		
1.	D.T. Greenwood, Classical Dynamics, Dover. Unit I : Chapter 1 : Sections: 1.1 -1.5 Unit II: Chapter 2 : Sections: 2.1 -2.3 Unit III: Chapter 4 : Sections: 4.1 - 4.2 Unit IV: Chapter 5 : Sections: 5.1 -5.3 Unit V : Chapter 6 : Sections: 6.1 & 6.3	
Reference Books		
1.	Goldstein. H., Poole. C., Safko. J. (2002). Classical Mechanics, Pearson Education, Inc., New Delhi.	
2.	R. Douglas Gregory(2006). Classical Mechanics, Cambridge University Press.	
Web Resources (Swayam / NPTEL)		
1.	https://onlinecourses.nptel.ac.in/noc20_ph18/preview	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA1AE	Number Theory and Cryptography	Elective – IA	5	4

Course Objectives

The Course intends to cover

- Basic ideas of number theory, and to use this as a context in which to discuss the development of mathematics through examples, conjectures, theorems, proofs and applications.
- Different methods of proof in the context of elementary number theory, and will apply some basic techniques of number theory to cryptography with illustration.
- The working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Remember and understand various properties of and relating to the integers including the well ordering principle, primes, unique factorization, the division algorithm, and greatest common divisors.	K1, K2
CLO2	Understand the concept of congruence and use various results related to congruencies.	K2
CLO3	Analyze the use of public key cryptography in key exchange ecology.	K4
CLO4	Apply standard algorithms which is used to provide confidentiality, integrity and authenticity.	K3
CLO5	Understand how to deploy encryption techniques to secure data in transit across data networks.	K2
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** – Analyze		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	2	3	3	3
CLO2	3	3	2	3	3
CLO3	3	2	3	2	1
CLO4	2	3	3	3	3
CLO5	3	3	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective IA: Number Theory and Cryptography

Unit	Content	No. of Hours
I	Number theory - Time estimates for doing arithmetic - divisibility and euclidean algorithm – congruences - some Applications to factoring.	15
II	Finite Fields – Quadratic Residues and Reciprocity.	15
III	Cryptography – some simple cryptosystems – Enciphering matrices – idea of public key cryptography – RSA.	15
IV	Primality and factoring - Pseudo primes and Strong Pseudo primes – The rho method – Fermat factorization and factor bases and Algorithm – The Continued fraction method and Algorithm.	15
V	Elliptic Curves – Basic Facts, Elliptic curves Cryptosystems	15
	Total Hours.	**75**
Text Book		
1.	Neal, Koblitz. (2012), A Course in Number Theory and Cryptography, Springer – Verlag. Unit I: Chapter 1 : Pg. No. : 1-30 Unit II: Chapter 2: Pg. No. : 31-53 Unit III: Chapter 3: Pg. No. : 54-96 Unit IV: Chapter 5: Pg. No. : 125-159 Unit V: Chapter 6: Pg. No. : 167-186	
Reference Books		
1.	Ivan Nivan and Herbert S. Zuckerman. (1972, 1991)., An Introduction to Theory of Numbers, Wiley Eastern Limited, New Delhi.	
2.	Tom Apostol, Introduction to Analytic Number Theory, Narosa Publications, New Delhi.	
3.	William Stallings. (2011). Cryptography and Network Security Principles and Practice, Prentice Hall.	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/106103015	

Course code	Course Name	Category	Hours / Week	Credits
24MMA1BE	Differential Geometry	Elective – IB	5	4

Course Objectives

The Course intends to cover

- A Systematic exposition of the essential concepts of modern differential geometry.
- The geometric objects like curves and surfaces in three dimensional space.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the representations of curves, curvature properties, existence and uniqueness of curves.	K2
CLO2	Apply the helical method to solve natural equation.	K3
CLO3	Analyze evolutes and involutes.	K4
CLO4	Evaluate the geometric surface using differential geometric problems.	K5
CLO5	Create the curvature of skew sections in terms of the obliquity.	K6
K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	1	2	3	1	3
CLO2	2	1	3	2	3
CLO3	3	2	3	3	3
CLO4	2	3	3	3	3
CLO5	3	3	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective – IB: Differential Geometry

Unit	Content	No. of Hours
I	Curves- Analytic representation - Arc Length – Osculation plane - Curvature torsion – Formula of Frenet.	15
II	Contact – Natural equations – Helices – General solutions of Natural equations - Evolutes and Involutes.	15
III	Elementary theory of surface- Analytic representation - First fundamental form – Normal, Tangent plane – Developable surfaces.	15
IV	Second fundamental form - Meusnier's theorem – Eule's Theorem – Dupin's indicatrix – Some surfaces.	15
V	The Fundamental Equations – Gauss - The equation of Gauss – Weingarten - The theorem of Gauss and the equations of Codazzi - Some applications of the Gauss and Codazzi equations.	15
	Total Hours.	**75**
Text Book		
1.	D. Struik (1988). Lectures on Classical Differential Geometry, Addison Wesley Publishing Company. Unit I: Chapter 1: Section: 1.1-1.6 Unit II: Chapter 1: Section: 1.7 -1.11 Unit III: Chapter 2: Section: 2.1-2.4 Unit IV: Chapter 2: Section: 2.5- 2.8 Unit V: Chapter 3: Section: 3.1-3.6	
Reference Books		
1.	Bär, Christian (2011). Elementary Differential Geometry, Cambridge University Press.	
2.	T.J.Willmore,(2002). An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi. (Indian Print)	
3.	J.A. Thorpe, (1979). Elementary topics in Differential Geometry, Under- graduate Texts in Mathematics, Springer – Verlag.	
4.	Kobayashi. S. and Nomizu. K.(1963). Foundations of Differential Geometry, Inter science Publishers.	
Web Resources (Swayam / NPTEL)		
1.	https://www.youtube.com/watch?v=p3QG7T0nNBU	

Course code	Course Name	Category	Hours / Week	Credits
24MMA1CE	Mathematical Methods	Elective – IC	5	4

Course Objectives

The Course intends to cover

- The fundamentals of integral transforms, integral equations and calculus of variations.
- Integral transforms, integral equations and calculus of variations as tools for problem solving.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the basic properties of Fourier and Hankel transforms which helps to transform signals between two domains.	K2
CLO2	Understand and apply the classical Fredholm theory which is used generate photo realistic image in computer graphics.	K2, K3
CLO3	Evaluate Volterra integral equations.	K5
CLO4	Analyze the abel integral equations.	K4
CLO5	Evaluate functionals dependent on higher order derivatives	K5
K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	1	1	2	2
CLO2	2	1	1	2	2
CLO3	1	1	1	2	3
CLO4	1	1	1	2	3
CLO5	2	2	1	1	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective – IC: Mathematical Methods

Unit	Content	No. of Hours
I	Fourier Transforms – Definition- Inversion theorem – Fourier cosine transforms - Fourier sine transforms – Fourier transforms of derivatives - Fourier transforms of some simple functions - Fourier transforms of rational functions – The convolution integral – convolution theorem – Parseval's relation for Fourier transforms – solution of PDE by Fourier transform. Laplace's Equation in Half plane Laplace's Equation in an infinite strip The Linear diffusion equation on a semi-infinite line The two-dimensional diffusion equation.	15
II	Definition of Elementary properties of Hankel Transforms - Hankel Transforms of Derivatives of functions - Hankel Transforms of some elementary functions - The Parseval relation for Hankel transforms – Relation between Fourier and Hankel transforms – Application to PDE. Axisymmetric Dirichlet problem for a half – space. Axisymmetric Dirichlet problem for a thick plate	15
III	Types of Integral equations – Equation with separable kernel - Fredholm Alternative Approximate method – Volterra integral equations – Classical Fredholm theory – Fredholm's First, Second, Third theorems.	15
IV	Initial value problems – Boundary value problems – singular integral equations – Abel Integral equation.	15
V	Variation and its properties – Euler's equation – Functionals of the integral forms Functional dependent on higher order derivatives – functionals dependent on the functions of several independent variables – variational problems in parametric form.	15
	Total Hours.	**75**
Text Books		
1.	Ian Sneddon., The Use of Integral Transforms, Tata Mc Graw Hill Unit I : Chapter 2 : Section 2.3 – 2.5 Chapter 3 : Section 3.3 – 3.4 Unit II : Chapter 5 : Section 5.1 – 5.2 , Chapter 8 : Section 8.1 – 8.2	
2.	R.P. Moscow Kanwal, Linear Integral Equations Theory and Techniques, Academic Press. Unit III : Chapter 2: Page No. 46-50 Unit IV : Chapter 3: Page No. 51 - 54	
3.	L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers. Unit V : Chapter 6: Section 6.1-6.7	
Reference Book		
1.	Lokenath Debnat., Dambaru Bhatta (2007)., Integral Transforms and their Applications, Taylor & Francis, London	
Web Resources (Swayam / NPTEL)		
1.	https://archive.nptel.ac.in/courses/111/107/111107098/	

