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 2020-2021 and onwards

Under CBCS PATTERN

MASTER OF MATHEMATICS

Course Scheme and Scheme of Examinations

(For students admitted from 2020-2021 and onwards)

Part	Category	Course Code	Title of the Course	ContactHrs/ week	Exam Duration hrs.	Max.Marks			Credits
						CIA	ESE	Total	
			SEMESTER – I						
III	Core: I	20MAP01	Advanced Algebra	6	3	25	75	100	4
III	Core :II	20MAP02	Real Analysis	6	3	25	75	100	4
III	Core : III	20MAP03	Ordinary Differential Equations	6	3	25	75	100	4
III	Core : IV	20MAP04	Measure Theory and Integration	5	3	25	75	100	4
III	Elective I	20MAP05A 20MAP05B	Numerical Analysis Control Theory	5	3	25	75	100	4
III	Core : V	20MAP06	Programming in Python - Practical	2	3	40	60	100	2
III	Core : VI	20MAP07	Comprehension in Mathematics – I (Self Study Course - Online Exam)	-	$1\frac{1}{2}$	-	100	100	1
			TOTAL	30				700	23
			SEMESTER - II						
III	Core :VII	20MAP08	Complex Analysis	6	3	25	75	100	4
III	Core : VIII	20MAP09	Partial Differential Equations	5	3	25	75	100	4
III	Core : IX	20MAP10	Classical Mechanics	5	3	25	75	100	4
III	Core :X	20MAP11	Differential Geometry	5	3	25	75	100	4

III	Elective II	20MAP12A 20MAP12B	Mathematical Statistics Programming in C++	5	3	25	75	100	4
III	Elective-II Practical	20MAP13A 20MAP13B	Mathematical Software – I (SPSS) – Practical Programming in C++ - Practical	2	3	40	60	100	2
III	Ability Enhancement	20AEPMA01	Cyber Security	2	3	100	-	100	2
III	Core : XI	20MAP14	Comprehension in Mathematics – II (Self Study Course - Online Exam)	-	1½	-	100	100	1
			TOTAL	30				800	25

SEMESTER – III

III	Core : XII	20MAP15	Topology	6	3	25	75	100	5
III	Core : XII	20MAP16	Theory of Numbers	6	3	25	75	100	5
III	Core : XIV	20MAP17	Optimization Techniques	6	3	25	75	100	4
III	Core : XV	20MAP18	Mathematical Software – II (R Software) - Practical	3	3	40	60	100	2
IV	Open Elective	***	**OPTIONAL**	3	3	25	75	100	3
V	Proficiency Enhancement	20PEPMA01	Industrial Mathematics (Self Study)	-	3	-	100	100	2
III	Elective III	20MAP19A 20MAP19B	Graph Theory Integral Transforms	6	3	25	75	100	4
III	Core : XVI	20MAP20	Comprehension in Mathematics – III (Self Study Course - Online Exam)	-	1½	-	100	100	1
			TOTAL	30				800	26

SEMESTER – IV

III	Core :XVII	20MAP21	Functional Analysis	6	3	25	75	100	5
III	Core: XVIII	20MAP22	Mathematical Methods	6	3	25	75	100	4
III	Core :XIX	20MAP23	Fluid Dynamics	6	3	25	75	100	4
III	Core :XX	20MAP24	Project Work & Viva Voce	6	3	20	80	100	4
III	Elective IV	20MAP25A 20MAP25B	Fuzzy Logic and Fuzzy Sets Actuarial Mathematics	6	3	25	75	100	4
III	Core :XXI	20MAP26	Comprehension in Mathematics – IV (Self Study Course - Online Exam)	-	1 1/2	-	100	100	1
			Total	30				600	22
		Online Course / Learning Object Repository		I – IV SEMESTER					2
		Certificate Course		I – IV SEMESTER					2
				Total Marks -2900 Credits -					100

15/10/22

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

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DEPARTMENT OF MATHEMATICS

M.Sc.DEGREE PROGRAMME

SEMESTER I

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP01	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	20MAP02	REAL ANALYSIS	72	-	4

Preamble

To enable the students to learn and gain knowledge about Riemann StiltjesIntegral,Sequence and Series of functions and Functions of Several Variables.

