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 2017-2018 and onwards

Under CBCS PATTERN

MASTER OF MATHEMATICS

Course Scheme and Scheme of Examinations

(For students admitted from 2017-2018 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	17MAP01	Algebra	6	3	25	75	100	4
III	Core II	17MAP02	Real Analysis	6	3	25	75	100	4
III	Core III	17MAP03	Ordinary Differential Equations	6	3	25	75	100	4
III	Core IV	17MAP04	Numerical Methods	6	3	25	75	100	4
III	Elective I	17MAP05A/ 17MAP05B	Latex / Cryptography	4	3	25	75	100	2
III	Elective I	17MAP06	Latex - **Practical**	2	3	40	60	100	2
			TOTAL	**30**				**600**	**20**
SEMESTER – II									
III	Core V	17MAP07	Complex Analysis	6	3	25	75	100	4
III	Core VI	17MAP08	Partial Differential Equations	6	3	25	75	100	4

III	Core VII	17MAP09	Mechanics	6	3	25	75	100	4
III	Core VIII	17MAP10	Optimization Techniques	5	3	25	75	100	4
III	Elective II	17MAP11A/ 17MAP11B	Differential Geometry / Neural Networks	5	3	25	75	100	4
III	Core IX	17MAP12	Comprehension in Mathematics - I (Online Exam)	-	$1\frac{1}{2}$	-	100	100	2
IV	Skill Enhancement Course I	17SEP01	Cyber Security	2	-	100	-	100	2
			TOTAL	**30**				**700**	**24**

SEMESTER – III

III	Core X	17MAP13	Topology	7	3	25	75	100	5
III	Core XI	17MAP14	Theory of Numbers	6	3	25	75	100	5
III	Core XII	17MAP15	Mathematical Statistics	7	3	25	75	100	5
III	Core XIII	17MAP16	Mathematical Software (SPSS)- **Practical**	2	3	40	60	100	2
III	Core Optional XIV	***	Optional	3	3	25	75	100	3
V	Proficiency Enhancement (Self Study)	17PEPMA1	Industrial Mathematics	-	3	100	-	100	2
III	Elective III	17MAP17A / 17MAP17B	Graph Theory / Programming in C++	5	3	25	75	100	4
III	Core XV	17MAP18	Comprehension in Mathematics - II (Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	**30**				**800**	**27**

SEMESTER – IV

III	Core XVI	17MAP19	Functional Analysis	6	3	25	75	100	6
III	Core XVII	17MAP20	Mathematical Methods	7	3	25	75	100	6
III	Core XVIII	17MAP21	Fluid Dynamics	6	3	25	75	100	5
III	Core XXI	17MAP22	Project and Viva Voce**	6	3	20	80	100	3
III	Elective IV	17MAP23A/ 17MAP23B	Fuzzy Logic and Fuzzy Sets / Control Theory	5	3	25	75	100	4

III	Core XXII	17MAP24	Comprehension in Mathematics-III (Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	30				600	25
V	Proficiency Enhancement	On-line Course / Learning Object Repository		II – IV SEMSTER					2
		Certificate Course		II - IV SEMESTER					2
				Total Marks - 2700 Credits - 100					100

R. Jaya 15/10/22

R. JAYALAKSHMI, M.Sc.,M.Phil.,PGDCA
Associate Professor & Head
Department of Mathematics,
Pr. R. Arts College for Women (Autonomous)
Gobichettipalayam - 638 476.

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DEPARTMENT OF MATHEMATICS

M.Sc. DEGREE PROGRAMME

SEMESTER I

ALGEBRA	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble

To enable the students to learn and gain knowledge about algebraic structures, theory of groups, rings & 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
CO4	recognize some advanced results of the theory of groups, rings & fields.	K_4
CO5	state and prove the 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 2015)– "Topics in Algebra", 2nd Edition.

UNIT I : Chapter 2 - Sections 2.11 to 2.13.

UNIT II : Chapter 3 - Sections 3.7 to 3.10.

UNIT III : Chapter 5 - Sections 5.1, 5.3 and 5.5.

UNIT IV : Chapter 5 - Section 5.6 & Chapter 7 - Section 7.1.

UNIT V : Chapter 6 - Sections: 6.4, 6.8 and 6.10.

REFERENCE BOOKS:

1. Fraleigh.J.B.(1988) – "A First Course in Abstract Algebra", Narosa Publishing House, New Delhi.
2. Artin.M (1991)– "Algebra", Prentice-Hall, Englewood Cliff.
3. Hungerford.T.W.(1974) – "Algebra", Springer, New York.