Components for Internal Assessment and Distribution of Marks for CIA and ESE (Theory)

Max Marks	Marks for		Components for CIA									
	CIA	ESE	CIA – I		CIA – II		Best of CIA-I & CIA-II	Model		Attendance	Active Engagement	Total
100	25	75	Actual	Weightage	Actual	Weightage	Weightage	Actual	Weightage	5	5	25
			50	5	50	5	5	75	10			

Question Paper Pattern

Component	Duration in Hrs.	Section A			Section B			Section C			Total
		Type of question	No. of questions	Marks	Type of question	No. of questions	Marks	Type of question	No. of questions	Marks	
CIA – I &II	2	MCQ	8	8x1=8	Either or	3	3x6=18	Either or	3	3x8=24	50
Model Exam /ESE	3	MCQ	10	10x1=10	Either or	5	5x5=25	Either or	5	5x8=40	75

Components for Internal Assessment and Distribution of Marks for CIA and ESE (Lab)

Max Marks	Marks for		Components for CIA							
	CIA	ESE	Test – I		Test - II		Model		Observation	Total
100	40	60	Actual	Weightage	Actual	Weightage	Actual	Weightage	5	40
			50	10	50	10	60	15		

Examination Pattern

Component	Duration in Hrs.	No. of experiments	Marks			Weightage
			Practical	Record	Total	
Test - I	1	1	50	-	50	10
Test - II	1	1	50	-	50	10
Model	3	2	60	-	60	15
ESE	3	2	50	10	60	-

Part – IV : Ability Enhancement Compulsory Courses

(All the Undergraduate Programmes)

Course Code	Course Name	Category	Hours/Week	Credits
24QUA1AE	Quantitative Aptitude	AECC - I	2	2

Course Objectives

The course intends to cover

- Basic concepts of numbers, time and work, interests, data representation and graphs
- Concepts of permutation, probability, discounts, percentage & profit loss.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Remember and Understand the concepts of numbers and average	K1, K2
CLO2	Understand about percentage and apply profit & loss related processing.	K2, K3
CLO3	To understand the concepts of time and work and interest calculations.	K2
CLO4	To understand about the concepts of permutation, combination and probability.	K2
CLO5	Understand , Apply and analyze the concept of problem solving involved in graphs and age.	K2,,K3,K4
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** -Analyze		

Ability Enhancement Compulsory Course - I: Quantitative Aptitude

Unit	Content	No. of Hours
I	Numbers - Simplification - BODMAS rule - Algebraic formulas - Decimal fractions - Square root and cube roots - Surds and indices - Divisibility rules - HCF and LCM - same remainder - different remainder - application problems – average – equation - mistaken value – replacement - including/excluding.	6
II	Percentage - increase/decrease – netchange – salary – election – marks – consumption - population / machine - profit and loss - profit and loss % - finding cp and sp - profit=loss - same product cp and sp with percentage – discount - ratio and proportion - divided into parts - based on numbers - increase/decrease/ income / expenditure – coins – partnership.	6
III	Time-and-work - individual/combined - alternative days - remaining work - efficiency based - amount split - chain rule - group of male and female or boys - pipes and cistern - finding time - efficiency based – alternative - remaining part - capacity of the tank - simple interest - finding principal - rate of interest – amount - time period - doubles or triples - compound interest - finding rate - finding time, principal - doubles or triples - difference between SI and CI.	6
IV	Permutation - finding value - vowels come together - vowel never comes together -some letters come together - no two vowels come together - vowels in odd/even places - based on repetition - circular permutation – application – combination - finding value and application – probability – coins - dice-cards - balls and miscellaneous problems - odd man out and number series.	6
V	Clock - finding angle - reflex angle - gain or loss – calendars - finding particular day - data interpretation - bar chart - line chart - pie chart – table – combined –ages ratio-twice or thrice - addition /subtraction - family based - problems on numbers - equations.	6
	Total Hours	**30**
Text Book		
1.	R.S. Aggarwal , Quantitative Aptitude, S.Chand & Company Ltd.,	
Reference Book		
1.	Ashish Arora, Quantitative Aptitude.	
Web Resources		
1.	https://www.javatpoint.com/aptitude/quantitative	
2.	https://www.indiabix.com/aptitude/questions-and-answers/	

Components for and Distribution of Marks for ESE (Theory)

Ability Enhancement Compulsory Course(AECC)

Duration in Hrs.	Mode of exam	Type of Questions	No. of Questions	Marks
2	Online	MCQ	50	50x1=50

Semester – 2

Course Code	Course Name	Category	Hours / Week	Credits
24MMA21C	Linear Algebra	Core – V	6	4

Course Objectives

The Course intends to cover

- Linear Transformations, Algebra of Polynomials, Invariant space and their properties.
- The canonical forms of linear transformations, diagonalizations of linear transformations, matrices and determinants.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the basic concepts of Linear transformations, characteristic roots and matrices of linear transformation and its applications.	K2
CLO2	Analyze the algebra of polynomials, polynomial ideals and prime factorization of a polynomial.	K4
CLO3	Understand the basic concepts of determinants and its additional properties.	K2
CLO4	Apply the concepts of Invariant subspaces and diagonalization process to find eigen values.	K3
CLO5	Analyze canonical Form, Jordan Form and Rational canonical Form, where the canonical form is used to predict data in medical diagnosis.	K4
K2 - Understand; **K3** - Apply; **K4** – Analyze		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	3	2	1	3
CLO2	2	3	3	2	1
CLO3	3	3	2	1	3
CLO4	1	2	1	3	2
CLO5	2	3	3	2	1
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - V: Linear Algebra

Unit	Content	No. of Hours
I	Linear transformations – Isomorphism of vector spaces – Representations of linear transformations by matrices – Linear functionals	18
II	The algebra of polynomials –Polynomial ideals - The prime factorization of a polynomial - Determinant functions.	18
III	Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values – Annihilating polynomials.	18
IV	Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct-sum decompositions – Invariant direct sums – Primary decomposition theorem.	18
V	Cyclic subspaces – Cyclic decompositions theorem (Statement only) – Generalized Cayley – Hamilton theorem - Rational forms – Jordan forms.	18
	Total Hours.	**90**
Text Book		
1.	Kenneth M Hoffman., Ray Kunze. (2013). Linear Algebra, Prentice-Hall of India Pvt. Ltd. Unit I: Chapter 3 : Sections 3.1-3.5 Unit II: Chapter 4 : Sections 4.1 & 4.2, 4.4 & 4.5 Chapter 5 : Sections 5.1, 5.2 Unit III: Chapter 5 : Sections 5.3, 5.4 Chapter 6 : Sections 6.1-6.3 Unit IV: Chapter 6 : Sections 6.4 - 6.8 Unit V: Chapter 7 : Sections 7.1 – 7.3	
Reference Books		
1.	M. Artin(2005). Algebra, Prentice-Hall of India Pvt. Ltd.,	
2.	I.N. Herstein (2013).Topics in Algebra, Wiley Eastern Ltd, New Delhi.	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/111/106/111106051/	

Course code	Course Name	Category	Hours / Week	Credits
24MMA22C	Partial Differential Equations	Core – VI	6	4

Course Objectives

The Course intends to cover

- The partial differential equations as models of various physical processes such as mechanical vibrations, transport phenomena and electrostatics.
- The partial differential equation (PDE) models, which will be developed in the context of modelling heat and mass transport and, in particular, wave phenomena, such as sound and water waves.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand and remember the physical situations with real world problems to construct mathematical models using partial differential equations and study the methods to solve.	K1, K2
CLO2	Analyze the type of partial differential equations and different methods to solve.	K4
CLO3	Evaluate the appropriate method to solve the partial differential equations applicable in electrostatics, fluid flow.	K5
CLO4	Evaluate Laplace equation and analyze its applications in astrophysics, heat conduction and electric potentials.	K5
CLO5	Apply variable separable method to solve Laplace equation.	K3
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** – Analyze; **K5** - Evaluate; **K6** – Create		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	2	2	1	2
CLO2	2	2	3	2	3
CLO3	1	3	2	3	3
CLO4	2	3	2	3	3
CLO5	2	3	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - VI: Partial Differential Equations

