M. Phil. Mathematics
(w.e.f. January 2017)
as per
Choice Based Credit System (CBCS)

Program Specific Outcomes

Students would be able to:

PSO1 Demonstrate critical understanding of up to date knowledge and research methodology in the field of Mathematics.

PSO2 Acquire analytical and logical thinking through various mathematical and computational techniques.

PSO3 Implement effective academic and personal strategies for carrying out research projects independently and ethically.

PSO4 Define emerging research problems and evaluate the research in relation to important latest issues in the field.

PSO5 Attain in-depth knowledge to pursue higher studies and ability to conduct research.

Scheme of Examination-Semester System
for
M.Phil. Mathematics(Semester–I)
(w.e.f. January 2017)

Note: ***The Scheme of Examination of Ph.D. Course Work will be the same as that for 1st Semester of M.Phil Mathematics.***

<u>SEMESTER-I</u> **(Total Credits:12)**

Paper	Title of the Course	Theory Marks	Internal-Assessment Marks	Total Marks	Time	Credits
17MATMP11C1	Research Methodology	80	20	100	4 Hours/ week	4
*	One paper either from Group A or Group B	80	20	100	4 Hours/ week	4
*	One paper either from Group A or Group B	80	20	100	4 Hours/ week	4
TOTAL MARKS OF SEMESTER-I				300		
*Students are required to opt courses both either from Group A or Group B						

<u>Group A</u>

17MATMP11DA1	:	Advanced Solid Mechanics
17MATMP11DA2	:	Waves and Viscoelasticity
17MATMP11DA3	:	Computational Biology
17MATMP11DA4	:	Reliability Theory
17MATMP11DA5	:	Stochastic Processes
17MATMP11DA6	:	Parametric and Non-Parametric Tests

<u>Group B</u>

17MATMP11DB1	:	Advanced Functional Analysis
17MATMP11DB2	:	Fixed Point Theory
17MATMP11DB3	:	Fuzzy Set Theory
17MATMP11DB4	:	Wavelets-I
17MATMP11DB5	:	Sobolev Spaces-I
17MATMP11DB6	:	Algebraic Coding Theory
17MATMP11DB7	:	Algebraic Number Theory

Note 1: The marks of internal assessment of each course shall be split as under :

Attendance	:	05 marks
Internal Assessment Test	:	05 marks
Presentation	:	10 marks
Total	:	**20 Marks**

Note 2: The syllabus of each course will be divided into **three or four** sections of **two or three** questions each. The question paper will consist of **eight** questions divided into sections as indicated in the syllabus. The students shall be asked to attempt **five** questions selecting atleast **one** question from each section.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper.

Note 4: Optional courses will be offered subject to availability of requisite resources/ faculty.

SEMESTER-I

(w.e.f. January 2017)

17MATMP11C1: Research Methodology

Max. Marks : 8 **Credits: 4**
Time: 3 Hours

Course Outcomes

Students would be able to:

CO1 Describe a research process and steps involved in the process.
CO2 Understand research design and its different types.
CO3 Distinguish between primary and secondary data and know how to collect these data using a relevant method.
CO4 Analyse data using various charts, diagrams and statistical tools.
CO5 Learn Microsoft Word and Microsoft Power Point Softwares.

Section-I (Three Questions)

Introduction: Meaning, objectives and types of research.
Research Process: Steps involved in research process, Problems encountered by researchers in India. Research Design: Meaning and need for research design, Different research designs.
Data collection through experimental techniques and theoretical calculations, Types of data and various methods of data collection and compilation.

Section-II(Three Questions)

Processing and analysis of data: Coding, editing, classification and tabulation of data, Elements of analysis, Data analysis using various kinds of charts, diagrams and statistical tools - Correlation; Fitting of curves and linear regression; Z, t, F, Chi Square tests and ANOVA.

Section-III(Two Questions)

Preparation of Dissertation: Types and layout of research, Precautions in preparing the research Dissertations. Bibliography and annexure discussion of results, Drawing conclusions, giving suggestions and recommendations to the concerned persons.
Knowledge of Microsoft Word and Power point.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Bill Taylor, Research Methodology: A Guide for Researchers, PHI.
2. R. P. Mishra, Research Methodology, Concept Publishing Company, New Delhi.
3. Suresh C. Shina and Anil K. Dhiman, Research Methodology, Ess, 2002
4. C. R. Kothari, Research Methodology, New Age International Publishers, 2004.

(w.e.f. January 2017)

17MATMP11DA1: Advanced Solid Mechanics

Max. Marks: 80 **Credit: 4**
Time: 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand the nonlinear effects in the deformation, the realistic information to be used in geophysics, earthquake engineering, civil and oil exploration studies.

CO2 To get familiar with the basic balance laws governing the deformation.

CO3 Interpret the pattern of deformation in various situations using Kelvin and Boussinesq problems.

CO4 Infer the thermal effects in various physical problems for industry use.

Section-I (Three Questions)

Non-Linear Theory

Deformation gradient tensor. Decomposition of a deformation stretch and rotation. Strain tensors. Strain-displacement relations. Principal stretches. Strain invariants. Length and angle changes. Deformation of volume and surface elements.

Homogeneous deformation-dilation, simple extension, simple shear and plane strain.

Material derivative. Velocity and acceleration fields. Principle of conservation of mass-equation of continuity. Principles of balance of linear and angular momentum. Equations of motion in spatial coordinates. Principle of conservation of energy. Piola stresses. Equations of motion in material co-ordinates.