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 Integraland Uniform Convergence	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 integraland Derivatives of Higher Order	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 - Uniform convergence and continuity –Uniform convergence and integration .

UNIT III:SEQUENCE AND SERIES OF FUNCTIONS (Continued….)(15 Hours)

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

UNIT IV: FUNCTIONS OF SEVERAL VARIABLES (15 Hours)

Linear transformation –Contraction principle.

UNIT V:FUNCTIONS OF SEVERAL VARIABLES (Continued….) (12 Hours)

Inverse function theorem –Implicit function theorem – Determinants – Differentiation of Integrals.

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	120-134
II	7	143-152
III	9	152-165
IV	3	204-211, 220-221
V	4	221-228, 231-238

REFERENCE BOOKS:

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

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

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP03	ORDINARY DIFFERENTIAL EQUATIONS	72	-	4

Preamble

To enable the students to learn and gain knowledge about linear differential equations, systemsof 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	construct 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 2004,Tata 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. andLevinson.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 OrdineryDifferentil Equations", PHI Learning Private Limited.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP04	MEASURE THEORY AND INTEGRATION	60	-	4

Preamble :

To enable the students to learn and gain knowledge about the concepts of measurable sets and measurable spaces.

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 Lebesgue measure in measurable sets	K_2
CO2	Define the concept of Lebesgue integral of a bounded measurable function and measurable nonnegative function	K_1
CO3	Apply differentiation and integration in monotone functions	K_3
CO4	Analyze integration of measurable functions over general measure spaces	K_4
CO5	Evaluate the construction of product Measures and Lebesgue measure on Euclidean space	K_5, K_6

UNIT I :Lebesgue Measure **(12 Hours)**

Introduction – Lebesgue Outer Measure – The $\sigma -$ Algebra of Lebesgue Measurable Sets – Outer and Inner Approximation of Lebesgue Measurable Sets – Countable Additivity, Continuity and the Borel–Cantelli Lemma.

UNIT II :Lebesgue Integration **(12 Hours)**

The Riemann Integral – The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure – The Lebesgue Integral of a Measurable Nonnegative Function –The General Lebesgue Integral.

UNIT III : Differentiation and Integration **(12 Hours)**

Continuity of Monotone Functions – Differentiability of Monotone Functions: Lebesgue's Theorem – Functions of Bounded Variations: Jordan's Theorem.

UNIT IV :Integration over General Measure Spaces **(12 Hours)**

Measurable Functions – Integration of Nonnegative Measurable Functions– The Radon–Nikodym Theorem.

UNIT V :The Construction of Particular Measures **(12 Hours)**

Product Measures: The Theorems of Fubini and Tonelli.

TEXT BOOK :

H.L. Royden, P.M. Fitzpatrick (2014) - "Real Analysis", 4th Edition, PHI Learning Private Limited, Delhi.

UNITS	CHAPTER	SECTIONS	PAGE No
I	2	2.1–2.5	29-47
II	4	4.1–4.4	68-89
III	6	6.1–6.3	107-118
IV	18	18.1–18.2, 18.4	359-371, 381-385
V	20	20.1	414-422

REFERENCE BOOKS :

1. Bartle R.G (1976) - "Elements of Real Analysis", 2nd Edition, John Wiley and Sons, New York.

2. RudinW(1986) - "Real and complex Analysis" , 3rd Edition,McGraw– Hill, New York.

3. Tom M.Apostal(2002)- "Mathematical Analysis" , 2nd Edition , Narosa Publishing House, New Delhi.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE I	20MAP05A	NUMERICAL ANALYSIS	60	-	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.

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 various methods in 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 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: NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

(15 Hours)

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

UNIT V: CHARACTERISTIC VALUE PROBLEMS (15 Hours)

Characteristic value problems –Eigen values of a matrix by Iteration –The power method-Jacobi Methods for finding Eigen values & Eigen vectors .

TEXT BOOK:

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

2.Dr.P.Kandasamy,Dr.K.Thilagavathi,Dr.K.Gunavathi(2005)-"Numerical Methods", S.Chand & Company LTD, New Delhi-110055.

