P.K.R. ARTS COLLEGE FOR WOMEN (AUTONOMOUS)

(Accredited with 'A' grade by NAAC - Affiliated to Bharathiar University, Coimbatore)

GOBICHETTIPALAYAM – 638 476

DEPARTMENT OF MATHEMATICS

MASTER OF SCIENCE IN MATHEMATICS

Syllabus

For the candidates admitted from the Academic Year 2018-2019 and onwards

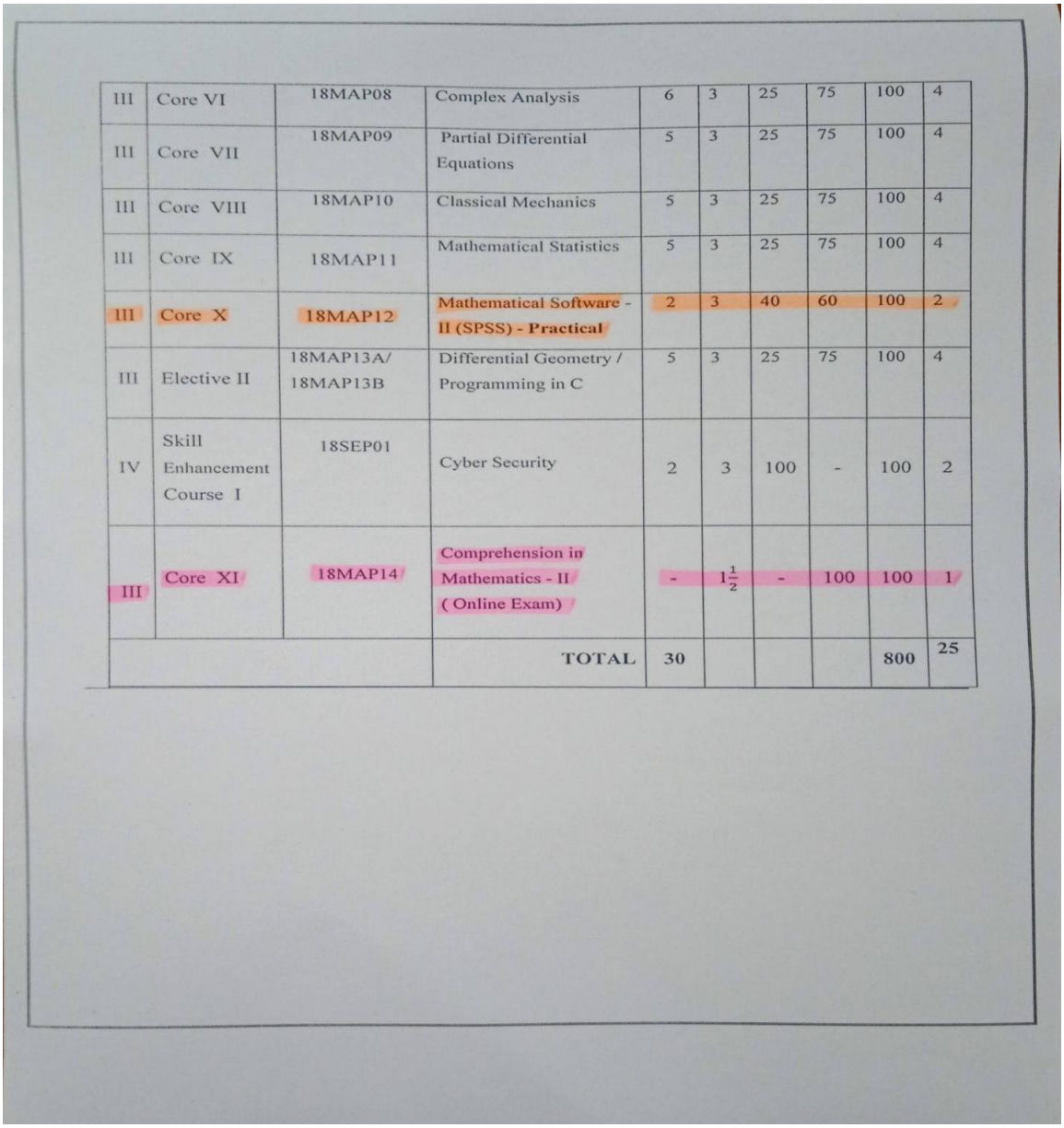
Under CBCS PATTERN

MASTER OF MATHEMATICS

Course Scheme and Scheme of Examinations

(For students admitted from 2018-2019 and onwards)

Part	Category	Course Code	Title of the Course	Contact Hrs/ week	Exam Duration Hrs.	Max.Marks			Credits
						CIA	ESE	Total	
SEMESTER – I									
III	Core I	18MAP01	Advanced Algebra	6	3	25	75	100	4
III	Core II	18MAP02	Real Analysis	6	3	25	75	100	4
III	Core III	18MAP03	Ordinary Differential Equations	6	3	25	75	100	4
III	Core IV	18MAP04	Numerical Analysis	6	3	25	75	100	3
III	Elective I	18MAP05A/ 18MAP05B	Matlab / Cryptography	4	3	25	75	100	2
III	Elective I	18MAP06	Mathematical software - I (Matlab) - **Practical**	2	3	40	60	100	2
III	Core V	18MAP07	Comprehension in Mathematics -I (Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	**30**				**700**	**20**
SEMESTER – II									



III	Core VI	18MAP08	Complex Analysis	6	3	25	75	100	4
III	Core VII	18MAP09	Partial Differential Equations	5	3	25	75	100	4
III	Core VIII	18MAP10	Classical Mechanics	5	3	25	75	100	4
III	Core IX	18MAP11	Mathematical Statistics	5	3	25	75	100	4
III	Core X	18MAP12	Mathematical Software - II (SPSS) - **Practical**	2	3	40	60	100	2
III	Elective II	18MAP13A/ 18MAP13B	Differential Geometry / Programming in C	5	3	25	75	100	4
IV	Skill Enhancement Course I	18SEP01	Cyber Security	2	3	100	-	100	2
III	Core XI	18MAP14	Comprehension in Mathematics - II (Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	**30**				**800**	**25**

SEMESTER – III

III	Core XII	18MAP15	Topology	7	3	25	75	100	5
III	Core XIII	18MAP16	Theory of Numbers	6	3	25	75	100	5
III	Core XIV	18MAP17	Optimization Techniques	7	3	25	75	100	5
III	Core XV	18MAP18	Mathematical Software - III (R Software) - **Practical**	2	3	40	60	100	2
III	Core Optional XVI	***	Optional	3	3	25	75	100	3
V	Competency Enhancement (Self Study)	18PEPMA01	Industrial Mathematics	-	3	100	-	100	2
III	Elective III	18MAP19A / 18MAP19B	Graph Theory / Programming in C++	5	3	25	75	100	4
III	Core XVII	18MAP20	Comprehension in Mathematics – III (Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	**30**				**800**	**27**

SEMESTER – IV

III	Core XVIII	18MAP21	Functional Analysis	6	3	25	75	100	5
III	Core XIX	18MAP22	Mathematical Methods	7	3	25	75	100	6
III	Core XX	18MAP23	Fluid Dynamics	6	3	25	75	100	5
III	Core XXIII	18MAP24	Project and Viva Voce**	6	3	20	80	100	3
III	Elective IV	18MAP25A/ 18MAP25B	Fuzzy Logic and Fuzzy Sets / Control Theory	5	3	25	75	100	4

III	Core XXIV	18MAP26	Comprehension in Mathematics-IV (Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	30				600	24
V	Competency Enhancement	On-line Course / Learning Object Repository		II – IV SEMSTER					2
		Certificate Course		II - IV SEMESTER					2
				Total Marks - 2900 Credits - 100					100

15/10/22

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DEPARTMENT OF MATHEMATICS

M.Sc. DEGREE PROGRAMME

SEMESTER I

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP01	ADVANCED ALGEBRA	72	-	4

Preamble

To enable the students to learn and gain knowledge about algebraic structures, theory of groups, rings and fields.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	gain deep knowledge about various algebraic structures.	K_1
CO2	understand the concepts from simple groups to extension field.	K_2
CO3	apply the algebraic methods for solving problems.	K_3 & K_5

CO4	recognize some advanced results of the theory of groups, rings and fields.	**K_4**
CO5	solve the problems by using various algebraic structures.	**K_5, K_6**

UNIT I: GROUP THEORY **(15 Hours)**

Another counting principle – Sylow's theorem – Direct products.

UNIT II: RING THEORY **(15 Hours)**

Euclidean rings – A particular Euclidean ring – Polynomial rings – Polynomials over the rational field.

UNIT III: **FIELDS** **(15 Hours)**

Extension Fields – Roots of polynomials – More about roots.

UNIT IV: FIELDS (Continuation) **(15 Hours)**

Elements of Galois theory – Finite Fields.

UNIT V: LINEAR TRANSFORMATIONS **(12 Hours)**

Canonical forms: Triangular form – Trace and Transpose – Hermitian, unitary and normal Transformations.