REAL ANALYSIS	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble

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

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	define and recognize the series of real numbers and convergence and define the basic terms under uniform convergence, linear transformation, Lebesgue measure and Lebesgue integral	K_1 & K_2
CO2	analyze and apply the concepts of convergence criteria, linear transformation, Lebesgue measure and Lebesgue integral	K_4 & K_3
CO3	prove the theorems in Riemann Stieltjes integral, Uniform convergence, Linear transformation, Lebesgue measure and Lebesgue integral	K_3, K_6 & K_5

UNIT I: RIEMANN STILTJES INTEGRAL (15 Hours)

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

UNIT II: UNIFORM CONVERGENCE (15 Hours)

Uniform convergence and continuity –Uniform convergence and integration - Uniform convergence and differentiation –Equicontinuous families of functions – The Stone Weierstrass 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 –(1976) "Principles of Mathematical Analysis", McGraw Hill, New York.
   Unit I & II : Chapter 6 & 7.
   Unit III : Chapter 9 (Pages 204 to 227)
2. Roydon.H.L – (1988), "Real Analysis", Third Edition, Macmillan, New York.
   Unit IV : Chapter 3 (Except Section –4)
   Unit V : Chapter 4 (Sections 2, 3 & 4 only)

REFERENCE BOOKS:

1.Bartle.R.G –(1976) " Elements of Real Analysis", 2nd Edition, John Wily and Sons, New York.
2.Rudin.W –(1986) "Real and Complex Analysis", 3rd Edition, McGraw-Hill, New York.

ORDINARY DIFFEENTIAL EQUATIONS	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble

To enable the students to learn and gain knowledge about Legendre equation, Bessel equation, Fundamental matrix, Picard's theorem and the solutions of systems of linear differential equations & Non- linear initial value problems.

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.	$\mathbf{K_1}$
CO2	understand the existence ,uniqueness of solutions of systems of linear differential equations & Non-linear initial value problems.	$\mathbf{K_2}$
CO3	identify the results in systems of linear differential equations & Non- linear initial value problems.	$\mathbf{K_3}$
CO4	examine the solutions of systems of linear differential equations and Non- linear initial value problems . Analyze the oscillations of solutions of second order differential equations.	$\mathbf{K_4}$
CO5	apply power series method andsuccessive approximation method to evaluate the solutions of systems of linear differential equations and Non-linear initial value problems.	$\mathbf{K_5, K_6}$

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 equation.

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(contd.) (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 approximation – 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-Winter – Oscillations of $x'' a(t)x + 0$ - Elementary non-linear oscillation.

TEXT BOOK:

Deo.S.G. and Raghavendra.V.(1997) – "Ordinary Differential Equations and Stability Theory", McGraw Hill, New York, 1997.

Unit I : Chapter – 3 - Section 3.2 – 3.5

Unit II : Chapter – 4 - Section 4.2 – 4.4

Unit III : Chapter – 4 - Section 4.5 – 4.7

Unit IV : Chapter – 5 - Section 5.3 – 5.8

Unit V : Chapter – 8 - Section 6.1 – 6.6

REFERENCE BOOKS:

1. Coddington.E.A. and Levinson.N., (1955), “Theory of Ordinary Differential Equations”, McGraw Hill, New York.
2. Sanchez.D.A. (1968), “Ordinary Differential Equations and Stability Theory”, W.H.Freeman & Co., San Francisco.

NUMERICAL METHODS	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble :

To enable the students to learn and gain knowledge about numerical differentiation, integration, Solution of system of both ordinary and partial differential equations and the difference between the boundary value and characteristic value problems.

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 and the difference between the boundary value and characteristic value problems.	**K_2 & K_4**
CO2	remember the formulae for central difference formulae, numerical differentiation, integration and also write the formulae for various methods.	**K_1**
CO3	identify the numerical results of both ordinary and partial differential equations by using various methods.	**K_3, K_6**
CO4	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: SOLUTION OF NONLINEAR EQUATIONS (15 Hours)

Newton's method –Convergence of Newton's method –Bairstow"s Method for quadratic factors.

NUMERICAL DIFFERENTIATION AND INTEGRATION: Derivatives from differences tables –Higher order derivatives –Divided difference, Central-Difference formulae – Composite formula of Trapezoidal rule –Romberg integration –Simpson's rules.