UNIT	BOOK	CHAPTER	SECTION
I	**I**	**III**	**3.7.1-3.7.2**
II	**I**	**V**	**5.1-5.4.3 (omit 5.2.1, 5.2.2)**
III	**I**	**VII**	**7.2, 7.4, 7.4.2, 7.5-7.6**
IV	**II**	**XII**	**12.5-12.10**
V	**II**	**XIII**	**13**

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 - I	20MAP05B	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 –ObservabilityGrammian –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. andPritchard.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.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP06	PROGRAMMING IN PYTHON - PRACTICAL	-	24	2

LIST OF PROGRAMS

All the following listed programs have to be executed and recorded

1. Write a program to create a class and object in Python.
2. Write a program to find correlation coefficient between the variables.
3. Write a program to find the probability of a prime number appearing when a 20 sided die is rolled.
4. Write a program to find standard deviation for the given set of values.
5. Write a program to calculate the mean, median and mode using Python.
6. Write a program to convert temperature from Celcius to Fahrenheit and vice versa.
7. Write a program for finding the roots of quadratic function.
8. Write a program to solve the initial value problem using Runge - Kutta method.
9. Write a program to solve ordinary differential equation using Python.
10. Write a Python program to calculate distance between two points using latitude and longitude.

SEMESTER II

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP08	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	analyzesingularities,complex integration and power series expansion.	K4
CO5	evaluate integrals along a path in the complex plane, branch points.	K_5, K_6

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 , McGraw Hill Education (India) Pvt.LtdNew 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:

RuelV.Churchill(1990) – "Complex Variables and Applications", Fifth Edition,McGraw – Hill International Editions**.**

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP09	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 about 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 method of Green's function to solve initial - boundary value problems.	K_3
CO4	classify second order partial differential equations and analyze the solutions of initial and BVP.	K_4
CO5	construct the solutions of second order partial differential equations and discuss the method of eigen functions.	K_5, K_6

UNIT I: MATHEMATICAL MODEL (12 Hours)

The Classical equation – The vibrating string – The vibrating membrane – Conduction ofheat 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 (12Hours)

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:

TynMyint. U with LokenathDebnath (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	20MAP10	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
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, K_6

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 PragattiPrakashan,Meerut.
2. Gupta.A.S.(2009)-"Calculus of Variation" PHI Learning pvt.ltd.Newdelhi.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP11	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
CO5	Evaluate the fundamental quadratic forms, intrinsic and extrinsic forms of surface	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 (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

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

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE II	20MAP12A	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	definethe concepts based on probability.	K_1
CO2	analyzethe 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.

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 – 4.4
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
ELECTIVE - II	20MAP12B	PROGRAMMING IN C++	60	-	4

Preamble

To enable the students to learn and gain knowledge about C++ Programming such as Tokens, Expressions, Control Structure, Classes and Objects.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	Understand and apply the C++ structure, tokens, expressions, control structures	K_1 &K_2
CO2	Ability to declare various prototyping, friend and virtual functions	K_3
CO3	Create Classes, objects, arrays of objects, constructors, and Destructors.	K_3&K_4
CO4	Analyze over loading operators	K_4
CO5	solve numerical problems by using C++ programs.	K_5 &K_6

UNIT - I : TOKENS, EXPRESSIONS AND CONTROL STRUCTURE (12 HOURS)

Basic Concept of Object Oriented Programming : Basic Concept of OOPS - Benefits of OOP – Application of OOP

Tokens, Expressions and Control Structure: Introduction – Tokens – Keywords – Identifiers and Constants – Basic Data Types – User Defined Data Types – Derived Data Types – Declaration of Variables – Dynamic Initialization of Variables – Reference Variables – Operators - 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 –Arrays of Objects – Objects as Function Arguments – Friend Functions.

UNIT – IV : CONSTRUCTORS AND DESTRUCTORS (12 HOURS)

Constructors and Destructors: Introduction – Constructors – Parameterized Constructors – Multiple Constructors in a Class – Constructors with Default Arguments – Dynamic Initializations of Objects – Copy Constructor – Destructors.

UNIT – V : OPERATOR OVERLOADING (12 HOURS)

Operator Overloading: Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends – Manipulating of Strings Using Operators – Rules for Overloading Operators.