TEXT BOOK:

Herstein.I.N (Reprint 2017) – "Topics in Algebra", 2nd Edition, Wiley Indian Pvt.Ltd, New Delhi-110002.

UNIT	CHAPTER	SECTION
I	**II**	**2.11 to 2.13**
II	**III**	**3.7 to 3.10**
III	**V**	**5.1,5.3 and 5.5**
IV	**V** **VII**	**5.6** **7.1.**
V	**VI**	**6.4, 6.8 and 6.10**

REFERENCE BOOKS:

1. Fraleigh.J.B.(2003) – "A First Course in Abstract Algebra",3rd Edition Narosa Publishing House, New Delhi.
2. Artin.M (1991)– "Algebra", Prentice-Hall, Englewood Cliff.
3. Hungerford.T.W.(1974) – "Algebra", Springer, New York.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP02	REAL ANALYSIS	72	-	4

Preamble

To enable the students to learn and gain knowledge about Lebesgue measure, Lebesgue integral and Riemann Stiltjes Integral.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the axiomatic foundation of the real number system	K_1
CO2	define and recognize the series of real numbers and convergence and define the basic terms under Riemann Stiltjes Integral, Lebesgue measure and Lebesgue integral	K_1 & K_2
CO3	analyze the concepts of convergence criteria and linear transformation.	K_4
CO4	apply the concept of Uniform convergence to find the convergence criteria of a certain function.	K_3
CO5	evaluate the Riemann Stiltjes integral and Lebesgue integral	K_5, K_6

UNIT I: THE RIEMANN STILTJES INTEGRAL (15 Hours)

Definition and Existence of the Integral –Properties of the integral –Integration and Differentiation –Integration of vector valued function .

UNIT II: SEQUENCE AND SERIES OF FUNCTIONS (15 Hours)

Uniform convergence and continuity –Uniform convergence and integration - Uniform convergence and differentiation –Equicontinuous families of functions – The Stone Weirstrass theorem.

UNIT III: FUNCTIONS OF SEVERAL VARIABLES (15 Hours)

Linear transformation –Contraction principle –Inverse function theorem –Implicit function theorem.

UNIT IV: LEBESGUE MEASURE (15 Hours)

Outer measure –Measurable sets and Lebesgue measure –Measurable functions – Littlewood's Theorem.

UNIT V: LEBESGUE INTEGRAL (12 Hours)

The Lebesgue integral of bounded functions over a set of finite measure – Integral of a Non –negative function –General Lebesgue Integral.

TEXT BOOKS:

1. Rudin.W –(2017) "Principles of Mathematical Analysis", Third edition, McGraw Hill Education Pvt.ltd, New York.

UNIT	CHAPTER	PAGE NUMBER
I	6	120-136
II	7	143-165
III	9	204-211,220-228

2. Roydon.H.L – (2004), "Real Analysis", Third Edition, Pearson Education, Inc.

UNIT	CHAPTER	PAGE NUMBER
IV	**3**	**54-64,66-74**
V	**4**	**75-95**

REFERENCE BOOKS:

1.Robert G.Bartle and Donald R.Sherbert (2010), Third Edition,"Introduction to Real Analysis", John Wiley and sons.

2. Rudin W(2012), "Real and complex Analysis", McGraw- Hill, New York, 3rd Edition,

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP03	ORDINARY DIFFERENTIAL EQUATIONS	72	-	4

Preamble

To enable the students to learn and gain knowledge about linear differential equations, systems of linear and Non-linear differential equations and their solutions.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	define ordinary point, Legendre equation, Bessel equation, Fundamental matrix, Picard's theorem and oscillations of solutions.	K_1
CO2	understand the existence and uniqueness of solutions of systems of linear differential equations and Non-linear initial value problems.	K_2
CO3	Identify and analyze the results in systems of linear differential equations and Non- linear initial value problems.	K_3 & K_4
CO4	examine the solutions of systems of linear differential equations and Non- linear initial value problems and analyze the oscillations of solutions of second order differential equations.	K_4, K_6

CO5	apply power series method and successive approximation method to evaluate the solutions of systems of linear differential equations and Non-linear initial value problems.	**K_3&K_5**

UNIT I: SOLUTIONS IN POWER SERIES (15 Hours)

Second order linear equations with ordinary points – Legendre equation and Legendre polynomials – Second order equations with regular singular points – Bessel function

UNIT II: SYSTEMS OF LINEAR DIFFERENTIAL EQUATIONS (15 Hours)

Systems of first order equations – Existence and uniqueness theorem – Fundamental matrix.

UNIT III: SYSTEMS OF LINEAR DIFFERENTIAL EQUATIONS (continuation) (15 Hours)

Non-homogeneous linear systems – Linear systems with constant coefficients – Linear systems with periodic co-efficients.

UNIT IV:EXISTENCE AND UNIQUENESS OF SOLUTIONS (15 Hours)

Successive approximations – Picard's theorem - Non-uniqueness of solution – Continuation and dependence on initial conditions, Existence of solutions in the large – Existence and uniqueness of solutions of systems.

UNIT V: OSCILLATIONS OF SECOND ORDER EQUATIONS (12 Hours)

Fundamental results – Sturm's comparison theorem – Elementary linear oscillations. Comparison theorem of Hille-Wintner – Oscillations of $x'' + a(t)x = 0$.

TEXT BOOK:

S.G.Deo, V.Lakshmikanthan and V.Raghavendra "Ordinary Differential Equations", Second Edition- seventh reprint 200, 4Tata McGraw-Hill Publishing company Limited, New Delhi.

UNIT	CHAPTER	SECTION
I	**III**	**3.2 – 3.5**
II	**IV**	**4.2 – 4.5**
III	**IV**	**4.6 – 4.8**
IV	**V**	**5.1 – 5.8**
V	**VIII**	**8.1 – 8.5**

REFERENCE BOOKS:

1. Coddington.E.A. and Levinson.N., (1955), "Theory of Ordinary Differential Equations", McGraw Hill, New York.
2. George F.Simmons(1974)," Differential Equations with applications And Historical Notes", Tata McGraw Hill, New York.
3. V.Dharmaiah " Introduction to theory of Ordinery Differentil Equations", PHI Learning Private Limited.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP04	NUMERICAL ANALYSIS	72	-	3

Preamble :

To enable the students to learn and gain knowledge about numerical differentiation, integration, Solution of system of both ordinary and partial differential equations.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the concept of numerical differentiation, integration, solution of system of both ordinary and partial differential equations.	K_1 & K_2
CO2	analyze the difference between the boundary value and characteristic value problems.	K_4
CO3	remember the formulae for central difference formulae, numerical differentiation, integration and also write the formulae for various methods.	K_1
CO4	apply Euler's method, Taylor series method, Shooting method to solve the problems numerically.	K_3, K_6

CO5	learn how to solve the problems numerically by using direct, indirect methods, single step and multistep methods and also the problems based on non linear equations.	**K_2 & K_5**

UNIT I: CENTRAL DIFFERENCE INTERPOLATION FORMULAE (15 Hours)

Central Difference table – Gauss's forward interpolation formula - Gauss's Backward interpolation formula – Stirling's formula.

UNIT II: NUMERICAL DIFFERENTIATION (12 Hours)

Introduction – Newton's forward difference formula to compute the derivatives - Newton's backward difference formula to compute the derivatives – Problems – Derivatives using Stirling's formula – Maxima and minima of a tabulated function.

Numerical Integration: Numerical Integration – The Trapezoidal Rule – Simpson's $1/3^{rd}$ and Simpson's $3/8^{th}$ Rules.

UNIT III: SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (15 Hours)

Taylor series method –Euler and Modified Euler methods –Rungekutta methods (Fourth Order)–Multistep methods –Milne's method –Adams Moulton method.

UNIT IV: BOUNDARY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS (15 Hours)

Finite Difference Method-The shooting method –Characteristic value problems –Eigen values of a matrix by Iteration –The power method.

UNIT V: NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (15 Hours)

(Solutions of Elliptic, Parabolic and Hyperbolic partial differential equations)
Finite-Difference Approximation to Derivatives –Laplace's equation on a rectangular region – Iterative methods for Laplace equation –Parabolic Equation-Hyperbolic Equation .

TEXT BOOK:

Sastry S.S (2005) -"Introductory Methods of Numerical Analysis ", Prentice-Hall of India Private limited, New Delhi-110001.

UNIT	BOOK	CHAPTER	SECTION
I	**1**	**III**	**3.7.1-3.7.2**
II	**1**	**V**	**5.1-5.4.3 (omit 5.2.1, 5.2.2)**
III	**1**	**VII**	**7.2, 7.4, 7.4.2, 7.5-7.6**
IV	**1**	**VII and VI**	**7.10.1-7.10.2 and 6.5 (omit 6.5.1, 6.5.2)**
V	**1**	**VIII**	**8.1-8.6 (omit 8.3.4 and 8.5)**

REFERENCE BOOKS:

1. Chapra.S.C. and Raymond.P.C. (2000) – " Numerical Methods for Engineers", Tata McGraw Hill, New Delhi.

2. Burden.R.L. and Douglas Faires.J. (1989) – " Numerical Analysis", Fourth Edition, P.W.S.Kent Publishing Company, Boston .