UNIT II: SOLUTION OF SYSTEM OF EQUATIONS (15 Hours)

The Elimination method –Gauss and Gauss Jordan methods –LU Decomposition method –Matrix inversion by Gauss-Jordan method –Methods of Iteration –Jacobi and Gauss Seidal Iteration –Relaxation method –Systems of Nonlinear equations.

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

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

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

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.

UNIT V: NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (12 Hours)

(Solutions of Elliptic, Parabolic and Hyperbolic partial differential equations) Representation as a difference equation –Laplace's equation on a rectangular region –Iterative methods for Laplace equation –The Poisson equation –Derivative boundary conditions –Solving the equation for time-dependent heat flow (i) The Explicit method (ii) The Crank Nicolson method –Solving the wave equation by Finite Differences.

TEXT BOOK:

Gerald.C.F. and Wheatley.P.O.- (1998 Fifth Edition). "Applied Numerical Analysis", Addison Wesley.

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 Fourth Edition) – " Numerical Analysis", P.W.S.Kent Publishing Company, Boston .

3.Sastry.S.S.(1998) – " Introductory methods of Numerical Analysis", Prentice Hall of India, New Delhi.

4.Kandasamy.P.(2003) – "Numerical Methods", S.Chand & Co.Ltd., New Delhi.

LATEX	CATEGORY	L	P	CREDIT
	ELECTIVE	48	-	2

Preamble :

To enable the students to learn and gain knowledge about the concepts of LaTex and the LaTex commands to write programs.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	learn the history of LaTex and understand the basics of a LaTex .	**K_1 & K_2**
CO2	apply LaTex concepts in creating tables and drawing pictures.	**K_3**
CO3	analyze the concepts of LaTex to write programs.	**K_4**
CO4	determine the LaTex commands .	**K_5, K_6**

UNIT I: BASICS OF LATEX (10 Hours)

Text formatting, TEX and its offspring, What's different in LATEX 2ϵ, Distinguishing LATEX 2ϵ , Basics of a LATEX file.

UNIT II: COMMANDS AND ENVIRONMENTS (10 Hours)

Commands and Environments–Command names and arguments, Environments, Declarations, Lengths, Special Characters, Fragile Commands, Exercises.

UNIT III: DOCUMENT LAYOUT AND ORGANIZATION (10 Hours)

Document Layout and Organization – Document class, Page style, Parts of the document, Table of contents, Fine – Tuning text, Word division. Displayed Text - Changing font, Centering and indenting, Lists, Generalized lists, Theorem–like declarations, Tabulator stops, Boxes.

UNIT IV: TABLES AND PICTURES (10 Hours)

Tables, Printing literal text, Footnotes and marginal notes. Drawing pictures with LATEX.

UNIT V: MATHEMATICAL FORMULAS (8 Hours)

Mathematical Formulas – Mathematical environments, Main elements of math mode, Mathematical symbols, Additional elements, Fine–tuning mathematics.

TEXT BOOK:

Kopka .H and P.W. Daly (1999) – "A Guide to LATEX", Third Edition, Addison – Wesley, London.

Unit I : Chapter 1 : Sections : 1.1-1.3, 1.4.1, 1.5.

Unit II : Chapter 2 : Sections : 2.1-2.7.

Unit III : Chapter 3 : Sections : 3.1-3.6, 4.1-4.7

Unit IV : Chapter 4 : Sections : 4.8-4.10, 6.1.

Unit V : Chapter 5: Sections : 5.1-5.5.

REFERENCE BOOK:

Fundamentals of Latex for Mathematicians, Physicists and Engineers by Velusamy Kavitha and Mani Mallika Arjunan Lap Lambert Academy Publishing, Germany, 2013.

CRYPTOGRAPHY	CATEGORY	L	P	CREDIT
	ELECTIVE	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 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 Remainder Theorem – Discrete Logarithms.

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(2011)- "Cryptography and Network Security", Fifth Edition, Dorling Kindersley India Pvt. Ltd.

Unit - I	Book-1	Section: 2.1,2.2,2.5,2.6	Page : 38-41,59-73
Unit – II	Book-2	Section: 8.1-8.5	Page : 267-281
Unit –III	Book-2	Section:4.1-4.7,5.1	Page : 127-153,172
Unit – IV	Book-2	Section: 2.1,3.1,3.2,3.6, 7.4	Page : 57-62,90-109,116-120, 256-258
Unit - V	Book-2	Section: 9.1,9.2,10.3,10.4	Page : 290-314,324-329,341-344

REFERENCE BOOK:

BRUICE SCHNEIER (2012) - "Applied Cryptography", Second Edition.