Text Book

E. Balaguruswamy, Object–Oriented Programming with C++, Seven Edition, Tata McGrawHill Publishing Company Limited.

UNIT	CHAPTER	SECTION
I	1 & 3	1.5 – 1.8, 3.1 – 3.8, 3.11 - 3.14 and 3.25
II	4	4.1 – 4.12
III	5	5.1 – 5.15
IV	6	6.1 –6.11
V	7	7.1 – 7.8

Reference Books :

1 Programming with C++ by D. Ravichandran, -Tata McGraw Hill publishing company limited, New Delhi.

2 Object Oriented Programming with C++ by S.S.Vinod Chandra, New age publishing company limited.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ELECTIVE II PRACTICAL	20MAP13A	MATHEMATICAL SOFTWARE – I (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.
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
PRACTICAL	20MAP12B	PROGRAMMING IN C++	-	36	2

LIST OF PROGRAMS

All the following listed programs have to be executed and recorded

1. DISTANCE CONVERSION PROBLEM:

Create two classes DM and DB which store the value of distances. DM store the value of distances. DM stores distances in meters and centimeters in DB in feet and inches. Write a Program that can create the values of the class objects and add one object DM with another object DB. Use a friend function to carry out addition operation. The object that stores the result may be DM object or DB object depending on the units in which results are required. The display should be in the order of meter and centimeter and feet or inches depending on the order of display.

2. OVERLOADING OBJECTS:

Create a class FLOAT that contains one float data member overload all the four arithmetic operators so that operate on the objects of FLOAT.

3. OVERLOADING CONVERSIONS:

Design a class polar which describes a pant in a plane using polar Co-ordinates radius and angle. A point in polar Co-ordinates is as shown below. Use the overloader + operator to add two objects of polar. Note that we cannot add polar values of two points directly. This requires first the conversion. Points into rectangular Co-ordinates and finally converting the result into polar Co-ordinates. You need to use following trigonometric formulas. *X= r * cos (a); Y= r * sin (a);* $a=\tan^{-1}(\frac{Y}{X})$; r= *sqrt (X * X +Y * Y);*

4. OVRELOADING MATRIX:

Create a class MAT of size M*N. Define all possible matrix operations for MAT type objects. Verify the identity. *(A-B)^2 = A^2+B^2 – 2*A*B*

5. AREA COMPUTATION USING DERIVED CLASS:

Area of rectangle = *X*Y*

Area of triangle = ½ * *X* * *Y*

6. VECTOR PROBLEM:

Define a class for vector containing scalar values. Apply overloading concepts for vector addition, Multiplication of a vector by a scalar quantity, replace the values in a position vector.

7. INHERITANCE:

Create three classes alpha, beta and gamma, each containing one data member. The class gamma should be inherited from both alpha and beta. Use a constructor function in the class gamma to assign values to the data members of all the classes. Write a program to print the data members of all the three classes.

8. INLINE FUNCTION:

Create two inline functions that can return the multiplication and division for two data members.

9. STATIC DATA MEMBER:

Write a program to illustrate the use of static data member.

10. **ARRAY OF OBJECT**:

Create a class employee and illustrate the use of object array.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
ABILITY ENHANCEMENT	20AEPMA01	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	20MAP15	TOPOLOGY	72	-	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, urysohnmetrization 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 (15 Hours)

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

UNIT II: CONNECTEDNESS(15 Hours)

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

UNIT III:COMPACT SPACE (15 Hours)

Compact Spaces –Compact subspacesof the real line-Limit Point Compactness – Localcompactness.

UNIT IV: COUNTABILITY (12 Hours)

The CountabilityAxioms – The Separation Axioms – Normal spaces – The Urysohn Lemma – The UrysohnMetrizationTheorem .

UNIT V: THE TYCHONOFF THEOREM(15 Hours)

The TychonoffTheorem – 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	20MAP16	THEORYOF 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.

UNIT IV:QUADRATIC RECIPROCITY (15 Hours)

Quadratic residues- Quadratic reciprocity – The Jacobi Symbol.