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP05A	MATLAB	48	-	2

Preamble :

To enable the students to learn and gain knowledge about the concepts of Matlab and the Matlab commands.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	learn and understand the basics of Matlab.	K_1 & K_2
CO2	apply Matlab concepts in creating tables and drawing pictures.	K_3
CO3	analyze the concepts of Matlab to write programs.	K_4
CO4	determine the Matlab commands .	K_5
CO5	create tables and pictures using matlab commands	K_6

UNIT I: BASICS OF MATLAB (10 Hours)

Introduction - Basics of MATLAB, Matlab windows - on-line help- Input – Output, File types – Platform dependence – General commands

UNIT II: INTERACTIVE COMPUTATION (10 Hours)

Interactive Computation: Matrices and Vectors – Matrix and Array operations –*Inline* functions – Using Built-in Functions and On-line Help – Saving and loading data – Plotting simple graphs.

UNIT III: PROGRAMMING IN MATLAB (10 Hours)

Programming in MATLAB: Scripts and Functions – Script files – Functions files- Language specific features – Advanced Data objects.

UNIT IV: APPLICATIONS (10 Hours)

Applications – Linear Algebra – Curve fitting and Interpolation – Data analysis and Statistics – Numerical Integration – Ordinary differential equations – Nonlinear Algebraic Equations.

UNIT V: GRAPHICS (8 Hours)

Graphics: Basic 2-D Plots – Using subplot for multiple graphs – 3-D Plots – Handle Graphics – Saving and printing Graphs .

TEXT BOOKS:

1. RUDRA PRATAP(2013) – "Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers", Oxford University Press,.

UNIT	CHAPTER	SECTION
I	I	1.1-1.6.
II	III	3.1-3.2, 3.5.1, 3.6-3.8.
III	IV	4.1 – 4.4
IV	V	5.1 – 5.6
V	VI	6.1 – 6.4, 6.6

REFERENCE BOOK:

1. William John Palm(2005) –" Introduction to Matlab 7" for Engineers, McGraw-Hill Professional.

2. Dolores M. Etter, David C. Kuncicky (2004) – " Introduction to MATLAB 7", Prentice Hall.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP05B	CRYPTOGRAPHY	72	-	4

Preamble

To enable the students to gain the knowledge about encryption techniques, block ciphers and key management.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand and gain the knowledge about the fundamentals of cryptography.	K_1& K_2
CO2	apply the basic concepts and algorithm of number theory to understand the design of DES and other cryptographic algorithms.	K_3&K_2
CO3	design security application in the field of information technology.	K_5, K_6
CO4	analyze the security issues in the network and resolve it.	K_3&K_5
CO5	gain the knowledge about public key cryptography	K_1

UNIT I:CRYPTOGRAPHY (15 Hours)

Introduction - Encryption and Decryption – Symmetric and asymmetric key cryptography.

UNIT II: NUMBER THEORY **(15 Hours)**

Number Theory: Introduction –Prime Numbers - Fermats and Euler's Theorems - The Chinese Remaunder Theorem – Discrete Logaritms.

UNIT III: FINITE FIELDS **(15 Hours)**

Finite fields: –The Euclidean Algorithm– Modular Arithmetic –Polynomial Arithmetic – Finite Field Arithmetic.

UNIT IV: SYMMETRIC KEY ENCRYPTION

Symmetric key encryption – Stream ciphers – Block Ciphers – DES **(15 Hours)**

UNIT V: PUBLIC KEY CRYPTOGRAPHY **(12 Hours)**

Public key cryptography – Concepts of public key cryptography – RSA – Elliptic curve cryptography.

TEXT BOOK

1. ATUL KAHATE (2009) - "Cryptography and Network Security", Second Edition, Tata McGraw Hill Education Pvt. Ltd.
2. WILLIAM STALLINGS(2013)- "Cryptography and Network Security", Fifth Edition, Dorling Kindersley India Pvt. Ltd.

UNIT	BOOK	SECTION	PAGE
I	**1**	**2.1,2.2,2.5,2.6**	**38-41,59-73**
II	**2**	**8.1-8.5**	**269-281**
III	**2**	**4.1-4.7,5.1**	**127-163,172**
IV	**2**	**2.1,3.1,3.2,3.6, 7.4**	**57-62,90-109,116-120, 256-258**
V	**2**	**9.1,9.2,10.3,10.4**	**290-314,324-329,341-344**

REFERENCE BOOK:

BRUICE SCHNEIER (2012) - "Applied Cryptography", Second Edition, Wiley Indian Pvt,Ltd., New Delhi-110002.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP06	MATLAB - PRACTICAL	-	24	2

LIST OF PROGRAMS

Group - A

All the following listed prgrams have to be executed and recorded

A1. Write a program using MATLAB to generate Fibonacci series.

A2. Using MATLAB, write a program to solve the system of simultaneous equations with two variables by matrix method.

A3. Write a program using MATLAB to calculate Mean, Median, Standard Deviation, Variance for a set of 'n' numbers.

A4. Write a program using MATLAB to calculate Maximum Value, Minimum Value, Range, Skewness and Kurtosis for a set of 'n' numbers.

A5. Write a program using MATLAB to find the Eigen Values and Eigen Vectors of a given matrix.

Group - B

B1. Using MATLAB, solve the following first order linear differential equation using Euler's method: $dy/dx = -y$, $y(0) = 1$. Draw the graph and compare the exact solution.

B2. Using MATLAB, obtain the straight line fit and estimate the value of Y when X=25, for the following data:

X :	5	10	20	50	100
Y :	15	33	53	140	301

B3. Using MATLAB, write a program to plot the function f(t) = t *sint, $0 \leq t \leq 10\boldsymbol{\pi}$.

B4. Draw a Pie chart using MATLAB, for the following data.

Continent	South America	North America	Africa	Europe	Asia
Population (in %)	6	8	13	12	61

B5. Using MATLAB, Plot the function y = sin(exp(x))-1 between the limit point for x – axis as [-5,4] and numpoints as 400.

SEMESTER II

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP08	COMPLEX ANALYSIS	72	-	4

Preamble :

To enable the students to learn the concept of complex number system.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the fundamental concepts of complex number system and analytic functions	K_1
CO2	define analytic function, Residues , Taylor series , Laurent series and mappings.	K_1 & K_2
CO3	apply Cauchy's theorem , Taylor's Theorem , Residue theorem , Weierstrass's Theorem, Riemann Mapping theorem for the analytic function.	K_3
CO4	analyze singularities, complex integration and power series expansion.	K_4 , K_6
CO5	evaluate integrals along a path in the complex plane, branch points.	K_5

UNIT I: INTRODUCTION TO THE CONCEPT OF ANALYTIC FUNCTION

(19 Hours)

Limits and continuity – Analytic functions – Polynomials – Rational functions. Conformality: Arcs and closed curves – Analytic functions in regions – Conformal Mapping – Length and Area – Linear Transformations: The Linear group – The Cross ratio – Elementary Riemann Surfaces.

UNIT II: COMPLEX INTEGRATION (19 Hours)

Line Integrals - Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's theorem for a rectangle - Cauchy's theorem in a disk- Cauchy's Integral formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives - Removable singularities, Taylor's Theorem – Zeros and Poles – The Local Mapping– The Maximum principle – Chains and cycles.

UNIT III: THE CALCULUS OF RESIDUES (12 Hours)

The Residue theorem – The Argument principle – Harmonic functions: Definitions and basic Properties – The Mean value property – Poisson's Formula.

UNIT IV: SERIES AND PRODUCT DEVELOPMENTS (12 Hours)

Weierstrass's Theorem – The Taylor Series – The Laurent Series – Partial fractions and Factorization: Partial Fractions – Infinite Products – Canonical Products.

UNIT V: MAPPING THEOREM (10 Hours)

The Riemann Mapping Theorem: Statement and Proof – Boundary Behaviour – Use of the reflection principle – Analytic Arcs – Conformal mapping of Polygons: The Behaviour at an angle – The Schwarz – Christoffel Formula – Mapping on a rectangle.

TEXT BOOK:

Ahlfors L.V. – (2014), "Complex Analysis" , 4th Reprint , Mc Graw Hill Education (India) Pvt.Ltd New York.