LATEX	CATEGORY	L	P	CREDIT
	ELECTIVE PRACTICAL	-	24	2

LIST OF PROGRAMS

Group - A

All the following listed programs have to be executed and recorded

A1. Type the following paragraph in LaTex, using the {quote} environment. Format the paragraph with the following: Text height 9.5 inches, Text width 6.30inches, Left margin 0.10 inches, Right margin 0.120inches, Top margin -0.6 inch, Line space 1.5inches. Also include a foot note.

A2. Produce a document in LATEX, using two-columns, Insert a title centered for the two columns.

A3. Produce a title page in LaTex, with the following:

(i)Title of the page, (ii)Name and Addresses of two authors, (iii)Footnotes for the corresponding author; e-mail address and telephone numbers of the each author, (iv)Date.

A4.Create a document in LATEX to produce the bibliographic information, using the { bibliography } environment.

Group – B

B1.Create the following table using LaTex:

S.No.	Register Number	Name of the Student	Percentage of Marks	Rank
1	XXXXXX	XXXXXX	XXXXX	XXXX
2	XXXXXX	XXXXXXX	XXXX	XXXX
3	XXXXXX	XXXXXX	XXXX	XXXXX

B2. Using LaTex, generate the following formula:

$$a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cfrac{1}{a_3 + \cfrac{1}{a_4}}}} + \begin{pmatrix} a & b \\ c & d \end{pmatrix} + \sum_{\alpha=0}^{\infty} (\beta^{\alpha} + \Gamma^{\alpha})$$

B3. Using LaTex, generate the following with the { eqnarray } environment:

$$(x + y)(x - y) = x^2 - xy + xy - y^2$$

$$= x^2 - y^2 \qquad (1.1)$$

$$(x + y)^2 = x^2 + 2xy + y^2 \qquad (1.2)$$

$$X_n u_1 + \ldots\ldots\ldots + x_{n+t-1} u_t = x_n u_1 + (a x_n + c)u_2 + \ldots\ldots$$

$$+ a^{t-1} x_n + c(a^{t-2} + \ldots\ldots + 1)u_t$$

$$= (u_1 + a u_2 + \ldots\ldots + a^{t-1} u_t)x_n + h(u_1, \ldots\ldots\ldots u_t)$$

B4. Using LaTex, draw the following diagram:

SEMESTER II

COMPLEX ANALYSIS	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble :

To enable the students to learn and gain knowledge about Cauchy's theorem , Taylor's Theorem , Residue Theorem , Weierstrass Theorem, Riemann Mapping Theorem for the analytic function.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	define analytic function, complex integration, Residues , Taylor Series , Laurent Series and mappings.	**K_1 & K_2**
CO2	apply Cauchy's theorem , Taylor's Theorem , Residue Theorem , Weierstrass Theorem, Riemann Mapping Theorem for the analytic function.	**K_3**
CO3	analyze singularities and power series expansion.	**K4**
CO4	evaluate integrals along a path in the complex plane, branch points.	**K_5, K_6**

UNIT I: INTRODUCTION TO THE CONCEPT OF ANALYTIC FUNCTION

(15 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 (15 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 (15 Hours)

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

UNIT IV: SERIES AND PRODUCT DEVELOPMENTS (15 Hours)

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

UNIT V: MAPPING THEOREM (12 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. – (1979), "Complex Analysis" Mc Graw Hill, New York.

Unit I : Chapter 2 - Section 1.1 – 1.4
Chapter 3 - Section 2.1 – 2.4, 3.1, 3.2 and 3.4
Unit II : Chapter 4 - Section 1.1 – 1.5, 2.1 – 2.3, 3.1 - 3.4,4.1
Unit III : Chapter 4 - Section 5.1 – 5.3, 6.1 – 6.3
Unit IV : Chapter 5 - Section 1.1 – 1.3, 2.1 – 2.3
Unit V : Chapter 6 - Section 1.1 – 1.4, 2.1 – 2.3

REFERENCE BOOK:

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

PARTIAL DIFFERENTIAL EQUATIONS	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble :

To enable the students to learn and gain knowledge about boundary value problems, 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 methods of separation of variables and methods of green's function to evaluate initial and 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 (15 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 (15 Hours)

The Cauchy problem – Cauchy – Kowalewskaya theorem –Homogeneous wave equation – Initial – Boundary value problems – Non-homogeneous boundary conditions – Non-homogeneous wave equation, Riemann Method**.**

UNIT III: METHODS OF SEPARATION OF VARIABLES (15 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 (15 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 Dirichlet problem for a rectangle – Neumann problem for a rectangle.