Unit	Content	No. of Hours
I	Partial differential equations- origins of first order Partial differential equations- Cauchy's problem for first order equations- Linear equations of the first order- Integral surfaces Passing through a Given curve- surfaces Orthogonal to a given system of surfaces.	18
II	Non-linear Partial differential equations of the first order-Cauchy's method of characteristics- compatible systems of first order equations- Charpits method- Special types of first order equations- Solutions satisfying given conditions- Jacobi's method.	18
III	Partial differential equations of the second order-Linear partial differential equations with constant co-efficient- Equations with variable coefficients- Characteristic curves of second order equations.	18
IV	The method of Integral Transforms-Deduction of the Definition of the Laplace Transform from that of the Integral Transform-Definition of the Laplace Transform-Some Methods for Finding Laplace Transforms-Fourier's Integral -The Fourier Transforms-Definition of Infinite Hankel Transform-Hankel Transform of the Derivatives of a Function.	18
V	Laplace equation-Elementary solutions of Laplace's equations-Families of equipotential Surfaces- Boundary value problems.	18
	Total Hours.	**90**
Text Book		
1.	Ian N. Sneddon (2006). Elements of Partial differential equations, Dover Publication –Inc. Unit I : Chapter II Sections : 2.1 – 2.6 Unit II : Chapter II Sections : 2.7 – 2.13 Unit III : Chapter III Sections : 3.4 – 3.6 Unit IV : Chapter II Sections : 3.10 Unit V : Chapter IV Sections : 4.2 – 4.4	
Reference Books		
1.	M.D. Raisinghania. (2001). Advanced Differential Equations , S.Chand and company Ltd., 2001.	
2.	E.T. Copson. Partial Differential Equations, Cambridge University Press.	
Web Resources (Swayam / NPTEL)		
1.	https://archive.nptel.ac.in/courses/111/101/111101153/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA23C	Computer Programming C++ - Theory	Core – VII	6	4

Course Objectives

The Course intends to cover

- An awareness of the object oriented programming.
- C++ programs using classes, functions and interfaces.
- Applications using C++ programs.

Course Learning Outcome

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand and apply the C++ structure, tokens, expressions, control structures.	K2, K3
CLO2	Apply various prototyping, friend and virtual functions	K3
CLO3	Create Classes, objects, arrays of objects, constructors, and Destructors.	K6
CLO4	Analyze overloading operators and inheritance in the matrix.	K4
CLO5	Create, design and develop quality programs in C++.	K6
K2 - Understand; **K3** - Apply; **K4** – Analyze; **K6** - Create		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	2	3	2	2
CLO2	2	3	2	3	2
CLO3	2	2	1	2	3
CLO4	2	3	3	1	3
CLO5	2	3	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - VII: Computer Programming C++ - Theory

Unit	Content	No. of Hours
I	**Basic Concept of Object-Oriented Programming**- Basic Concept of OOPS- Benefits of OOP – Applications of OOP. **Tokens, Expressions and Control Structure:** Introduction – Tokens – Keywords – Identifiers and Constants – Basic Data Types – User Defined Data Types – Derived Data Types – Declaration of Variables – Dynamic Initialization of Variables – Reference Variables – Operators - Scope Resolution Operator- Control Structures	18
II	**Functions in C++:** Introduction – The Main Function – Function Prototyping – Call by Reference– Return by Reference – Inline Functions – Default Arguments – const Arguments – Recursion – Function Over Loading – Friend and Virtual Functions – Math Library Functions.	18
III	**Classes and Objects:** Introduction – C Structures Revisited – 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 –Arrays of Objects – Objects as Function Arguments – Friend Functions. Constructors and **Destructors:** Introduction – Constructors – Parameterized Constructors – Multiple Constructors in a Class – Constructors with Default Arguments – Dynamic Initializations of Objects – Copy Constructor – Destructors.	18
IV	**Operator Overloading**: Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends – Manipulating of Strings Using Operators – Rules for Overloading Operators. **Inheritance - Extending Classes**: Introduction – Defining Derived Classes – Single Inheritance – Making a Private Member Inheritable – Multilevel Inheritance – Multiple Inheritance – Hierarchical Inheritance – Hybrid Inheritance – Virtual Base Classes – Abstract Classes.	18
V	**Streams:** Introduction – C++ Streams – C++ Stream Classes. Working with files: Classes for File Stream Operations - Opening and Closing a File – File Modes – File Pointers and their Manipulations – Sequential Input and Output Operations – Random Access.	18
	Total Hours.	**90**
Text Book		
1.	E. Balaguruswamy, Object–Oriented Programming with C++, Tata McGraw Hill Publishing Company Limited.	
Reference Books		
1.	D. Ravichandran, Programming with C++, Tata McGraw Hill publishing company limited, New Delhi.	
2.	S.S. Vinod Chandra, Object Oriented Programming with C++, New age.	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/106/105/106105151/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA24P	Computer Programming C++ - Practical	Core Lab – I	3	2

S. No.	List of Programs
1.	Friend **function** usage: Create two classes to store the value of distances in meters, centimeters and feet-inches. Write a program that can create the values of the class objects and add one object with another. Use a friend function to carry out addition operation. The result may be stored in any object depending on the units in which results are required. The display should be in the order of meters & centimeter and feet & inches depending on the order of display.
2.	**Overloading objects**: Create a class that contains one float data member. Overload all the four arithmetic operators so that operate on the objects of the class.
3.	**Overloading conversions**: Design a class Polar which describes a point in a plane using polar co-ordinates radius and angle. Use the overloaded + operator to add two objects of Polar. Note that we cannot add polar values of two points directly. This requires first the conversion of points into rectangular co-ordinates and finally converting the result into polar co-ordinates. You need to use following trigonometric formulae: = r * cos (a); = r * sin (a);= ; = ∗ + ∗ .
4.	**Overloading vector:** Define a class for Vector containing scalar values. Apply overloading concepts for Vector Addition, Multiplication of a Vector by a scalar quantity, replace the values in a Position Vector.
5.	**Overloading matrix**: Create a class MAT of size m * n. Define all possible matrix operations for MAT type objects. Verify the identity: (A-B) 2 = A2+B2 – 2AB.
6.	**Inheritance:** Create three classes: alpha, beta and gamma, each containing one data member. The class gamma should be inherited from both alpha and beta. Use a constructor function in the class gamma to assign values to the data members of all the classes. Write a program to print the value of data members of all the three classes.
7.	**File handling:** Write a program to create a disk file containing the list of names and telephone numbers in two columns, using a class object to store each set of data. Design an interactive menu to access the file created and to implement the following tasks: (a) Determine the telephone number of the specified person. (b) Determine the name if a telephone number is known. (c) Update the telephone number, whenever there is a change.
	Total Hours : 45
Text Book	
1.	E. Balaguruswamy, Object–Oriented Programming with C++, Tata McGraw Hill Publishing Company Limited.
Reference Books	
1.	D. Ravichandran, Programming with C++, Tata McGraw Hill publishing company limited, New Delhi.