UNIT	CHAPTER	SECTION
I	2 3	1.1 – 1.4 2.1 – 2.4, 3.1, 3.2 and 4.3
II	4	1.1 – 1.5, 2.1 – 2.3, 3.1 - 3.4,4.1
III	4	5.1 – 5.2, 6.1 – 6.3
IV	5	1.1 – 1.3, 2.1 – 2.3
V	6	1.1 – 1.4, 2.1 – 2.3

REFERENCE BOOK:

Ruel V.Churchill (1990) – "Complex Variables and Applications", Fifth Edition, Mc Graw – Hill International Editions.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP09	PARTIAL DIFFERENTIAL EQUATIONS	60	-	4

Preamble :

To enable the students to learn and gain knowledge about initial boundary- value problems, Methods for solving Partial Differential Equation and Green's function.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	gain the knowledge in hyperbolic, parabolic, elliptic type partial differential equations, method of separation of variables, initial and boundary value problems, Green's function.	K_1
CO2	understand the classification of second order partial differential equations, D'Alembert's solution, existence and uniqueness of solutions, method of images.	K_2
CO3	apply the method of separation of variables and Green's function to evaluate initial - boundary value problems.	K_3
CO4	classify second order partial differential equations and analyze the solutions of initial and boundary value problems.	K_4

CO5	construct the solutions of second order partial differential equations.	**K_5, K_6**

UNIT I: MATHEMATICAL MODEL (12 Hours)

The Classical equation – The vibrating string – The vibrating membrane – Conduction of heat in solids. Classification of second order equations: Second order equations in two independent variables – Cannonical forms – Equations with constant coefficients – General solution.

UNIT II: THE CAUCHY PROBLEM (12 Hours)

The Cauchy problem – Cauchy – Kowlalewskaya theorem –Homogeneous wave equation – Initial – Boundary value problems – Non-homogeneous boundary conditions – Non-homogeneous wave equation.

UNIT III: METHOD OF SEPARATION OF VARIABLES (12 Hours)

Separation of variables – The vibrating string problem – Existence and Uniqueness of solution of the vibrating string problem. The heat conduction problem – Existence and uniqueness of solution of the heat conduction problem – The Laplace and beam equations.

UNIT IV: BOUNDARY VALUE PROBLEMS (12 Hours)

Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorems – Dirichlet problems for a circle – Dirichlet problems for a circular annulus – Neumann problem for a circle Drirchlet problem for a rectangle – Neumann problem for a rectangle.

UNIT V: GREEN'S FUNCTIONS (12 Hours)

The Dirac delta function – Properties of Green's function – Method of Green's functions – Dirichlet problem for the Laplace operator – Method of images – Method of Eigen functions.

TEXT BOOK:

Tyn Myint. U with Lokenath Debnath (2007) – "Linear Partial Differential Equations for Scientists and Engineers", 4th Edition , Birkhusar Boston, New York.

UNIT	CHAPTER	SECTION
I	**III** **IV**	**3.1 – 3.5 (omit 3.4)** **4.1 – 4.4**
II	**V**	**5.1 – 5.5,5.7**
III	**VII**	**7.1 – 7.6**
IV	**IX**	**9.1 – 9.9 (omit 9.8)**
V	**XI**	**11.1 – 11.8 (omit 11.6)**

REFERENCE BOOKS

1. Evans.L.C., (2003) – "Partial Differential Equations", AMS, Providence, R I.

2. Sneddon.I.N. (1957) - "Elements of Partial Differential Equations", McGraw Hill, London.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP10	CLASSICAL MECHANICS	60	-	4

Preamble :

To enable the students to learn and gain knowledge about mechanical systems.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the notions of configuration space, generalised coordinates, canonical transformations and phase space in mechanics.	K_1 & K_2
CO2	analyze the Euler-Lagrange equations from a variational principle and Hamiltonian formulation of a mechanical system	K_4
CO3	apply theoretical techniques including variational principles and Hamilton Jacobi Theory in mechanical systems.	K_3, K_6
CO4	analyze theoretical techniques	K_4
CO5	evaluate the cause of linear, rotational and rolling motions, by describing torques, work and energy, impulse and momentum associated with objects undergoing each type of motion.	K_5

UNIT I: INDRODUCTORY CONCEPTS (12 Hours)

Mechanical system – Generalized coordinates –Constraints – Virtual work – Energy and momentum.

UNIT II: LAGRANGE'S EQUATIONS (12 Hours)

Derivations of Lagrange's Equations– Examples-Integrals of motion.

UNIT III: HAMILTON'S EQUATIONS (12 Hours)

Hamilton's Principle – Hamilton's equations.

UNIT IV: HAMILTON – JACOBI THEORY (12 Hours)

Hamilton's principle function – Hamilton – Jacobi equation.

UNIT V: CANONICAL TRANSFORMATIONS (12 Hours)

Differential forms and generating functions –Lagrange and Poisson brackets.

TEXT BOOK:

Greenwood.D.T. (1997) – "Classical Dynamics", Dover Publication, New York.

UNIT	CHAPTER	SECTION
I	1	1.1 - 1.5
II	2	2.1 – 2.3
III	4	4.1 – 4.2
IV	5	5.1 – 5.2
V	6	6.1,6.3

REFERENCE BOOKS:

1. Gupta.S.C,Kumar.V.Sharma.H.V.(2015)-"Classical Mechanics" K.K Mittal for Pragatti Prakashan,Meerut.
2. Gupta.A.S.(2009)-"Calculus of Variation" PHI Learning pvt.ltd.New delhi.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP11	MATHEMATICAL STATISTICS	60	-	4

Preamble

To enable the students to learn and gain knowledge about various probability distributions.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	define the concepts based on probability.	K_1
CO2	analyze the various kinds of distribution functions.	K_4
CO3	gain the knowledge about the different types of density functions.	K_2
CO4	apply the concepts based on moment – generating functions to find the moments.	K_3
CO5	evaluate the problems based on Uniform, Bernoulli, Binomial, Uniform, Exponential and Chi-Square Distributions.	K_5, K_6

UNIT I : THEORY OF PROBABILITY (12 Hours)

Introduction – Sample spaces – Sample point – Discrete and Continuous sample spaces - Events – Venn diagrams – The probability of an Event – Rules of Probability.

UNIT II : PROBABILITY DISTRIBUTIONS (12 Hours)

Random variables – Discrete and Continuous Random Variables – Probability Distributions – Distribution function – Continuous Random Variables – Probability density functions.

UNIT III : MATHEMATICAL EXPECTATION (12 Hours)

Introduction – The expected value of a Random Variable – Moments - Chebyshev's theorem – Related Examples – Moment – Generating functions.

UNIT IV : SPECIAL PROBABILITY DISTRIBUTIONS (12 Hours)

Introduction – The Discrete Uniform Distribution – The Bernoulli Distribution – Bernoulli trial (Repeated trials) – The Binomial Distribution – Moment Generating function of Binomial Distribution – The Negative Binomial and Geometric Distributions.

UNIT V : SPECIAL PROBABILITY DENSITIES (12 Hours)

Introduction – The Uniform Distribution – Mean and Variance – The Gamma Distribution – Exponential Distribution – The Chi-Square Distribution.

TEXT BOOK :

Irwin Miller and Marylees Miller (2012) - "Mathematical Statistics ", Seventh Edition, Pearson Publications, New Delhi.

UNIT	CHAPTER	SECTION
I	II	2.1 – 2.5
II	III	3.1 – 3.4
III	IV	4.1 – 4.5
IV	V	5.1 – 5.5
V	VI	6.1 – 6.3

REFERENCE BOOK :

Kapur.J.N and Saxena.H.C. (2011) - "Mathematical Statistics", 20th Edition, S.Chand & company, Ram Nagar, New Delhi.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP12	MATHEMATICAL SOFTWARE – II (SPSS) - PRACTICAL	-	24	2

LIST OF PROGRAMS

All the following listed programs have to be executed and recorded

1. Create a SPSS database and to find Mean, Harmonic Mean and Geometric Mean.
2. Create a SPSS database and to find Median and Mode.
3. Find the Standard deviation, Variance and Range by using SPSS database.
4. Find the Standard error of Mean, Maximum and Minimum by using SPSS database.
5. Create a SPSS database and to find both Pearson's and Spearman's correlation in both 1- Tailed and 2-Tailed tests.
6. Create the SPSS database to fit the Straight line and plot the Exponential curve using Regression.
7. Create a SPSS database and present that data through charts and diagrams.
8. Find the probability distribution by using Binomial distribution in SPSS.
9. Find the probability distribution by using Poisson distribution in SPSS.
10. Find the probability distribution by using Normal distribution in SPSS.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP13A	DIFFERENTIAL GEOMETRY	60	-	4

Preamble

To enable the students to learn and gain knowledge about the space curves, fundamental forms and geodesic on a surface.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	gain the knowledge about the theory of space curves and surfaces	K_1
CO2	understand the basic terms and tools of differential geometry	K_2
CO3	determine the Gaussian curvature,principal curvatures and lines of curvatures of the curve	K_3
CO4	analyse the nature of points on the space curve and surface and deduce the conditions that a point to be singular,ordinary,elliptic,etc..	K_4, K_6
CO5	Evaluate the fundamental quadratic forms,intrinsic and extrinsic forms of surface	K_5

UNIT I : THEORY OF SPACE CURVES (15 Hours)

Introduction – Representation of space curves – Unique parametric representation of a space curve – Arc-length – Tangent and osculating plane – Principle normal and binormal – Curvature and torsion –Contact between curves and surfaces.