UNIT V:ARITHMETIC FUNCTIONS (12 Hours)

Greatest integer function - Arithmetic functions – The Moebius Inversion formula – The multiplication of arithmeticfunctions .

TEXT BOOK

Ivan Nivan and HerbertsZucherman (2013) – "An Introduction to Theory of Numbers",Fifth edition,Wiley Indian PvtLtd.,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
IV	III,IV	3.1 - 3.3
V	IV	4.1-4.3

REFERENCE BOOKS

1. Apostol.T.M.(1995)– "Introduction to Analytic Number Theory",FirsteditionSpringer 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	20MAP17	OPTIMIZATION TECHNIQUES	72	-	4

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, K_6
CO4	analyze the use of basic methodology for the solution of linear programs and integer programs.	K_4
CO5	define the basic terms under transportation problems, Network scheduling and probability.	K_1

UNIT I: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– MODI Method.

UNIT II:NETWORK SCHEDULING (15 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 III:GAMES AND STRATEGIES (12 Hours)

Games and Strategies – Introduction – Two – Person Zero – Sum Games – Some Basic Terms – The Maximin – Minimax Principle – Games Without Saddle Points – Mixed Strategies.

UNIT IV:ASSIGNMENT PROBLEM (15 Hours)

Assignment Problem – Introduction – Mathematical formulation of the problem – Solution Methods of Assignment Problem – Special Cases in Assignment Problem.

UNIT V:PROBABILITY (15 Hours)

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

TEXT BOOK:

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

UNIT	CHAPTER	SECTION
I	**X**	**10.1 – 10.09, 10.13**
II	**XXV**	**25.1 – 25.6, 25.8 (omit 25.7)**
III	**XVII**	**17.1 – 17.5**
IV	**XI**	**11.1 – 11.4**
V	**XIV**	**14.1 – 14.5**

REFERENCE BOOK:

HamdyA.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	20MAP18	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 gedit and Libre Office Calc 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 analyze the data using one and two sample ‘t’ test and paired ‘t’ test.

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
PROFICIENCY ENHANCEMENT (SELF STUDY)	**20PEPMA01**	**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	**K_2 &K_4**

	problems by using various methods.	
CO5	evaluatethe 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-carlosimulation .

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. KantiSwarup, 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. DharaniVenkata 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 - III	20MAP19A	GRAPH THEORY	72	-	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.

UNITV: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. Narsinghdeo (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 - III	**20MAP19B**	**INTEGRAL TRANSFORMS**	**72**	**-**	**4**

Preamble

To enable the students to learn and gain knowledge about Fourier Cosine and Sine Transforms and Hankel transforms.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	definethe concepts based on Fourier Sine and Cosine transforms, Hankel transforms	$\mathbf{K_1}$
CO2	apply the Fourier Transforms in Laplace Equation	$\mathbf{K_3}$
CO3	gain the knowledge about the properties of Fourier and Hankel Transforms.	$\mathbf{K_2}$
CO4	analyze the problems on Fourier Transform	$\mathbf{K_4}$
CO5	evaluate the problems based on Fourier Cosine and	$\mathbf{K_5}$, $\mathbf{K_6}$

	sine Transforms, Axisymmetric Dirichlet problems.	

Unit I: FOURIER TRANSFORMS (15 Hours)

Fourier sine and cosine transforms –Fourier transforms of derivatives -Fourier transforms of simple functions

Unit : II FOURIER TRANSFORMS (Con…) (15 Hours)

Convolution integral – Parseval's Theorem-Solution of PDE by Fourier transform –Laplace equation in half plane - Laplace equation in infinite strip –

Unit III FOURIER TRANSFORMS (Con…) (15 Hours)

Laplace equation in semi infinite strip. The Linear diffusion equation on a semi infinite line –The two dimensional diffusion equation. Solution of the diffusion equation $\frac{\partial^2 u}{\partial x^2} = \frac{1}{k}\frac{\partial u}{\partial t}$ with the boundary condition $u_x(0,t) = f(t)$, $t \geq 0$ and the initial condition $u(x,0) = 0$ - Solution of diffusion equation on a semi infinite line.