Course Code	Course Name	Category	Hours / Week	Credits
24MMA2AE	Fuzzy Logic and Fuzzy Sets	Elective – IIA	5	4

Course Objectives

The Course intends to cover

- Identification of fuzzy sets and perform set operations on fuzzy sets.
- Fuzzy logic in various real-life situations such as decision making and inventory control.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the basic types of fuzzy sets and the difference between crisp sets and fuzzy sets.	K2
CLO2	Analyze and apply the knowledge of fuzzy relations.	K3, K4
CLO3	Evaluate the classes of fuzzy measures.	K5
CLO4	Evaluate uncertainty in control system.	K5
CLO5	Understand the types of uncertainty measures and system behavior in fuzzy controller.	K2
K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	1	2	3	1	2
CLO2	2	3	2	3	3
CLO3	3	3	1	2	3
CLO4	3	3	1	2	3
CLO5	2	3	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective – II A: Fuzzy Logic and Fuzzy Sets

Unit	Content	No. of Hours
I	Introduction to Crisp sets: An over view-The Notion of Fuzzy Sets-basic concepts of Fuzzy Sets – Classical Logic: complement-Fuzzy Union-Fuzzy intersection – Combination of operations – General aggregation of operations.	15
II	Crisp and Fuzzy relations – Binary relations – Binary relations on a single set – Equivalence and similarity relations – Compatibility on Tolerance Relations-Orderings – Morphism – Fuzzy relations Equations.	15
III	Belief and plausibility Measures –Probability measures – Possibility and Necessity measures.	15
IV	Relationship among classes of fuzzy measures - Types of Uncertainty – Measures of Fuzziness Classical Measures of Uncertainty.	15
V	Measures of Dissonance-Measures of Confusion – Measures of Non-Specificity – Uncertainty and Information – Information and Complexity – Principles of Uncertainty and information.	15
	Total Hours.	**75**
Text Book		
1.	George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall of India Private Limited. Unit I: Chapter 1 : Section : 1.1-1.5 Chapter 2 : Section : 2.1-2.6 Unit II: Chapter 3: Section : 3.1-3.8 Unit III: Chapter 4: Section : 4.1- 4.4 Unit IV: Chapter 4: Section : 4.5 Chapter5: Section : 5.1-5.3 Unit V: Chapter 5: Section : 5.4-5.9	
Reference Book		
1.	George J. Klir and Bo Yuan, - Fuzzy Sets and Fuzzy Logic - Theory and Applications, Prentice-Hall of India Private Limited	
Web Resources (Swayam / NPTEL)		
1.	https://onlinecourses.nptel.ac.in/noc22_ee21/preview	

Elective – II B: Elements of Stochastic Process

Course code	Course Name	Category	Hours / Week	Credits
24MMA2BE	Elements of Stochastic Process	Elective – IIB	5	4

Course Objectives

The Course intends to cover

- The key concepts in various settings- discrete and finite space.
- The outcomes in uncertain situations concerning returns on investment, inflation rates, and market volatility.

Course Learning Outcome

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

CLO	CLO Statements	Knowledge Level
CLO1	Remember the discrete and continuous distributions and to understand markov chain.	K1, K2
CLO2	Apply the semi-markov process on long term analysis.	K3
CLO3	Analyze birth and death queues with different capacities.	K4
CLO4	Evaluate network of queues in toll gates and fair price shop	K5
CLO5	Analyze and evaluate Brownian motion in random movement of organism in population ecology	K4, K5
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	1	3	2	2
CLO2	3	2	1	3	1
CLO3	2	2	1	2	3
CLO4	1	3	3	1	3
CLO5	2	1	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective – IIB: Elements of Stochastic Process

Unit	Content	No. of Hours
I	Discrete time Markov model – discrete time Markov chains – examples of markov models - transient distributions – occupancy times – limiting behavior.	15
II	Renewal Process, Cumulative Process, Semi-Markov Process, Examples and Long term Analysis.	15
III	Queueing Systems, Single-Station Queues, Birth and Death queues with Finite and Infinite Capacity.	15
IV	M/G/1 and G/M/1 Queues and Network of Queues.	15
V	Standard Brownian Motion, Brownian Motion and First Passage Times.	15
	Total Hours.	**75**
Text Book		
1.	V. G. Kulkarni (2011). Introduction to Modelling and Analysis of Stochastic Systems, Springer. Unit I: Chapter 2 : Section : 2.1-2.5 Unit II: Chapter 3: Section : 3.1-3.8 Unit III: Chapter 4: Section : 4.1- 4.4 Unit IV: Chapter 4: Section : 4.5 Chapter5: Section : 5.1-5.3 Unit V: Chapter 5: Section : 5.4-5.9	
Reference Books		
1.	J. Medhi (2009). Stochastic Processes, New Age.	
2.	Papoulis A. Probability, Random Variables and Stochastic process, Tata McGraw Hill Education Pvt. Ltd., New Delhi	
Web Resources (Swayam / NPTEL)		
1.	https://nptel.ac.in/courses/111102014	

Course code	Course Name	Category	Hours / Week	Credits
24MMA2CE	Algebraic Geometry	Elective – IIC	5	4

Course Objectives

The Course intends to cover

- The key concepts in various settings- discrete and finite space.
- The outcomes in uncertain situations concerning returns on investment, inflation rates, and market volatility.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Remember the notion of ring theory.	K1
CLO2	Analyze Chinese remainder theorem in data storage system for decoding reed-solomon codes.	K4
CLO3	Analyze algebraic sets and affaine algebraic sets.	K4
CLO4	Evaluate affine varieties	K5
CLO5	Analyze spectrum of rings.	K4
K1 – Remember; **K4** - Analyze; **K5** – Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	1	3	2	2
CLO2	3	2	1	3	1
CLO3	2	2	1	2	3
CLO4	1	3	3	1	3
CLO5	2	1	2	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective – IIC: Algebraic Geometry

Unit	Content	No. of Hours
I	Rings, polynomial rings, quotient rings, ideals, rings of fractions, principal ideals domain, unique factorisation domain, irreducibility of the polynomials.	15
II	Modules homomorphism, quotient modules, finite modules, free modules, finitely generated modules.	15
III	Modules with Chain Condition Artinian Modules - Noetherian Modules-Modules of Finite Length -Artinian Rings- Noetherian Rings – Radicals- Nil Radical-Jacobson Radical-Radical of an Artinian Ring.	15
IV	Affine varieties- Projective Varieties- Morphisms- Rational Maps-Nonsingular Varieties – Nonsingular Curves- Intersections in Projective space.	15
V	Schemes- Sheaves –First properties of Schemes – Separated and proper morphisms-Sheaves of Modules – Divisors- Projective morphisms – Differentials – Formal Schemes.	15
	Total Hours.	**75**
Text Books		
1.	David S. Dummit. Richard M.Foote. (2018). Abstract Algebra, Wiley Unit I: Chapter 7: Section: 7.1-7.6.	
2.	Chitikila Musili, Introduction to rings and modules, Narosa Publishing House. Unit II: Chapter 5: Section: 5.1,5.3, 5.6-5.9. Unit III: Chapter 6: Section: 6.1 – 6.7	
3.	Robin Harshrone, Algebraic Geometry, Springer. Unit IV: Chapter 1: Section: 1.1-1.7 Unit V: Chapter 2: Section: 2.1-2.9	
Reference Book		
1.	Atiyah, M.F. Macdonald, I.G. Introduction to Commutative Algebra, Addison-Wesley.	
Web Resources (Swayam / NPTEL)		
1.	https://onlinecourses.nptel.ac.in/noc23_ma63/preview	

Skill Enhancement Course - I: Computational Mathematics with SageMath

Course code	Course Name	Category	Hours / Week	Credits
24MMA25P	Computational Mathematics using SageMath	SEC - I	2	2

Unit	Content
I	**Introduction and Basics:** Introduction and Installation of Sage Math – basic arithmetic – predefined functions and values – Graphical representations of functions 2D and 3D plotting with Sage Math.
II	**Algebra and Calculus:** Polynomial and fractional expressions – Solving equations – Sequences and series – Limits – Derivatives – Partial derivatives – Integration – Improper integral - Applications using Sage Math.
III	**Linear Algebra:** Vectors and matrix formation – Solving system of linear equations – vector spaces – Basis and dimensions of vector spaces – Linear transformations – Eigenvalues and vectors – Inner product using Sage Math
IV	**Differential Equations and Numerical Methods:** Solving 1st and 2nd order ODE - Euler's Method to solve 1st order ODE with Sage Math. Numerical Solutions of System of linear equations – Interpolations - Runge-Kutta method for System of ODE and Applications - Solving ODE using Laplace Transforms - Numerical Integration in Sage Math.
V	**Linear Programming:** Linear Programming Problems (LPP) - Solving Linear Programming Problems using Graphical Methods - Simplex Method - Big-M Method – Revised Simplex Method - Two Phase Simplex Method - in Sage Math.
	Total Hours: 10
Text Books	
1.	Paul Zimmerman (2019). Computational Mathematics with SageMaths, SIAM
2.	Razvan A Mezei, (2015). An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods, Wiley

Components for Internal Assessment and Distribution of Marks for CIA and ESE (Theory)

Max Marks	Marks for		Components for CIA									
	CIA	ESE	CIA – I		CIA – II		Best of CIA-I & CIA-II	Model		Attendance	Active Engagement	Total
100	25	75	Actual	Weightage	Actual	Weightage	Weightage	Actual	Weightage	5	5	25
			50	5	50	5	5	75	10			