UNIT II : THEORY OF SPACE CURVES (CONTINUATION) (15 Hours)

Osculating circle and osculating sphere – Locus of centre of spherical curvature – Tangent surfaces – Involutes and Evolutes –Spherical indicatrix- Intrinsic equations of space curves – Fundamental existence theorem for space curves.

UNIT III : THE FIRST FUNDAMENTAL FORM (10 Hours)

The first fundamental form – Local intrinsic properties of a surface: Introduction - Definition of a surface – Nature of points on a surface – Representation of a surface – Curves on surfaces – Metric on a surface –The first fundamental form– Families of curves – Orthogonal trajectories – Double family of curves.

UNIT IV : THE SECOND FUNDAMENTAL FORM (10 Hours)

The Second Fundamental form and local non-intrinsic properties of a surface: Introduction – The Second fundamental form-Classification of points on a surface- Principal curvatures- Lines of curvature.

UNIT V : GEODESIC ON A SURFACE (10 Hours)

Normal property of Geodesics –Gaussian curvature-The Fundamental Equations of Surface Theory: Introduction – Tensor notations –Gauss equations –Weingarten equations-Mainardi-Codazzi equations.

TEXT BOOK:

Somasundaram.D (2010)– "Differential Geometry", Fourth Reprint , Narosa Publishing House Pvt. Ltd., Chennai.

UNIT	CHAPTER	SECTION
I	**I**	**1.1 - 1.7, 1.10**
II	**I**	**1.11 - 1.13 , 1.15 – 1.17**
III	**II**	**2.1 - 2.5, 2.9-2.13**
IV	**IV**	**4.1 - 4.5**
V	**III**	**3.5, 3.12, 5.1-5.5**

REFERENCE BOOK

Struik D.T(1961) - **"**Lectures on Classical Differential Geometry", Addison – Wesley, Publishing company INC.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP13B	PROGRAMMING IN C	60	-	4

Preamble

To enable the students to learn about the basic structure, statements, arrays, functions of C language.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the basic structure of C Programme.	K_1 & K_2
CO2	gain the knowledge about various types of operators and statements of C language	K_2
CO3	analyze the decision making statements and expressions.	K_4, K_6
CO4	learn the concepts of arrays.	K_2
CO5	solve numerical problems by using C programs.	K_5

UNIT I: INTRODUCTION (12 Hours)

Introduction – Importance of C - Basic structure of C program - Character set - Constants – Keywords and identifiers – Variables Data types – Declaration of variables – Assigning values to variables –Defining symbolic constants.

UNIT II: OPERATORS (12 Hours)

Arithmetic operators - Relational operators - Logical operators – Assignment operators –Increment and decrement operates –Conditional operators – Special operators – Arithmetic expressions –Evaluation of expressions –Precedence of arithmetic operators.

UNIT III: DECISION MAKING STATEMENTS (14 Hours)

Reading and Writing character – Formatted input and output. Decision making with IF statement – Simple IF statement – The if ELSE statement - Nesting of IF…..ELSE statement – The ELSE IF ladder. The Switch statement –The ? Operator –The GOTO statement.

UNIT IV: STATEMENTS (10 Hours)

The WHILE statement - The DO statement - The FOR statement –Jumps in loops.

UNIT V: ARRAYS (12 Hours)

One dimensional arrays - Two dimensional arrays – Initiating two dimensional arrays – Multidimensional arrays.

TEXT BOOK:

Balagurusamy .E (2017) - "Programming in ANSI C", Fourth Edition , Tata McGraw –Hill Publishing company limited, New Delhi.

Unit - I	**Chapter I** **Chapter II**	**Page: 12** **Page: 22 – 45**
Unit – II	**Chapter III**	**Page: 51 - 65**
Unit –III	**Chapter IV** **Chapter V**	**Page: 81-94** **Page: 111 -136**
Unit –IV	**Chapter VI**	**Page: 149-167**
Unit – V	**Chapter VII**	**Page: 189-205,** **212-213**

REFERENCE BOOKS:

1.Byron Gottfried (1996) - "Programming with C"(Schaum's outline series), Second Edition, -Tata McGrawHill publishing company.

2. Ashok N.Kamthane (2007) - "Programming with Ansi and Turbo C", Third Edition, Pearson Education publishers.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
SKILL ENHANCEMENT	18SEP01	CYBER SECURITY	24	-	2

Preamble

To understand the basics of cyber security and the security threats in day-to-day activities.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the basic concepts of information security and its types	K_1
CO2	obtaining the knowledge thoroughly on cyber security and its principles	K_1
CO3	deals with risk management and threats	K_1 & K_2
CO4	gain detailed knowledge on security issues in social media	K_3 & K_4
CO5	apply and work with cyber security applications in real world	K_5 & K_6

Unit I: INFORMATION SECURITY (5 Hours)

History of Information Security - Need for Security-**Types of security:** Physical Security – Network security –Personal security –Operation security –Communication security - Information security threats.

Unit II: INTRODUCTION TO CYBER SECURITY (5 Hours)

Cyber Security: Objectives- Roles- Differences between Information Security and Cyber Security. **Cyber Security Principles:** Confidentiality- Integrity – Availability.

Unit III: RISKS & VULNERABILITIES (5 Hours)

Risk Meaning: Risk Management –Problems of Measuring Risk -Risk Levels-Risk Analyzes-Risk Assessment –Response to Risk Terminology- **Threats:** Components of Threats-Types of Threats- **Vulnerabilities:** Computing System Vulnerabilities –Hardware Vulnerabilities-Software Vulnerabilities-Data Vulnerabilities-Human Vulnerabilities.

Unit IV: SOCIAL MEDIA (5 Hours)

Introduction to social media: What, Why –Pros and cons- **Security issues in social media:** Mail-Facebook-Whatsapp-Twitter-Preventive and control measures.

Unit V: CASE STUDY (4 Hours)

Impact of social media: Education -Business- Banking-Mobile –Human Life- Present generation-Indian scenario.

WEB REFERENCES

1. **https://m.youtube.com/watch?v=o6pgd8gLFHg**
2. **https://m.youtube.com/watch?v=3rl4ZjZpcHU**
3. **https://blog.barkly.com/10-fundamental-cybersecurity-lessons-for-beginners**
4. **https://5social media security risk and how to avoid them.html**
5. **https://10 cyber security twitter profiles to watch.html**
6. **https://cyber security in banking 4 trends to watch in 2017.html**
7. **https://gmail hacking security tips-indian cyber security solutions.html**
8. **https://why social media sites are the new cyber weapons of.html**
9. **EBook:A complete guide to Staying Ahead in the Cyber Security Game**

SEMESTER III

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP15	TOPOLOGY	84	-	5

Preamble

To enable the students to learn and gain knowledge about Topological Space.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the axioms of topological space, connected space, countability, separation, completely regular space, complete metric space.	K_1
CO2	define and recognize the properties of general topological space, continuous function, metric space,compactness.	K_1 & K_2
CO3	apply the concepts of urysohn lemma, urysohn metrization theorem, the tychonoff theorem and ascoli's theorem in topological spaces.	K_3
CO4	analyze the separation properties, convergent sequence, metric space in the general theory of topological space	K_4, K_6
CO5	prove the theorems in Topological space, connectedness and compactness, countability and separation axioms , completely regular space and complete metric.	K_3 & K_5

UNIT I: TOPOLOGICAL SPACE (17 Hours)

Topological spaces – Basis for a Topology – The Order Topology – Product Topology – Closed sets and Limit Points – Continuous Functions.

UNIT II: CONNECTEDNESS (18 Hours)

Metric Topology-Connected Spaces –Connected sets in the real line –Components and path components -Local connectedness.

UNIT III: COMPACT SPACE (18 Hours)

Compact Spaces –Compact subspaces of the real line-Limit Point Compactness –Local compactness.

UNIT IV: COUNTABILITY (17 Hours)

The Countability Axioms – The Separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn Metrization Theorem .

UNIT V: THE TYCHONOFF THEOREM (14 Hours)

The Tychonoff Theorem – Completely regular spaces – The stone - Cech Compactification.

TEXT BOOK:

James R. Munkres (2005) - "Topology" ,2nd edition, Prentice Hall of India Private Limited, New Delhi.

UNIT	CHAPTER	PAGE NUMBER
I	II	75 - 111
II	II,III	119 – 133, 147 - 162
III	III	163 - 185
IV	IV	189 - 218
V	V	230 - 241

REFERENCE BOOKS:

1. J. Dugundji, (1966) –"Topology", Allyn and Bacon, (Reprinted in India by Prentice Hall of India Private Limited)

2. George F. Simmons,(1963) - " Introduction to Topology and Modern Analysis", McGraw Hill Book Company.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP16	THEORY OF NUMBERS	72	-	5

Preamble :

To enable the students to learn and gain knowledge about Number theory.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	gain the knowledge in theory of numbers	K_1
CO2	understand the concepts of Congruences, Quadratic reciprocity and Arithmetic functions.	K_2
CO3	analyze and solve the problems by using Congruence formula	K_4 &K_5
CO4	apply Quadratic reciprocity law to solve the problems	K_3&K_6
CO5	evaluate the solutions of congruences of higer degree	K_5

UNIT I: INTRODUCTION TO THE CONCEPT OF NUMBERS (15 Hours)

Introduction- Divisibility-Primes.