Unit IV: HANKEL TRANSFORMS (15 Hours)

Properties of Hankel Transforms – Hankel inversion theorem – Hankel Transform of derivative of functions - The Parseval's relation for Henkel Transforms –Axisymmetric Dirichlet problem for a half space

Unit V HANKEL TRANSFORMS (Con…) (12 Hours)

Axisymmetric Dirichlet problem for a thick plate. Relation between Fourier and Hankel Transforms – Problems.

TEXT BOOKS:

For Units I and II:

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

UNIT	CHAPTER	SECTION
I	**2**	**2.4 – 2.7**
II	**2**	**2.9 – 2.10**

III	**2**	**2.16- 1(a),(b),(c), 2.16 – 2 (a), (b)**
IV	**5**	**5.2 – 5.4, 5.6 & 5-10-1**
V	**5**	**5-10-2, 5.7**

SEMESTER IV

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	**20MAP21**	**FUNCTIONAL ANALYSIS**	**72**	**-**	**5**

Preamble

To enable the students to learn and gain knowledge aboutBanach 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	Gain tha knowledge about banach space, Hilbert	**K_1 &K_2**

	spaceand the conjugate of an operator.	
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 banachSteinhaus 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	20MAP22	MATHEMATICAL METHODS	72	-	4

Preamble

To enable the students to learn and gain knowledge about 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 Various types of integral equations and Calculus of Variations.	K_1
CO2	apply the integral equations in ordinary differential	K_4 &K_3

	equations.	
CO3	Understand the various types of integral equations	**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 Fredhlom Integral Equation and Volterra Integral equations.	**K_5, K_6**

Unit I: INTEGRAL EQUATIONS

Types of Integral equations –Integral Fredholm Alternative–Equation with separable Kernel.

Unit II: METHOD OF SUCCESSIVE APPROXIMATIONS

Method of successive Approximations – Iterative Scheme - Volterra integral equations – examples.

Unit III: SINGULAR& ABEL INTEGRAL EQUATIONS

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

Unit IV: **CALCULUS OF VARIATIONS**

Variation and its properties – Fundamental lemma of calculus of variations - Euler's equation – Functionals of the integral forms -Functional dependent on higher order derivatives – Euler poisson equations.

Unit V:CALCULUS OF VARIATIONS(Con…)

Functionals dependent on the functions of several independent variables – Ostrogradsky equation - Variational problems in parametric form –Applications.

TEXT BOOKS:

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	I II	1.1 – 1.6 2.3 – 2.5
II	III	3.1 – 3.4
III	V VIII	5.1 – 5.2 8.1 – 8.2
IV	VI	6.1 – 6.4
V	VI	6.5 – 6.7

CATEGORY	COURSE CODE	TITLE OF THE COURSE	C	P	CREDIT
CORE	20MAP23	FLUID DYNAMICS	72	-	4

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	definethe 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	learnand 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 Motions – 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 – StaedyCouettc flow between cylinders in relative motion .

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, McMillanCompany.

For Units III, IV and V:

Curle.Nand Davies.H.J (1968) – "Modern Fluid Dynamics" – (Volume I) DVan 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, 3.5.3,3.6)
IV	V	5.1 – 5.3.2
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 - IV	20MAP25A	FUZZY LOGIC AND FUZZY SETS	72	-	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	K_3

	fuzzy relations.	
CO3	analyze the fuzzy measures.	$\mathbf{K_3}$
CO4	evaluate the fuzzy logic in various types of uncertainity	$\mathbf{K_4}$
CO5	evaluate their relation to information and complexity.	$\mathbf{K_5, K_6}$

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 (15 Hours)

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

UNIT – III :FUZZY MEASURES (15Hours)

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

UNIT –IV : UNCERTAINTY AND INFORMATION (15 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 (15 Hours)

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

TEXT BOOK:

GeoregeJ.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 - IV	**20MAP25B**	**ACTUARIAL MATHEMATICS**	**72**	**-**	**4**

Preamble

To teach the students about Annuities, Premium calculation, Commutation functions, Population functions and risk models.