Question Paper Pattern

Component	Duration in Hrs.	Section A			Section B			Section C			Total
		Type of question	No. of questions	Marks	Type of question	No. of questions	Marks	Type of question	No. of questions	Marks	
CIA – I &II	2	MCQ	8	8x1=8	Either or	3	3x6=18	Either or	3	3x8=24	50
Model Exam /ESE	3	MCQ	10	10x1=10	Either or	5	5x5=25	Either or	5	5x8=40	75

Components for Internal Assessment and Distribution of Marks for CIA and ESE (Lab)

Max Marks	Marks for		Components for CIA							
	CIA	ESE	Test – I		Test - II		Model		Observation	Total
100	40	60	Actual	Weightage	Actual	Weightage	Actual	Weightage	5	40
			50	10	50	10	60	15		

Examination Pattern

Component	Duration in Hrs.	No. of experiments	Marks			Weightage
			Practical	Record	Total	
Test - I	1	1	50	-	50	10
Test - II	1	1	50	-	50	10
Model	3	2	60	-	60	15
ESE	3	2	50	10	60	-

Part – IV : Ability Enhancement Compulsory Courses

(All the Undergraduate Programmes)

Course Code	Course Name	Category	Hours / Week	Credits
24SOF2AE	Soft Skills	AECC - II	2	2

Course Objectives

The course intends to cover

- The essential soft skills that is crucial for success in today's dynamic and interconnected workplace.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the comprehensive skills to participate actively in conversation, writing short texts with expression	K1, K2, K3
CLO2	Infer the cohesive devices to describe and discuss any objects, pictures using compound, complex sentence forms.	K2, K3
CLO3	Comprehend the logic in the given situation to organize the ideas to write formal and informal letters.	K2, K3
CLO4	Understand the given material to organize it in a logical sequence to present a paragraph with main and supporting ideas with concluding sentences.	K3
CLO5	Present valuable ideas in conversation to emulate the main ideas and key points in short essays.	K3
K1 - Remember; **K2** - Understand; **K3** - Apply;		

Ability Enhancement Compulsory Course - II : Soft Skills

Unit	Details	No. of Hours
I	**Presentation Skills : Getting to Know You:** Grammar: Introduction to Tenses; Listening: Fill in the blanks; Speaking: Self Introduction, Everyday English, Role-Play; Reading: Different ways of communication. **My Day:** Grammar: Present simple positive & negative / Adverbs of Frequency; Vocabulary & Speaking: Daily Activities; Listening: Observe and Answer / Telling the time; Reading & Writing: Describe where you live. **Your World:** Grammar: Possessive determiners; Vocabulary & Speaking: Talk about countries, nationalities; Listening: Positive & negative contractions; Reading & Writing: Personal profile. **The World Of Work:** Grammar: Yes/No & Wh Questions; Vocabulary & Speaking: Jobs; Listening: Recognize the schwa sound; Reading & Writing: Opening and closing an email. .**Places And Things:** Grammar: There is / there are, articles; Vocabulary & Speaking: Talk about rooms & furniture; Listening: Directions; Reading & Writing: Imperatives.**24 Hours:** Grammar: Likes & Dislikes; Vocabulary & Speaking: Speak about hobbies and interests; Listening: Observe & answer; Reading: Match the photos with descriptions; Writing: Write complete sentence using prompts;	6
II	**Confidence : Clothes and Shopping:** Grammar: Modal verbs / Adverbs of Frequency / Adjectives and Adverbs; Vocabulary & Speaking: Shopping; Listening: Observe and Answer; Reading & Writing: Product Review. **Travel & Transport:** Grammar: Past simple questions; Vocabulary & Speaking: Talk about holidays; Listening: At the train station; Reading & Writing: Email - A perfect holiday. **Health & Fitness:** Grammar: Past simple irregular verbs; Vocabulary & Speaking: Talk about a healthy lifestyle; Listening: Listen & Answer; Reading & Writing: Time sequencers. **Music:** Grammar: Present perfect simple; Vocabulary & Speaking: Survey about music; Listening: Listen two people talk about music; Reading: Use adjectives and create sentences. **Let's go shopping:** Grammar: Countable & Uncountable; Vocabulary & Speaking: Town Survey; Listening: Listen and answer; Reading & Writing: Read and match	6
III	**Creativity :Cooking & Eating:** Grammar: Some & Any, Quantifiers; Vocabulary & Speaking: Food & Drink; Listening: Kitchen conversation; Reading & Writing: Article reading & answering. **Survival:** Grammar: Comparison of adjectives; Vocabulary & Speaking: Describing people; Listening: Listen & Answer; Reading & Writing: Read and Answer. **Working Together:** Grammar: Verb + Noun phrases; Vocabulary & Speaking: Talk about technology; Listening: Listen & Answer; Reading & Writing: Notice. **Music:** Grammar: Present perfect simple; Vocabulary & Speaking: Survey about music; Listening: Listen two people talk about music; Reading: Use adjectives and create sentences. **Culture and Arts:** Grammar: Present perfect; Vocabulary & Speaking: Speak on the phone; Listening: Listen and answer; Reading & Writing: Review	6

Unit	Content	No. of Hours
IV	**Problem-Solving :Do's and Don'ts:** Grammar: Modal verbs; Vocabulary & Speaking: Role play; Listening: Holidays in January; Reading & Writing: Article reading & answering. **Body:** Grammar: First conditional; Vocabulary & Speaking: Personality & Appearance; Listening: Listen to conversations about personality; Reading & Writing: Read and Answer about your skills. **Speed:** Grammar: Present simple passive; Vocabulary & Speaking: Talk about relationships; Listening: Listen & Answer; Reading & Writing: Error spotting. **Work:** Grammar: Adverbs of manner; Vocabulary & Speaking: Talk about work advice; Listening: Observe & Answer; Reading: Read & check your ideas	6
V	**Critical Thinking : Influence:** Grammar: would / past habits; Listening: Sentence Correction; Speaking & Vocabulary: Your inspiration; Reading: Picture description; Writing: Rewrite the sentences. **Money:** Grammar: Second conditional; Listening: radio programme; Speaking & Vocabulary: Talk about games; Reading & Writing: Fill in the blanks. **Things that changed the world:** Grammar: articles; Speaking & Listening: Talk about chewing gum; Reading & Writing: Read and write a book review	6
	Total Hours	**30**

Components for and Distribution of Marks for ESE (Theory)

Ability Enhancement Compulsory Course (AECC)

Duration in Hrs.	Mode of Exam	Type of Questions	No. of Questions	Marks
2	Online	MCQ	50	50x1=50

Semester – 3

Semester – 3									
Course Code	**Part**	**Course Category**	**Course Name**	**Hrs. / week**	**Examination**				**Credits**
					Duration in hrs.	**Max Marks**			
						CIA	**ESE**	**Total**	
25MMA31C	III	Core – VIII	Topology	6	3	25	75	100	4
25MMA32C	III	Core – IX	Mathematical Statistics	6	3	25	75	100	4
24MMA33P	III	Core Lab(Embedded)	Numerical Analysis	3	3	40	60	100	5
	III		Numerical Analysis using C++ Programming	4					
25MMA34C	III	Core- X	Fluid Dynamics	5	3	25	75	100	4
25MMA3AE/ 25MMA3BE/ 25MMA3CE/	III	Elective –III	Neural Networks Control Theory Mathematical Methods	4	4	25	75	100	3
25MMA35S	III	SEC – II	**Lab:** Mathematical Documentation using LaTeX	2	3	40	60	100	2
25MMA37I	III	Internship	Internship / Institutional Training	-	-	50	-	-	2
25MOO3AE	IV	AECC– III	Online Course – MOOC	–	-	-	-	-	2
Total				**30**				**600**	**26**

Course Code	Course Name	Category	Hours / Week	Credits
24MMA31C	Topology	Core-VIII	6	4

Course Objectives

The Course intends to cover

- The introduction of General topology with Basic Terminology
- The properties of arbitrary topological spaces such as connectedness and compactness
- The problems of topology involving the countability and separation axioms

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Define topological spaces, basis, product topology, subspace topology, closed sets and limit points	K1
CLO2	Explain the concepts of continuous functions, product topology, metric topology and the quotient topology	K2
CLO3	Understand the countability and separation axioms and their importance in proving various theorems	K2
CLO4	Apply the properties such as connected, compact, Hausdorff, regular, normal and metrizable in various spaces	K3
CLO5	Analyze the application of the Countability and separation axioms	K4
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** – Analyze		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	2	1	1	2
CLO2	3	2	2	3	3
CLO3	3	2	2	2	2
CLO4	3	3	2	3	2
CLO5	3	3	3	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core VIII - Topology