UNIT II: CONGRUENCES (15 Hours)

Congruences-Solutions of congruences- Congruences of Degree 1- The functions $\phi(n)$ -Congruences of higher degree-Prime power moduli-Prime modulus.

UNIT III: CONGRUENCES (15 Hours)

Primitive roots and power residues-Congruences degree 2- Prime modulus-Power Residues-Number theory from an algebraic view point - Multiplicative groups-Rings and fields-Quadratic residues **.**

UNIT IV: QUADRATIC RECIPROCITY (15 Hours)

Quadratic reciprocity – The Jacobi Symbol – Greatest integer function.

UNIT V: ARITHMETIC FUNCTIONS (12 Hours)

Arithmetic functions – The Moebius Inversion formula – The multiplication of arithmetic functions – Recurrence functions.

TEXT BOOK

Ivan Nivan and Herberts Zucherman (2013) – "An Introduction to Theory of Numbers", Fifth edition, Wiley Indian Pvt,Ltd.,New Delhi-110002.

UNIT	CHAPTER	SECTIONS
I	**I**	**1.1-1.3**
II	**II**	**2.1-2.3,2.6 & 2.7**
III	**II,III**	**2.8-2.11,3.1**
IV	**III,IV**	**3.2,3.3 & 4.1**
V	**IV**	**4.2-4.4**

REFERENCE BOOKS

1. Apostol. T.M. (1995)**–** "Introduction to Analytic Number Theory", First edition Springer Verlag.

2. Gareth Jones .A. & Mary Jones J.(1998) – " Elementary Number Theory" -Springer publications.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP17	OPTIMIZATION TECHNIQUES	84	-	5

Preamble :

To enable the students to learn and gain knowledge about various methods to solve the problems in Operations Research.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the mathematical tools that are needed to solve optimization problems.	K_2
CO2	learn how to solve the transportation problems by using various techniques and to find the shortest path for Network scheduling.	K_3 & K_5
CO3	evaluate the problems based on the advanced methods for large-scale transportation and assignment problems.	K_5
CO4	analyze the use of basic methodology for the solution of linear programs and integer programs.	K_4, K_6
CO5	define the basic terms under transportation problems, Network sheduling and probability.	K_1

UNIT I: INTRODUCTION TO O.R. **(16 Hours)**

What is Operations Research? – Introduction –Origin and Development of O.R. – Nature and Features of O.R. – Scientific Method in O.R. – Modelling in Operations Research - Linear Programming Problem – Introduction – Linear Programming Problem – Mathematical Formulation of the Problem – Illustration on Mathematical Formulation of LPP's.

UNIT II: TRANSPORTATION PROBLEM **(19 Hours)**

Transportation problem – Introduction – Linear Programming Formulation of the Transportation Problem – Existence of Solution in T.P. – Duality in Transportation Problem – The Transportation Table – Loops in Transportation Tables – Triangular basis in a T.P. – Solution of a Transportation problem – Finding an Initial Basic Feasible Solution.

UNIT III: NETWORK SCHEDULING **(17 Hours)**

Network Scheduling by PERT/CPM – Introduction – Network: Basic Components – Logical Sequencing – Rules of Network Construction - Concurrent Activities - Critical Path Analysis – Distinction between PERT and CPM.

UNIT IV: GAMES AND STRATEGIES **(17 Hours)**

Games and Strategies – Introduction – Two – Person Zero – Sum Games – Some Basic Terms – The Maximin – Minimax Principle – Games Without Saddle Points – Mixed Strategies – Assignment Problem – Introduction – Mathematical formulation of the problem – Solution Methods of Assignment Problem – Special Cases in Assignment Problem – A Typical Assignment Problem.

UNIT V: PROBABILITY **(15 Hours)**

Probability – Introduction – Uncertainty and Probability – Sample Space and Probability – Algebra of Events – Conditional Probability.

TEXT BOOK:

Kanti Swarup, Gupta P.K., Man Mohan (2014) – "Operations Research", Fifteenth Thoroughly Revised Edition , Sultan Chand and Sons, Educational Publishers, New Delhi.

UNIT	CHAPTER	SECTION
I	**I** **II**	**1.1 – 1.5** **2.1 – 2.4**
II	**X**	**10.1 – 10.09**
III	**XXV**	**25.1 – 25.6, 25.8 (omit 25.7)**
IV	**XVII** **XI**	**17.1 – 17.5** **11.1 – 11.5**
V	**XIV**	**14.1 – 14.5**

REFERENCE BOOK:

Hamdy A.Taha (2008) – "Operations Research – An Introduction", Eighth Edition , PHI Learning Pvt. Ltd, New Delhi.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP18	MATHEMATICAL SOFTWARE – II (R SOFTWARE) - PRACTICAL	-	24	2

LIST OF PROGRAMS

All the following listed programs have to be executed and recorded

1. To use R software as a calculator.
2. To enter, manipulate and retrieval of data from Notepad and Excel sheet to R.
3. To create data frame directly in R.
4. To display data using pie diagram, box plot, histogram and bar plot.
5. To define and call the functions in R environment.
6. To find mean, median, geometric mean, harmonic mean of numerical data.
7. To find the standard deviation, variance of the given data.
8. To find Correlation co-efficient and linear regression line for Bivariate data.
9. To find multiple linear regression models.
10. To compute probabilities in various distributions.
11. To draw the graph of probability mass and density functions.
12. To analyse the data using one and two sample ‘t’ test and paired ‘t’ test.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
COMPETENCY ENHANCEMENT (SELF STUDY)	18PEPMA01	INDUSTRIAL MATHEMATICS	-	-	2

Preamble

To enable the students to learn decision making problems based on operations research and gain the knowledge about numerical methods.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the meaning, purpose, and tools of operations research.	K_2
CO2	gain the knowledge about simulation, Inventory control and Numerical Methods.	K_1
CO3	apply the concepts of Inventories to find EOQ.	K_3
CO4	Analyze the concept of Interpolation with equal and unequal integrals and find the solution to the problems by using various methods.	K_2 & K_4
CO5	evaluate the problems based on types of inventory control.	K_5, K_6

Unit I: INTRODUCTION TO OPERATIONS RESEARCH

Scientific methods in O.R –Modeling in operations research – Advandages and limitations of models – Methodology of operations research – O.R and Decision Making – Applications of operations research -Opportunities and short comings of operations research.

UNIT II: SIMULATION

Introduction – Process of simulation – Simulation models – Eevent–type simulation – generation of random numbers Mmonte-carlo simulation .

UNIT-III: INVENTORY CONTROL

Types of inventories - Objectives of scientific Inventory control-Inventory costs – EOQ Problem with no shortages .

UNIT IV : INFORMATION THEORY

Introduction – Measure of information – Entropy-The expected information –Joint conditional entropies .

UNIT V: INTERPOLATION

Interpolation with equal integrals: (Central Diffrence Interpolation Formulae)

Gauss Forward formula – Gauss Backward formula - Stirling's Formula.

Interpolation with unequal integrals:

Lagrange's Interpolation – Inverse interpolation.

TEXT BOOK:

1. Kanti Swarup, P. K. Gupta, Man Mohan (2017) –" Operations Research" 18th Revised Edition , S. Chand & Sons Education Publications, New Delhi.
2. Dr.Venkataraman.M.K.(2013) – "Numerical Methods in Science and Engineering", The National Publishing Company, Chennai.

UNIT	BOOK	CHAPTER	PAGE
I	1	1	27-35
II	1	22	639-646
III	1	19	507-524
IV	1	30	885-889, 901-903
V	2	7 8	216-225, 253-259, 262-263

REFERENCE BOOKS:

1. Dharani Venkata Krishnan .S – " Operations Research Principles and Problems" Keerthi publishing house PVT Ltd.
2. Kandasamy. P, Thilagavathi. K and Gunavathi. K (2007) - "Numerical methods" S. Chand and Company Ltd, New Delhi – Revised Edition.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP19A	GRAPH THEORY	60	-	4

Preamble:

To enable the students to learn and gain knowledge about Graphs, Euler tours, Hamiltonian cycles, Matching and Colourings of edges as well as vertices.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the basic concepts of graph theory.	K_1
CO2	gain the knowledge about graph and types of graph.	K_2
CO3	apply the concepts in Euler tours and Hamiltonian cycles.	K_3
CO4	analyze the Matching and Independent sets.	K_3& K_4
CO5	Evaluate the Colouring.	K_5, K_6

UNIT I: FUNDAMENTAL CONCEPTS OF GRAPHS AND TREES (12 Hours)

Graphs - Simple Graphs – Graph Isomorphism – The Incidence and Adjacency matrices – Subgraphs – Vertex Degrees – Paths and Connection – Cycles and trails. Trees – Cut edges and Bonds – Cut vertices – Cayley's formula.