UNIT V: GREEN'S FUNCTION (12 Hours)

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

TEXT BOOK:

Tyn Myint. U with Lokenath Debnath (2011 4th Edition) – "Linear Partial Differential Equations for Scientists and Engineers".

Unit I : Chapter 3 -Section 3.1 – 3.5 (omit 3.4)

Chapter 4 - Section 4.1 – 4.4

Unit II : Chapter 4 - Section 5.1 – 5.8 (omit 5.6)

Unit III : Chapter 7 - Section 7.2 – 7.6

Unit IV : Chapter 9 - Section 9.1 – 9.9 (omit 9.8)

Unit V : Chapter 11 - Section 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.

MECHANICS	CATEGORY	L	P	CREDIT
	CORE	72	-	4

Preamble :

To enable the students to learn and gain knowledge about Euler-Lagrange equations, Hamilton's Equations and Lagrange and Poisson Brackets.

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 & Hamilton Jacobi Theory and also to apply these techniques to analyze elementary mechanical systems.	**K_3 & K_4**
CO4	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, K_6**

UNIT I: INDRODUCTORY CONCEPTS (15 Hours)

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

UNIT II: LAGRANGE'S EQUATIONS (15 Hours)

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

UNIT III: HAMITON'S EQUATIONS (15 Hours)

Hamilton's principle – Hamilton's equations.

UNIT IV: HAMILTON – JACOBI THEORY (15 Hours)

Hamilton's principle function – Hamilton – Jacobi equation – Separability.

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-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. Gantmacher.F (1975) – "Lectures in Analytic Mechanics", MIR Publishers, Moscow.
2. Gelfand.I.M. and Fomin.S.V. (2013) – "Calculus of Variations", Prentice Hall.

CORE IX: OPTIMIZATION TECHNIQUES

OPTIMIZATION TECHNIQUES	CATEGORY	L	P	CREDIT
	CORE	60	-	4

Preamble :

To enable the students to learn and gain knowledge about the Transportation problems, Network Scheduling and Assignment problems.

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. introduce the use of basic methodology for the solution of linear programs and integer programs. introduce the advanced methods for large-scale transportation and assignment problems.	**K_3, K_6, K_4 & K_5**
CO3	define the basic terms under transportation problems, Network sheduling and probability.	**K_1**

UNIT I: INTRODUCTION OF O.R. (15 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 (15 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 – Test for Optimality.

UNIT III: NETWORK SCHEDULING (10 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 – Applications of NETWORK Techniques – Advantages of Network Techniques **–** Limitations and Difficulties in Using Network.

UNIT IV: GAMES AND STRATEGIES (10 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 (10 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 Fifteenth Thoroughly Revised Edition) – "Operations Research", Sultan Chand & Sons, Educational Publishers, New Delhi.

UNIT I	-	Chapter 1	-	Section 1.1 – 1.5,
		Chapter 2	-	Section 2.1 – 2.4.
UNIT II	-	Chapter 10	-	Section 10.1 – 10.10.
UNIT III	-	Chapter 25	-	Section 25.1 – 25.6, 25.8-25.11 (omit 25.7).
UNIT IV	-	Chapter 17	-	Section 17.1 – 17.5,
		Chapter 11	-	Section 11.1 – 11.5.
UNIT V	-	Chapter 14	-	Section 14.1 – 14.5.

REFERENCE BOOK:

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

DIFFERENTIAL GEOMETRY	CATEGORY	L	P	CREDIT
	ELECTIVE	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	evaluate problems by using the different types in binomial series.	**K_5**
CO2	gain the knowledge about the concept of sequence and series.	**K_1 & K_2**
CO3	identify the process of convergence and divergence through different types of test.	**K_4**
CO4	learn how to use reciprocals and transformations to solve equations.	**K_2**
CO5	evaluate the problems by using Newton's and Horner's method.	**K_5, K_6**

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 (CONTD.) (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 – Intrinsic properties.