Unit	Content	No. of Hours
I	**Topological Spaces:** Types of Topological Spaces and Examples - Basics for a topology - The order topology - The product topology on X x Y - The subspace topology - Closed sets and limits points.	18
II	**Continuous functions:** The Product Topology - The metric topology - Sequence lemma- Uniform limit theorem - Connected spaces - Connected subspaces of the real line - Components and Local connectedness.	18
III	**Compact spaces:** Compact subspaces of the real line -Uniform continuity theorem - Limit Point Compactness – Complete metric spaces –Compactness in metric spaces.	18
IV	**Countability and Separation Axioms:** First and Second countable spaces - Lindeloff and Separable spaces - Countability axioms - The separation axioms - Normal spaces - The Uryshon's lemma.	18
V	**Normal Spaces:** The Urysohn Metrization Theorem - Tietze Extension Theorem - **The Tychonoff theorem:** Stone Cech compactifications.	18
	Total Hours.	**90**
Text Books		
1	James R.Munkres, Topology (Second Edition), Prentice – Hall of India, Private Ltd, New Delhi (2013). Unit I : Chapter 2: Section: 12 – 17 Unit II : Chapter 2: Section: 18 – 21, 23–25 Unit III : Chapter 3: Section: 26 – 28 Chapter 7: Section: 43,45 Unit IV : Chapter 4: Section: 30-33 Unit V : Chapter 4: Section: 34 – 35 Chapter 5: Section: 37 & 38	
Reference Books		
1	G.F.Simmons, Introduction to Topology and Modern Analysis, Tata McGraw Hill Edition, New Delhi (2004).	
2	Fred H.Croom, Principles of Topology, Cengage India Pvt Ltd, New Delhi (2009).	
3	Seymour Lipschutz, Theory and Problems of General Topology, McGraw-Hill Edition, New Delhi (2006).	
Web Resources (Swayam / NPTEL)		
1	https://archive.nptel.ac.in/courses/111/101/111101160/	
2	https://archive.nptel.ac.in/courses/111/106/111106159/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA32C	Mathematical Statistics	Core-IX	6	4

Course Objectives

The Course intends to cover

- Statistical inferences using properties of estimators, convergence theorems, and hypothesis testing methods
- Advanced concepts of probability theory and distribution functions to model and interpret real-world random phenomena.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Recall fundamental concepts of probability, including set theory and probability set functions,	K1
CLO2	Apply concepts of expectation, special inequalities, and multivariate distributions to solve problems	K3
CLO3	Use the concepts of expectation, key inequalities, and standard probability distributions to solve problems involving univariate and bivariate random variables.	K3
CLO4	Differentiate between t and F distributions and interpret the properties of estimators	K4
CLO5	Distinguish between various statistical inference techniques, including confidence intervals and hypothesis testing,	K4
K1 - Remember; **K3** - Apply; **K4** – Analyze		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	3	3	3	3
CLO2	3	2	2	3	3
CLO3	3	2	2	2	2
CLO4	3	3	2	3	2
CLO5	3	3	3	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Course IX - Mathematical Statistics

Unit	Content	No. of Hours
I	**Probability and Distributions:** Introduction - Set Theory - The Probability Set Function - Conditional Probability and Independence –Random Variables - Discrete Random Variables-Continuous Random Variables- Expectation of a Random Variables - Some Special Expectations - Important Inequalities.	18
II	**Multivariate Distributions:** Distributions of Two Random Variables - Transformations: Bivariate Random Variables - Conditional Distributions and Expectations - Independent Random Variables.	18
III	**Some Special Distributions:** The Binomial and Related Distributions - The Poisson Distribution - The Γ, $\chi 2$, and β Distributions - The Normal Distribution- t and F-Distributions.	18
IV	**Unbiasedness, Consistency and Limiting Distributions:** Expectations of Functions - Convergence in Probability - Convergence in Distribution - Central Limit Theorem.	18
V	**Some Elementary Statistical Inferences**: Sampling and Statistics – More on Confidence Intervals - Introduction to Hypothesis Testing - Additional Comments About Statistical Tests - Chi-Square Tests – The Method of Monte Carlo.	18
	Total Hours.	**90**
Text Books		
1	Robert V. Hogg, Allen T. Craig and Joseph W. McKean. Pearson (2005), Introduction to Mathematical Statistics, 6^{th} edition. Unit-I : Chapter-1, Sec: 1.1 – 1.10, Unit-II : Chapter -2, Sec: 2.1-2.3,2.5, Unit-III : Chapter -3, Sec: 3.1 – 3.4,3.6, Unit-IV : Chapter-4, Sec: 4.1 – 4.4, Unit-V : Chapter -5, Sec: 5.1, 5.4 – 5.8	
Reference Books		
1	Michael J. Crawley. (2012), The R Book , John Wiley & Sons	
2	M. Rajagopalan and P. Dhanavanthan ,(2012) Statistical Inference By. PHI Learning Pvt. Ltd., New Delhi .	
Web Resources (Swayam / NPTEL)		
1	https://archive.nptel.ac.in/courses/111/105/111105090/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA33P	Numerical Analysis	Core Lab (Embedded)	3	5

Course Objectives

The course intends to cover

- The numerical methods for solving nonlinear and linear equations, numerical differentiation , integration and ordinary differential equations.
- The numerical techniques to solve boundary value problems, characteristic value problems and partial differential equations.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Define various methods for solving nonlinear equations	K1
CLO2	Explain direct and iterative methods using various examples	K2
CLO3	Apply numerical techniques such as finite differences, trapezoidal and Simpson's rules and solve ordinary differential equations	K3
CLO4	Analyze and solve boundary value and characteristic value problems	K4
CLO5	Evaluate and solve partial differential equations of elliptic, parabolic, and hyperbolic types using numerical methods.	K4
K1 – Remember **K2** - Understand; **K3** - Apply; **K4** Analyze		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	2	1	1	2
CLO2	3	2	2	3	3
CLO3	3	2	2	2	2
CLO4	3	3	2	3	2
CLO5	3	3	3	3	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Embedded Course: Numerical Analysis

Unit	Content	No. of Hours
I	**Solving Nonlinear Equations:** Interval Halving Method-Linear Interpolation Method-Newton's Method – Muller's Method – Fixed-Point Iteration: $x = g(x)$ Method.	9
II	**Solving Sets of Equations:** The Elimination method- Gauss Jordan method-LU decomposition method – Matrix inversion by Gauss-Jordan Method-Iterative Methods – Gauss Jacobi and Gauss Seidel Methods.	9
III	**Numerical Differentiation and Integration**: Derivatives from differences tables-The trapezoidal rule –Simpson's rules. **Solution of Ordinary Differential Equations:** Taylor series method – Euler and modified Euler methods – Runge- Kutta methods – Multistep methods – Milne's method – Adams-Moulton method.	9
IV	**Boundary value problems and Characteristic value problems**: The shooting method – Solution through a set of equations – Derivative boundary conditions–Characteristic-value problems – Eigen values of a matrix by iteration – The power method.	9
V	**Numerical solution of Partial Differential Equations:** Elliptic equations-Parabolic equations and Hyperbolic equations.	9
	Total Hours	**45**
Text Books		
1	**C.F. Gerald and P.O. Wheatley** (2022). Applied Numerical Analysis, Seventh Edition, Wesley Publishing Company. Unit I: Chapter 1: Sections: 1.1-1.5 Unit II: Chapter 2: Sections: 2.2,2.3 & 2.5 Unit III: Chapter 5: Sections: 5.1-5.3 Chapter 6: Sections: 6.1-6.4 Unit IV: Chapter 6: Sections: 6.7-6.8 Unit V: Chapter 8: Sections: 8.1-8.3	
Reference Books		
1	Jain MK, Iyengar SRK (2022). Numerical Methods for Scientific and Engineering Computation,6th Edition, New Age International Publishers, New Delhi.	
2	S.S. Sastry (2012). Introductory Methods of Numerical Analysis,5th Edition, Prentice Hall of India Pvt.Ltd, New Delhi.	
Web Resources (Swayam / NPTEL)		
1	https://nptel.ac.in/courses/111/107/111107105/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA33P	**Numerical Analysis using C++ Programming**	**Core Lab (Embedded)**	**4**	**5**