UNIT II: CONNECTIVITY AND PATHS (12 Hours)

Connectivity – Blocks. Euler tours and Hamilton Cycles: Euler tours – Hamilton Cycles.

UNIT III: MATCHINGS (12 Hours)

Matchings and coverings in Bipartite Graphs – Perfect Matchings. Edge colourings: Edge Chromatic number – Vizing's theorem.

UNIT IV: INDEPENDENT SETS AND VERTEX COLOURINGS (12 Hours)

Independent sets – Chromatic Number – Brook's Theorem – Hajo's Conjecture.

UNIT V: PLANAR GRAPHS (12 Hours)

Plane and planar Graphs – Dual Graphs – Euler's formula – Bridges – Kuratowski's theorem (Proof omitted) – Five Colour Theorem and Four colour Conjecture.

Text Book:

J.A.Bondy and U.S.R.Murty(1976), "Graph Theory with Applications", American Elsevier Publishing company., Inc., New York,.

UNIT	CHAPTER	SECTION
I	1 2	1.1-1.7 2.1-2.4
II	3 4	3.1-3.2 4.1-4.2
III	5 6	5.1-5.3 6.1-6.2
IV	7 8	7.1 8.1-8.3
V	9	9.1-9.6

REFERENCE BOOKS:

1. Narsingh deo (1987) “Graph Theory”, Prentice Hall of India Private Limited, New Delhi.

2. Frank Harary, “Graph Theory”, Narosa Publishing House, New Delhi.

3. R.Balakrishnan and K.Ranganathan, Springer (2008), “A Text Book of Graph Theory”, New Delhi.

4. V.K. Balakrishnan, Tata Mcgrawhill (2004), “ Graph Theory”, Schaum’s outlines, New Delhi.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP19B	PROGRAMMING IN C++	60	-	4

Preamble

To enable the students to gain knowledge about characteristics of a object oriented program.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	use the basic object-oriented design principles in computer problem solving and understand the basic concepts of oop, functions in C++, C++ streams, specifications about the class, Defining operator overloading, types of inheritances.	$K_{1\&}$ K_5
CO2	learn the characteristics of an object-oriented programming language: data abstraction and information hiding, inheritance, and dynamic binding of the messages to the methods.	$K_{2\&}$ K_4
CO3	learn how to design and implement generic classes with C++ templates.	K_4

CO4	apply overloading of operators in C++ .	**K_3**
CO5	write the programs by using the concepts of C++	**K_5, K_6**

UNIT I: **PRINCIPLES OF OOP** **(12 HOURS)**

Basic Concept of Object-Oriented Programming – Benefits of OOP – Object-Oriented Languages –Applications of OOP. Tokens, Expressions and Control Structure: Introduction – Tokens – Keywords –Identifiers and Constants – Basic Data Types – User Defined Data Types – Storage Classes –Derived Data Types –Symbolic Constants – Type Compatibility – Declaration of Variables – Dynamic Initialization of Variables – Reference Variables – Operations in C++ - Scope Resolution Operator – Member Dereferencing Operators – Memory Management Operators – Manipulators – Type Cast Operator – Expressions and Their Types – Special Assignment Expressions – Implicit Conversions – Operator Overloading – Operator Precedence – Control Structures.

UNIT II: **FUNCTIONS IN C++** **(12 HOURS)**

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.

UNIT III: **CLASSES AND OBJECTS** **(12 HOURS)**

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 – Memory Allocation for Objects – Static Data Members – Static Member Functions – Arrays of Objects –Objects as Function Arguments – Friendly Functions – Returning Objects – Const Member Functions. Constructors and Destructors: Introduction – Constructors – Parameterized Constructors– Multiple Constructors in a Class – Constructors with Default Arguments – Dynamic Initializations of Objects – Copy Constructor –Const Objects – Destructors.

UNIT IV: **OPERATOR OVERLOADING** **(12 HOURS)**

Operator Overloading: Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends –

Manipulation of Strings Using Operators – Some Other Operator Overloading Examples – Rules for Overloading Operators.

UNIT-V: **INHERITANCE** **(12HOURS)**

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 – Constructors in Derived Classes – Member Classes: Nesting of Classes.

TEXT BOOK:

Balaguruswamy.E (2013)– " Object–Oriented Programming with C++", Tata McGraw-Hill Publishing Company Limited, Sixth Edition.

UNIT	CHAPTER	SECTION
I	**1, 3**	**1.5 –1.8 and 3.1 – 3.25**
II	**4**	**4.1 –4.12**
III	**5, 6**	**5.1 – 5.17, 6.1 – 6.7 and 6.10 – 6.11**
IV	**7**	**7.1 –7.8**
V	**8**	**8.1 –8.12**

REFERENCE BOOKS:

1. John R Hubbard (2006) - "Programming with C++", Second Edition Tata MCgraw Hill Publishers, New Delhi.

2. Bjarne Stroustrup (1999) – " The C++ Programming Language", Third Edition Addison Wesley New Jersey.

SEMESTER IV

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP21	FUNCTIONAL ANALYSIS	72	-	5

Preamble

To enable the students to learn and gain knowledge about Banach spaces and Hilbert spaces.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the basic concept of Banach spaces, Continuous linear functional, Bounded linear operator , Hilbert spaces and operators.	K_1
CO2	define banach space, Hilbert space and the conjugate of an operator.	K_1 & K_2
CO3	apply the knowledge of functional analysis to solve mathematical problems.	K_3 & K_5
CO4	analyze some basic properties by using metric spaces, normed linear space, parallelogram law, orthogonal complements, the adjoint operators, projection theorem.	K_4
CO5	establish the weak and weak* topology, complete orthogonal set, complete orthonormal set adjoint operators and projection operators.	K_5, K_6

UNIT I: BANACH SPACES (15 Hours)

Introduction- Basic inequalities –Metric Space and its properties –Vector space – Normed linear spaces, Definitions and properties-Examples of Banach spaces-Quotient spaces-Direct sum of subspace-Continuous linear transformations.

UNIT II: CONTINUOUS LINEAR FUNCTIONALS (15 Hours)

Introduction- continuous linear functional-Representation theorems for functional-The Hahn Banach Theorem-Some consequences of the Hahn Banach Theorems.

UNIT III: BOUNDED LINEAR OPERATORS (15 Hours)

Introduction-The open mapping theorem-The closed graph theorem-The banach Steinhaus theorem-The Weak and Weak* Convergence-The conjugate of an operator.

UNIT IV: HILBERT SPACE (15 Hours)

Introduction- Definitions and Examples-Hilbert space and its basic properties-Applications of the parallelogram law-Orthogonal Complements-The Orthogonal Decomposition Theorem-Orthonormal sets-Complete orthogonal sets.

UNIT V: OPERATORS ON HILBERT SPACES (12 Hours)

Introduction-The adjoint Operator-Self adjoint operator-Normal operator-Unitary operator-Projection operators.

TEXT BOOK:

D.Somasundaram (2013) - "A First Course in Functional Analysis ", Third Re-Print , Narosa Publishing House ,New Delhi.

Unit	Chapter	Sections
I	I	1.1 – 1.9
II	II	2.1-2.5
III	III	3.1 –3.2, 3.4-3.7
IV	IV	4.1 -- 4.8
V	V	5.1 – 5.6

REFERENCE BOOKS:

1 .C. Goffman and G. Pedrick(1987) - "A First Course in Functional Analysis", Prentice Hall of India, New Delhi.

3. G.F. Simmons(1963) - "Introduction to Topology and Modern Analysis", McGraw –Hill Book Company, London.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP22	MATHEMATICAL METHODS	84	-	6

Preamble

To enable the students to learn and gain knowledge about Fourier Cosine and Sine Transforms, Hankel transforms, Integral Equations and Calculus of Variations.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	define the concepts based on Fourier Sine and Cosine transforms, Hankel transforms, Various types of integral equations and Calculus of Variations.	K_1
CO2	analyze and apply the Fourier Transforms in Laplace Equation and also apply the integral equations in ordinary differential equations..	K_4 & K_3
CO3	gain the knowledge about the properties of Fourier and Hankel Transforms.	K_2
CO4	learn and analyze the concepts of Fredhlom Integral Equation and Volterra Integral equation, Calculus of Variation.	K_2 & K_4
CO5	evaluate the problems based on Fourier Cosine and sine Transforms, Axisymmetric Dirichlet problems, Euler's Eqaution and Fredhlom Integral Equation and Volterra Integral equations.	K_5, K_6

Unit I: FOURIER TRANSFORMS: (20 Hours)

Fourier sine and cosine transforms –Fourier transforms of derivatives -Fourier transforms of simple functions -Convolution integral –Parseval's Theorem - Solution of PDE by Fourier transform –Laplace equation in half plane. The Linear diffusion equation on a semi infinite line –The two dimensional diffusion equation.