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

Unit I	-	Chapter 1	-	Section 1.1 - 1.7, 1.10
Unit II	-	Chapter 1	-	Section 1.11 - 1.13 , 1.15 – 1.17
Unit III	-	Chapter 2	-	Section 2.1 - 2.5, 2.9, 2.11, 2.12, 2.15
Unit IV	-	Chapter 4	-	Section 4.1 - 4.5
Unit V	-	Chapter 3	–	Section 3.5, 3.12, 5.1-5.5

REFERENCE BOOK

Struik D.T(1950) - **"**Lectures on Classical Differential Geometry", Addison – Wesely, Mass.

NEURAL NETWORKS	CATEGORY	L	P	CREDIT
	ELECTIVE	60	-	4

Preamble

To enable the students to learn and gain knowledge about the Mathematical Neuron Model and Network Architectures.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	analyze the difference between Hamming Network and Hopfield Network.	K_4
CO2	gain the knowledge about the concept of Quadratic functions and conjugate gradient.	K_1 & K_2
CO3	apply Taylor series to solve different types of problems.	K_3
CO4	learn the concepts of Multilayer Perceptrons.	K_2
CO5	evaluate the problems by using Back propagation Algorithm .	K_5, K_6

UNIT I: (12 Hours)

Mathematical Neuron Model- Network Architectures- Perceptron-Hamming Network- Hopfield Network-Learning Rules.

UNIT II: (12 Hours)

Perceptron Architectures and Learning Rule with Proof of Convergence. Supervised Hebbian Learning-Linear Associator.

UNIT III: **(14 Hours)**

The Hebb Rule-Pseudo inverse Rule-Variations of Hebbian Learning-Back Propagation-Multilayer Perceptrons.

UNIT IV: **(12 Hours)**

Back propagation Algorithm-Convergence and Generalization .

UNIT V: **(10 Hours)**

Performances Surfaces and Optimum Points-Taylor series.

Text Book:

Martin T.Hagan, Howard B. Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi,2002.

Unit I	-	Chapter 2	-	Section 2.2-2.13 ;
		Chapter 3	-	Section 3.3-3.12 ;
		Chapter 4	-	Section 4.2;
Unit II	-	Chapter 4	-	Section 4.3-4.15 ;
Unit III	-	Chapter 7	-	Section 7.4-7.12 ;
Unit IV	-	Chapter 11	-	Section 11.7, 11.19, 11.21
Unit V	-	Chapter 8	-	Section 8.1,8.2

REFERENCE BOOKS:

1. James A. Freeman, David M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.

2. Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.

CYBER SECURITY	CATEGORY	L	P	CREDIT
	SKILL ENHANCEMENT COURSE	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	17MAP15	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,	K_3 & K_5

	connectedness and compactness, countability and separation axioms , completely regular space and complete metric.	

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	17MAP16	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_5
CO5	evaluate the solutions of congruences of higer degree	K_5, K_6

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	17MAP15	MATHEMATICAL STATISTICS	84	-	5

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 of 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: (18 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: (18 Hours)

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

UNIT III : MATHEMATICAL EXPECTATION: (15 Hours)

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

UNIT IV : SPECIAL PROBABILITY DISTRIBUTIONS: (18 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: (15 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 PRACTICAL	17MAP16	MATHEMATICAL SOFTWARE – I (SPSS)	-	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
PROFICIENCY ENHANCEMENT (SELF STUDY)	17PEP01	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 Monte-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 BOOK:

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	17MAP20A	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	5.1-5.3

	6	**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	17MAP20B	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	17MAP22	FUNCTIONAL ANALYSIS	72	-	6

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 -- 4.9**
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.

2. 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	17MAP23	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,	K_5, K_6

	Euler's Eqaution and Fredhlom Integral Equation and Volterra Integral equations.	

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	17MAP24	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	17MAP28A	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 : APPLICATIONS **(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	17MAP28B	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.	$\mathbf{K_2}$
CO2	gain the knowledge about research methodology.	$\mathbf{K_1}$
CO3	identify the differential equation models to the real system.	$\mathbf{K_4}$
CO4	learn how to use the various techniques of control systems.	$\mathbf{K_2}$ & $\mathbf{K_3}$
CO5	evaluate the different types of equations to solve real life problems.	$\mathbf{K_5}$, $\mathbf{K_6}$

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.

R. JAYALAKSHMI, M.Sc.,M.Phil.,PGDCA,
Associate Professor & Head
Department of Mathematics,
P.S.R. Arts College for Women (Autonomous)
Gobichettipalayam 638 476.