S. No.	List of Programs	
1	Program to find the roots of a non-linear equation using Newton-Raphson method	
2	Program to find the roots of a non-linear equation using Secant method	
3	Create a program to demonstrate Gauss Elimination method	
4	Program for Gauss Jordan Reduction Technique	
5	Program to solve inversion of Matrix using Gauss Jordan Reduction Technique	
6	Program for solving equations having tridiagonal coefficient matrix	
7	Develop a program to find Gauss-Seidel Substitution Technique	
8	Compute the dominant eigenvalue of a matrix by power method	
9	Program for finding the numerical solution of integrals using Trapezoidal method	
10	Program for finding the numerical solution of integrals using Simpson's method	
11	Program for demonstrating Euler's predictor-corrector method	
12	Develop a program for differential equation by Runge Kutta method.	
13	Compute the solution of a Boundary Value Problem by using Shooting method	
14	Calculate the numerical solution of Laplace equation in two variables by suitable method	
15	Calculate the numerical solution of heat equation by suitable method	
16	Compute the numerical solution of wave equation by suitable method	
	Total Hours	**60**
Text Book		
1	Pallab Ghosh (2006), Numerical Methods with Computer Programs in C++, Eastern Economy Edition, Prentice-Hall India of India Private Limited, New Delhi.	
Reference Book		
1	Ajay Wadhwa (2012), Numerical Analysis with Algorithms and Computer Programs in C++, Kindle Edition.	
Web Resources (Swayam/NPTEL)		
1	https://nptel.ac.in/courses/111101165	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA33C	Fluid Dynamics	Core-X	5	3

Course Objectives

The Course intends to cover

- The fundamental concepts of fluids and its properties
- The real-life applications of fluid dynamics**.**

Course Learning Outcomes

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

CLOs	CLO Statements	Knowledge Level
CLO1	Recall the basic concepts of velocity, density and curvilinear co-ordinates	K1
CLO2	Explain fluid motion using Euler's theorem, Bernoulli's principle, energy equations, circulation, and vortex dynamics.	K2
CLO3	Understand the concepts of the force experienced by a two dimensional fixed body in a steady irrotational flow	K2
CLO4	Analyze the approximate solutions of the Navier – Stokes equation	K4
CLO5	Analyze and apply the appropriate method to solve integral equation of boundary layer, Blasius equation and its series solution.	K4
K1 – Remember; **K2** - Understand; **K4** - Analyze;		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	2	2	2	3
CLO2	3	2	2	3	2
CLO3	3	2	2	3	2
CLO4	3	2	3	3	3
CLO5	3	2	3	3	2
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Core - X: Fluid Dynamics

Unit	Content	No. of Hours
I	**Bernoulli's Equation and Equations of Motion:** Introductory Notions – Velocity – Stream Lines and Path Lines – Stream Tubes and Filaments – Fluid Body – Density – Pressure. Differentiation with respect to the time – Equation of continuity – Boundary conditions – Kinematical and physical – Rate of change of linear momentum – Equation of motion of an inviscid fluid.	12
II	**Equations of Motion :** Euler's momentum Theorem – Conservative forces – Bernoulli's theorem in steady motion – energy equation for inviscid fluid – circulation – Kelvin's theorem – vortex motion – Helmholtz equation.	12
III	**Two Dimensional Motion** : Two Dimensional Functions – Complex Potential – basic singularities – source – sink – Vortex – doublet – Circle theorem. Flow past a circular cylinder with circulation – Blasius Theorem – Lift force. (Magnus effect)	12
IV	**Dynamics of Real Fluids:** Viscous flows – Navier-Stokes equations – Vorticity and circulation in a viscous fluid – Steady flow through an arbitrary cylinder under pressure – Steady Couette flow between cylinders in relative motion – Steady flow between parallel planes.	12
V	**The Laminar Boundary Layer in Incompressible Flow:** Boundary Layer concept – Boundary Layer equations – Displacement thickness, Momentum thickness – Kinetic energy thickness – integral equation of boundary layer – flow parallel to semi infinite flat plate – Blasius equation and its solution in series.	12
	Total Hours.	**60**
Text Books		
1 2 .	L. M. Milne Thomson(1968), Theoretical Hydro Dynamics, Macmillan Company, 5th Edition Unit I : Chapter I : Sections 1.0 – 1.3., 3.10-3.41 Unit II: Chapter III : Sections 3.42 – 3.53 (omit 3.44) Modern Fluid Dynamics Volume I (1968), N. Curle and H. J. Davies, D. Van Nostrand Company Limited., London. Unit III: Chapter III : Sections 3.1 – 3.7.5 Unit IV: Chapter V : Sections 5.2.1– 5.3.3 Units V: Chapter VI : Sections 6.1 – 6.3.1	
Reference Books		
1 2	F.Chorlton (2004), Textbook of Fluid Dynamics, CBS Publishers, New Delhi. A.J.Chorin and A.Marsden (1993), A Mathematical Introduction to Fluid Dynamics, SpringerVerlag, New York.	
Web Resources (MOOC/ Swayam / NPTEL)		
1	https://nptel.ac.in/courses/112/116/112106200/	
2	https://nptel.ac.in/courses/112/105/112105171/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA3AE	Neural Networks	Elective-III	4	3

Course Objective

The Course intends to cover

- The fundamental principles and techniques of neural network systems while exploring key neural network models and their applications.
- The complete understanding of nonlinear dynamics.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the mathematical neuron model and its significance in neural networks.	K2
CLO2	Apply linear associators to practical applications such as pattern matching and content-addressable memory systems.	K3
CLO3	Apply the Hebb rule to tasks like associative memory and neural pattern recognition.	K3
CLO4	Analyze the application of Taylor series in approximating neural network functions and improving optimization.	K4
CLO5	Analyze Newton's method for efficient optimization in complex neural network architectures.	K4
K2 - Understand; **K3** -Apply; **K4**- Analyze;		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	1	2	2	3
CLO2	3	2	2	3	2
CLO3	1	2	2	1	1
CLO4	2	2	1	1	3
CLO5	2	2	3	3	2
3 - Substantial (high)		**2** - Moderate (medium)			**1** - Slight (low)

Elective III A -Neural Networks

Unit	Content	No. of Hours
I	**Neuron Model and Network Architectures:** Neuron Model- Network Architectures- Perceptron-Hamming Network- Hopfield Network.	12
II	**Perceptron Learning Rule:** Learning Rules-Perceptron Architectures - Perceptron Learning Rule - Proof of Convergence.	12
III	**Supervised Hebbian Learning:** Linear Associator-The Hebb Rule-Pseudo inverse Rule-Variations of Hebbian Learning.	12
IV	**Performance Surface and Optimum Points:** Taylor series- Directional Derivatives-Minima-Necessary Conditions for Optimality-Quadratic Functions. **Performance Optimizations:** Steepest Descent-Newton's Method-Conjugate Gradient.	12
V	**Back Propagation:** Multilayer Perceptrons-Back propagation Algorithm-Convergence and Generalization.	12
	Total Hours.	**60**
Text Book		
1	Martin T. Hagan (2014), Howard B. Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi. Unit I: Chapter 2 P.No. 2.1-2.23 Chapter 3 P.No.: 3.1-3.16 Unit II: Chapter 4 P.No.: 4.1-4.36 Unit III: Chapter 7 P.No.: 7.4-7.31 Unit IV: Chapter 8 P.No.: 8.1-8.36 Chapter 9 P.No.: 9.1-9.39 Unit V: Chapter 11 P.No.: 11.1-11.44	
Reference Books		
1	James A. Freeman(2015), David M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education.	
2	Robert J. Schalkoff(2007), Artificial Neural Network, McGraw-Hill International Edition.	
Web Resources (Swayam / NPTEL)		
1	https://nptel.ac.in/courses/117/105/117105084/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA3BE	Control Theory	Elective-III	4	3

Course Objectives

The Course intends to cover

- The concepts of observability, controllability and Stability.
- Knowledge about linear time varying systems.
- The stabilization techniques using linear feedback control using Bass method.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Explain observability and estimate the observability of constant coefficient system, linear, nonlinear system, and discuss reconstruction kernel.	K2
CLO2	Apply controllability criteria to constant coefficient system, linear, nonlinear system, and explain steering function.	K3
CLO3	Analyze the stability of linear system, linear time varying system, perturbed linear system and nonlinear system.	K4
CLO4	Analyze the non-linear systems and Lyapunov stability.	K4
CLO5	Evaluate the concept of stabilization via linear feedback control and Bass method	K5
K2 - Understand; **K3** - Apply; **K4** – Analyze ;**K5** -Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	3	2	2	1	3
CLO2	2	2	3	2	2
CLO3	3	3	2	2	2
CLO4	2	2	3	3	3
CLO5	3	3	2	3	2
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective III B: Control Theory