Unit II: HANKEL TRANSFORMS: (15 Hours)

Properties of Hankel Transforms –Hankel transformation of derivatives of functions (Statementonly) –Hankel Inversion Theorm (Statement only)-The Parseval's relation –Axisymmetric Dirichlet problem for a half space -Axisymmetric Dirichlet problem for a thick plate.

Unit III: INTEGRAL EQUATIONS: (20 Hours)

Types of Integral equations –Integral Fredholm Alternative -Approximate method –Equation with separable Kernel -Volterra integral equations

Unit IV: **SINGULAR & ABEL INTEGRAL EQUATIONS: (15 Hours)**

Application of Integral equation to ordinary differential equation –Initial value problems – Boundary value problems –Singular integral equations – Abel Integral equation.

Unit V: CALCULUS OF VARIATIONS: **(14 Hours)**

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 –Applications.

TEXT BOOKS:

For Units I and II:

Sneddon.I.N.(1974) – "The Use of Integral Transforms", Tata Mc Graw Hill, New Delhi.

For Units III and IV:

Kanwal.R.P. (1971) – "Linear Integral Equations Theory and Technique" , Academic press, New York.

For Unit V:

Elsgolts.L. (1970) – "Differential Equations and Calculus of Variations", Mir publishers, Moscow.

UNIT	CHAPTER	SECTION
I	II	2.4 – 2.7, 2.9 – 2.10, 2.16- 1(a), 2.16.2(a),(b)
II	v	5.2 – 5.4, 5.6, 5.10 (5.10.1,5.10.2)
III	II III	2.3 – 2.5 3.3 – 3.4
IV	V VIII	5.1 – 5.2 8.1 – 8.2
V	VI	6.1 – 6.7

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	18MAP23	FLUID DYNAMICS	72	-	5

Preamble

To enable the students to learn and gain knowledge about the concept of energy equation and boundary layer in compressible and incompressible flow.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	define the concepts based on compressible and incompressible flow, stream lines ,path lines, velocity, density and pressure, source and sink, vortex.	K_1
CO2	analyze and apply the concepts of fluid dynamics in momentum theorem, Blasius theorem and Navier Strokes equations.	K_4 & K_3
CO3	gain the knowledge about vorticity and circulation in various fluid, conservative forces and boundary layer equations.	K_2
CO4	learn and analyze the concepts based on displacement thickness, momentum thickness and kinetic energy thickness.	K_2 & K_4
CO5	evaluate the problems based on stream lines, path lines in two – dimensional motion.	K_5, K_6

Unit I: STREAM LINES AND PATH LINES (15 Hours)

Introductory Notions – Velocity – Stream Lines and Path Lines – Stream Tubes and Filaments – Fluid Body – Density – Pressure. Differentiation following the Fluid – Equation ofcontinuity – Boundary conditions – Kinematical and physical – Rate of change of linear momentum – Equation of motion of an inviscid fluid.

Unit II: ENERGY EQUATION FOR INVISCID FLUID: (15 Hours)

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.

Unit III: TWO DIMENSIONAL MOTION: (15 Hours)

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)

Unit IV: NAVIER-STOKES EQUATIONS: (15 Hours)

Viscous flows – Navier-Stokes equations – Vorticity and circulation in a viscous fluid – Steady flow through an arbitrary cylinder under pressure – Staedy Couettc flow between cylinders in relative motion – Steady flow between parallel planes.

Unit V: BOUNDARY LAYER EQUATIONS (12 Hours)

Laminar Boundary Layer in incompressible flow: Boundary Layer concept – BoundaryLayer equations – Displacement thickness, Momentum thickness – Kinetic energy thickness –Integral equation of boundary layer – Flow parallel to semi infinite flat plate – Blasius equationand its solution in series.

TEXT BOOKS:

For Units I and II:

Milne Thomson. L.M. (1968) –"Theoretical Hydro Dynamics", 5th Edition, McMillan Company.

For Units III, IV and V:

Curle.N and Davies.H.J (1968) – "Modern Fluid Dynamics" – (Volume I) D Van Nostrand Company Limited, London.

UNIT	CHAPTER	SECTION
I	I	1.0 – 1.3., 3.10-3.41 (omit 3.32)
II	III	3.42 – 3.53 (omit 3.44)
III	III	3.1 – 3.7.5 (omit 3.3.4, 3.4, 3.5.2,3.6)
IV	V	5.1 – 5.3.3
V	VI	6.1 – 6.3.1(omit 6.2.2., 6.2.5)

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP25A	FUZZY LOGIC AND FUZZY SETS	60	-	4

Preamble

To enable the students to learn and gain knowledge about fuzzy sets, fuzzy relations, fuzzy measures, uncertainity and information and also their applications.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	gain the knowledge about fundamentals of fuzzy set theory with fuzzy logic.	**K_1 & K_2**
CO2	apply the concepts of fuzzy sets in fuzzy relations.	**K_3**
CO3	analyze the fuzzy measures.	**K_3**
CO4	evaluate the fuzzy logic in various types of uncertainity	**K_4**
CO5	evaluate their relation to information and complexity.	**K_5, K_6**

UNIT – I: CRISP SETS AND FUZZY SETS (12 Hours)

The Notion of Fuzzy sets – basic concepts of Fuzzy sets – Fuzzy complement – Fuzzy union – Fuzzy intersection.

UNIT – II : FUZZY RELATIONS (12 Hours)

Crisp and Fuzzy relations – Binary relations – Binary relations on a single set – Equivalence and similarity relations.

UNIT – III :FUZZY MEASURES (12 Hours)

Belief and plausibility Measures – Probability measures – Possibility and Necessity measures.

UNIT – IV : UNCERTAINTY AND INFORMATION (12 Hours)

Types of Uncertainity – Measures of Fuzziness – Classical measures of Uncertainity – Hartley information – Shannon entropy - Measures of Dissonance – Measures of confusion – Measures of Non-Specificity.

UNIT – V : UNCERTAINTY AND INFORMATION (12 Hours)

General discussion – Natural, life and social sciences – Management and decision making – Computer Science.

TEXT BOOK:

Georege J.Klir and Tina A. Folger, (1995) - "Fuzzy Sets, Uncertainity and Information", Prentice-Hall of India Private Limited.

UNIT	CHAPTER	SECTION
I	1 2	1.3-1.4 2.2-2.4
II	3	3.1-3.4
III	4	4.2-4.4
IV	5	5.1-5.6
V	6	6.1 – 6.6

REFERENCE BOOK:

George J.Klir and Boyuan, “Fuzzy Sets and Fuzzy Logic – Theory and Applications”, Prentice-Hall of India Private Limited.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE	18MAP25B	CONTROL THEORY	60	-	4

Preamble

To enable the students to gain the knowledge about modeling the control systems using difference equations.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	understand the mathematical tools that are needed to solve differential equations.	K_2
CO2	gain the knowledge about research methodology.	K_1
CO3	identify the differential equation models to the real system.	K_4
CO4	learn how to use the various techniques of control systems.	K_2 & K_3
CO5	evaluate the different types of equations to solve real life problems.	K_5, K_6

Unit I: OBSERVABILITY: (12 Hours)

Linear Systems –Observability Grammian –Constant coefficient systems –Reconstruction kernel –Nonlinear Systems.

Unit II: CONTROLLABILITY: (12 Hours)

Linear systems –Controllability Grammian – Adjoint systems –Constant coefficient systems –steering function –Nonlinear systems.

Unit III: STABILITY: (12 Hours)

Stability –Uniform Stability –Asymptotic Stability of Linear Systems.

Unit IV: STABILITY (Continuation) (12 Hours)

Perturbed linear systems –Nonlinear systems – OPTIMAL CONTROL: Linear time varying systems.

Unit V: STABILIZABILITY: (12 Hours)

Stabilization via linear feedback control –Bass method –Controllable subspace –Stabilization with restricted feedback.

TEXT BOOK :

Balachandran.K and Dauer.J.P.(2012)– "Elements of Control Theory", 2nd edition, Narosa, New Delhi.

UNIT	CHAPTER	PAGE NO.
I	2	21 - 38
II	3	40 – 56
III	4	75 - 81
IV	4, 6	82 – 91, 119 – 128, 130 -131,
V	5	100 - 117

REFERENCE BOOKS:

1. Conti .R (1976) – "Linear Differential Equations and Control", Academic Press, London.
2. Curtain.R.F. and Pritchard.A.J.(1977) – " Functional Analysis and Modern Applied Mathematics", Academic Press, New York.
3. Klamka.J (1991) – "Controllability of Dynamical Systems", Kluwer Academic Publisher, Dordrecht.
4. Russell.D.L. (1979) – "Mathematics of Finite Dimensional Control Systems" , Marcel Dekker, New York.

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