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 probability and Annuities.	**K_1& K_2**

CO2	apply Statistical tools in Life insurance related problems.	**K_3**
CO3	analyze the Premium Calculation.	**K_3**
CO4	evaluateSome Special Integrals in probability.	**K_4**
CO5	evaluate the use of demographic concepts and population theories to understand contemporary socio-economic issues and current affairs	**K_5, K_6**

UNIT I BASICS OF PROBABILITY AND INTEREST: (12 Hours)

Probability - Theory of Interest: Variable Interest Rates -Continuous-time Payment Streams – Problems. Interest& Force of Mortality: More on Theory of Interest - Annuities & Actuarial Notation -Loan Amortization & Mortgage Refinancing - Illustration on Mortgage Refinancing – Computational illustration in Splus - Coupon & Zero-coupon Bonds Force of Mortality & Analytical Models: Comparison of Forces of Mortality – Problems .

UNIT II PROBABILITY & LIFE TABLES: (15 Hours)

Interpreting Force of Mortality - Interpolation Between Integer Ages - Binomial Variables & Law of Large Numbers: Exact Probabilities, Bounds & Approximations - Simulation of Life Table Data: Expectation for Discrete Random Variables -Rules for Manipulating Expectations - Some Special Integrals – Problems .

Expected Present Values of Payments: Expected Payment Values: Types of Insurance & Life Annuity Contracts - Formal Relations among Net Single Premiums - Formulas for Net Single Premiums - Expected Present Values for m = 1 - Continuous Contracts & Residual Life: Numerical Calculations of Life Expectancies – Problems.

UNIT III COMMUTATION & RESERVES: (15 Hours)

Premium Calculation: m-Payment Net Single Premiums: Dependence Between Integer & Fractional Ages at Death - Net Single Premium Formulas – two cases Approximate Formulas via first case - Net Level Premiums - Benefits Involving Fractional Premiums-Problems.

Idea of Commutation Functions: Variable-benefit Commutation Formulas- Secular Trends in Mortality - Reserve & Cash Value of a Single Policy: Retrospective Formulas & Identities - Relating Insurance & Endowment Reserves -Reserves under Constant Force of Mortality - Reserves under Increasing Force of Mortality - Recursive Calculation of Reserves - Paid-Up Insurance - Select Mortality Tables & Insurance - Illustration of Commutation Columns - Examples on Paid-up Insurance – Problems .

UNIT IV POPULATION THEORY: (15 Hours)

Population Functions & Indicator Notation: Expectation & Variance of Residual Life - Stationary-Population Concepts - Estimation Using Life-Table Data – Non-stationary Population Dynamics: - Appendix: Large-time Limit of ¸(t; x) - Population Word Problems. Estimation from Life-Table Data: General Life-Table Data - ML Estimation for Exponential Data - MLE for Age Specific Force of Mortality: Extension to Random Entry & Censoring Times - Kaplan-Meier Survival Function Estimator – Problems.

UNIT V RISK MODELS & SELECT MORTALITY: (15 Hours)

Proportional Hazard Models - Excess Risk Models - Select Life Tables – Problems. Multiple Decrement Models: Multiple Decrement Tables - Death-Rate Estimators: Deaths Uniform within Year of Age -Force of Mortality Constant within Year of Age – Cause-Specific Death Rate Estimators - Single-Decrement Tables and Net Hazards of Mortality – Cause-Specific Life Insurance Premiums – Problems Central Limit Theorem & Portfolio Risks –problems

Text Book:

Eric V. Slud, Actuarial Mathematics and Life-Table Statistics, Mathematics Department,

University of Maryland, College Park, Edition 2001

Reference Books:

1. Jerry Alan Veeh, Lecture Notes on Actuarial Mathematics (E-notes), 2006.

2. Bowers, N., Gerber, H., Hickman, J., Jones, D. and Nesbitt, C. Actuarial Mathematics, Society of Actuaries, Itasca, Ill. 1986.

3. Feller, W. An Introduction to Probability Theory and its Applications, vol.I, 2nd ed. Wiley, New York, 1957.

4. Gerber, H. Life Insurance Mathematics, 3rd ed. Springer-Verlag, New York, 1997.

5. Hogg, R. V. and Tanis, E. Probability and Statistical Inference, 5th ed. Prentice-Hall Simon & Schuster, New York, 1997.

R. Jaya

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