Unit	Content	No. of Hours
I	**Observability:** Linear systems, Observability grammian, Constant coefficient systems, Reconstruction kernel, Nonlinear systems.	12
II	**Controllability:** Linear systems, Controllability grammian, Adjoint systems, Constant coefficient systems, steering function, Nonlinear systems.	12
III	**Stability for Linear systems:** Linear systems, Perturbed Linear Systems	12
IV	**Stability for Non-Linear systems:** Non-linear systems, Lyapunov stability	12
V	**Stabilizability:** Stabilization via linear feedback control, Bass method, Controllable subspace, Stabilization with restricted feedback.	12
	Total Hours.	**60**
Text Book		
1	K. Balachandran and J. P. Dauer (2012), "Elements of Control Theory", 2nd edition, Narosa, New Delhi. Unit I: Chapter 2 Section : 2.1-2.2 Unit II: Chapter 3 Section : 3.1-3.2 Unit III: Chapter 4 Section : 4.1- 4.2 Unit IV: Chapter 4 Section : 4.3- 4.4 Unit V: Chapter 5 Section : 5.1-5.3	
Reference Books		
1	R. Conti (2009), "Linear Differential Equations and Control", Academic Press, London.	
2	R. F. Curtain and A. J. Pritchard (1977), "Functional Analysis and Modern Applied Mathematics", Academic Press, New York.	
3	J. Klamka (1991), "Controllability of Dynamical Systems", Kluwer Academic Publisher, Dordrecht.	
Web Resources (Swayam / NPTEL)		
1	https://nptel.ac.in/courses/111107118	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA3CE	Mathematical Methods	Elective-III	4	3

Course Objectives

The Course intends to cover

- The fundamentals of integral transforms, integral equations and calculus of variations.
- Integral transforms integral equations and calculus of variations as tools for problem solving.

Course Learning Outcomes

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

CLO	CLO Statements	Knowledge Level
CLO1	Understand the basic properties of Fourier and Hankel transforms which helps to transform signals between two domains.	K2
CLO2	Understand and apply the classical Fredholm theory which is used generate photo realistic image in computer graphics.	K2, K3
CLO3	Evaluate Volterra integral equations.	K5
CLO4	Analyze the Abel integral equations.	K4
CLO5	Evaluate functionals dependent on higher order derivatives	K5
K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate		

CLO – PLO Mapping

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	2	1	1	2	2
CLO2	2	1	1	2	2
CLO3	1	1	1	2	3
CLO4	1	1	1	2	3
CLO5	2	2	1	1	3
3 - Substantial (high)		**2** - Moderate (medium)		**1** - Slight (low)	

Elective III C: Mathematical Methods

Unit	Content	No. of Hours
I	**Fourier Transforms**: Definition- Inversion theorem – Fourier cosine transforms - Fourier sine transforms – Fourier transforms of derivatives - Fourier transforms of some simple functions - Fourier transforms of rational functions – The convolution integral – convolution theorem – Parseval's relation for Fourier transforms – solution of PDE by Fourier transform. Laplace's Equation in Half plane Laplace's Equation in an infinite strip The Linear diffusion equation on a semi-infinite line. The two-dimensional diffusion equation.	12
II	**Hankel Transforms :**Definition of Elementary properties of Hankel Transforms - Hankel Transforms of Derivatives of functions - Hankel Transforms of some elementary functions - The Parseval relation for Hankel transforms – Relation between Fourier and Hankel transforms – Application to PDE. Axisymmetric Dirichlet problem for a half –space. Axisymmetric Dirichlet problem for a thick plate	12
III	**Integral equations :**Types of Integral equations – Equation with separable kernel – Fredholm Alternative Approximate method – Volterra integral equations – Classical Fredholm theory – Fredholm's First, Second, Third theorems.	12
IV	**Application of integral equations to ordinary integral equations and singular integral equations:** Initial value problems – Boundary value problems – singular integral equations – Abel Integral equation.	12
V	**Calculus of variations:** Variation and its properties – Euler's equation – Functional of the integral forms Functional dependent on higher order derivatives – functionals dependent on the functions of several independent variables – variational problems in parametric form.	12
	Total Hours.	**60**
Text Books		
1	Ian Sneddon., The Use of Integral Transforms, Tata Mc Graw Hill Unit I : Chapter 2 : Section 2.3 – 2.5 Chapter 3 : Section 3.3 – 3.4 Unit II : Chapter 5 : Section 5.1 – 5.2 , Chapter 8 : Section 8.1 – 8.2	
2	R.P. Moscow Kanwal, Linear Integral Equations Theory and Techniques, Academic Press. Unit III : Chapter 2: Page No. 46 - 50 Unit IV : Chapter 3: Page No. 51 - 54	
3	L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers. Unit V : Chapter 6: Section 6.1 - 6.7	
Reference Book		
1	Lokenath Debnat., Dambaru Bhatta (2007)., Integral Transforms and their Applications, Taylor & Francis, London	
Web Resources (Swayam / NPTEL)		
1	https://archive.nptel.ac.in/courses/111/107/111107098/	

Course Code	Course Name	Category	Hours / Week	Credits
24MMA35S	Mathematical Documentation using LaTeX	SEC-II	2	2

S. No.	List of Practical Programs
1	Create a basic LaTeX document with title, author and date
2	Develop a program for formatting text with font sizes, styles, and colours and using sections and subsections for paragraphs.
3	Create a program to label table of contents
4	Create a document using chapters, sections, subsections and add appendices in document structure
5	Program for finding typeset mathematical equations using inline and display mode
6	Program to create matrix and arrays using LaTeX
7	Create tables using the tabular environment option
8	Insert images using the include graphics command
9	Create a bibliography using BibTeX
10	Create a program using citation commands
	Total Hours. 30
Textbook:	
1	Helmut Kopka and Patrick W.Daly(2004), “Guide to LaTeX”, Addison - Wesley, Pearson Education , Fourth Edition.
Reference Book	
1	George Grätzer, (2000).” Math into LaTeX“,Birkhauser Boston Inc; 3rd ed. 2000 edition
Web Resources (Swayam / NPTEL)	
1	https://onlinecourses.swayam2.ac.in/aic20_sp17

Components for Internal Assessment and Distribution of Marks for CIA and ESE (Theory)

Max Marks	Marks for		Components for CIA						
100	CIA	ESE	CIA		Model		Attendance	Active Engagement	Total
	25	75	Actual	Weightage	Actual	Weightage	5	5	25
			50	**5**	75	**10**			

Question Paper Pattern

Component	Duration in Hours	Section A			Section B			Section C			Total
		Type of Question	No. of Questions	Marks	Type of Question	No. of Questions	Marks	Type of Question	No. of Questions	Marks	
CIA	2	MCQ	8	8x1=8	Either or	3	3x6=18	Either or	3	3x8=24	50
Model Exam / **ESE**	3	MCQ	10	10x1=10	Either or	5	5x5=25	Either or	5	5x8=40	75

Components for Internal Assessment and Distribution of Marks for CIA (Lab)

Max Marks	Marks for		Components for CIA						
	CIA	ESE	Test		Model		Experiments / Programs	Observation	Total
100	40	60	Actual	Weightage	Actual	Weightage	Marks	5	**40**
			50	**10**	60	**15**	**10**		

Examination Pattern

Component	Duration in Hours	Marks			Total Marks
		Practical Exam	Record	Weightage	
Test	2	50	-	**10**	50
Model	3	60	-	**15**	60
Experiments	-	-	-	**10**	10
Observation	-	-	-	**05**	05
Total Marks - CIA				**40**	**40**
ESE	3	50	10	-	**60**

Components for Internal Assessment and Distribution of Marks for CIA (Foundation Course -Theory)

Max Marks	Marks for		Components for CIA				
	CIA	ESE	CIA		Model		Total
			Actual	Weightage	Actual	Weightage	
50	50	-	50	25	50	25	50

Question Paper Pattern

Duration in Hours	Mode of Exam	Type of Questions	No. of Questions	Marks
2	Offline	Open Choice	5 (Out of 8)	5 x 10=50

Components and Distribution of Marks for ESE (Theory) Ability Enhancement Compulsory Courses (AECC) & Question Paper Pattern

Duration in Hours	Mode of Exam	Type of Questions	No. of Questions	Marks
2	Online	MCQ	50	50x1=50