Section-II (Three Questions)

General Solution of the equilibrium equations

Papkovitch-Neubersolution Lame's strain potential. Galerkin vector. Love's strain function. Applications to the solution of the Kelvin problem for an unbounded medium and the Boussinesq problem for a semi-infinite medium.

Exact solution of some linear elastic problems

Spherical shell subject to internal and external pressures. Gravitating elastic sphere.

Section-III (Two Questions)

Thermoelasticity

Generalized Hooke's law including the effects of thermal expansion, ThermoelasticNavier's equation, Thermal stresses in a long cylindrical shell and solid cylinder, Thermal stresses in a hollow spherical shell and solid spherical shell.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Mal. A.K. and Singh, S.J. Deformation of Elastic Solids, Prentice Hall, 1991
2. Fung, Y.C., Foundations of Solid Mechanics.
3. S. Valliappan, Continuum Mechanics – Fundamentals, Oxford & IBH Publishing Co., 1981
4. I.S. Sokolnikoff- Mathematical Theory & Elasticity, Tata McGraw Hill, New Delhi , 1977
5. S. Saada, A.S. Elasticity: Theory and Applications, Pergaman Press, 1973.

(w.e.f. January 2017)

17MATMP11DA2: Waves and Viscoelasticity

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Describe the waves on strings, their fundamental properties and mathematical formulation for different string models and Lamb's problem.

CO2 Study liquid waves for various physical models such as deep water, canal, tank, surface of a uniform stream, interface between two liquids etc.

CO3 Have knowledge of various viscoelastic models and their constitutive equations, and the correspondence principal of viscoelasticity and its applications.

Section-I (Two Questions)

Waves on Strings

Free vibrations of an infinite string. Reflection at a change of density. Reflection at a concentrated load. Strings of finite length-normal modes. String plucked at its mid-point. String with load at its mid point. (Coulson: Waves, Secs. 13-23).

Lamb's Problem : A periodic line or normal point force acting on the surface of a semi-infinite elastic solid (formal solution only).

Section-II (Three Questions)

Liquid Waves

Types of liquid waves, Gravity waves, Particle path, Waves in deep water, Wave energy, Rate of transmission of energy for harmonic wave, Group velocity, Effect of surface tension, Stationary waves, Waves in a canal, rectangular tank, cylindrical tank. Complex potential for a simple harmonic progressive wave, Waves on the surface of a uniform stream, Waves at the interface between fluids and effect of surface tension, Circular waves.

Section-III (Three Questions)

Viscoelasticity

Spring and dashpot. Maxwell and Kelvin models. Three parameter solid. Constitutive equations for generalized Maxwell and Kelvin models. Creep compliance and relaxation modulus. Hereditary integrals. Vibrations-complex compliance, dissipation, application to specific materials, the simple spring-mass system, forced vibrations. Stress-strain relations for viscoealstic body. Correspondence principle and its application to the deformation of a viscoelastic thick-walled tube in plane strain. (Relevent Sections of Flugge's book "Viscoelasticity").

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Atkin, R.J. and Fox, N. An Introduction to the Theory of Elasticity.
2. Bath, M., Mathematical Aspects of Seismology, Elsevier.
3. Ben-Menahem, A. and Singh, S.J. Seismic Waves and Sources, Springer.
4. Bullen, K.E. and Bolt, A. An Introduction to the Theory of Seismology, Cambridge University Press.
5. Coulson, C.A., Waves, Longman.
6. Flugge, W., Viscoelasticity.
7. Fung, Y.C., Foundations of Solid Mechanics.
8. Besant, W. H. and Ramsey, A. S., A Treatise on Hydromechanics.

(w.e.f. January 2017)

17MATMP11DA3: Computational Biology

Max. Marks : 80 **Credits: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand the contents and the properties of the molecular biology, perform text and sequence based analysis and discuss the results in the light of molecular biological knowledge.

CO2 Explain the major steps in pairwise and multiple sequences alignment and develop understanding of algorithms for them.

CO3 Describe the principle for sequence assembly and execute pairwise sequence alignment by dynamic programming.

Section-I (3 Questions)

Basic concepts of molecular biology. DNA and Proteins. The Central Dogma. Gene and Genome Sequences.

Restriction Maps - Grphas, Interval graphs. Measuring Fragment sizes.

Section-II (2 Questions)

Algorithms for double digest problem (DDP) - Algorithms and complexity, approaches to DDP. Integer Programming. Partition problems. Travelling Salesman Problem (TSP) Simulated annealing.

Section-III (3 Questions)

Sequence Assembly – Sequencing strategies. Assembly in practices, fragment overlap statistics, fragment alignment, sequence accuracy.

Sequence comparisons Methods - Local and global alignment. Dynamic programming method. Multiple sequence alignment.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recoimmended:

1. M.S. Waterman, Introduction to Computational Biology, Chapman & Hall, 1995.
2. A. Baxevanis and B. Quelette, Bioinformatics, A Practical Guide to the analysis of Genes and Proteins, Wiley Interscience (1998).

(w.e.f. January 2017)

17MATMP11DA4: Reliability Theory

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand different system structures and system redundancy used in the system reliability modeling.

CO2 Demonstrate time dependent hazard models and system reliability models.

CO3 Compute failure rate, mean time to failure, mean time between failures and system reliability.

CO4 Carry out reliability and availability analysis of various systems using regenerative point and supplementary variable techniques.

CO5 Describe economics of reliability engineering with different cost models.

Section-I(Three Questions)

Reliability and Quality. Failure Data Analysis: Failure data, Failure density, Failure rate.

Some Important distributions: Exponential, Rayleigh, Weibul, Gamma and Lognormal distributions.

Laplace and Stieltjes transforms and convolutions.

Component Reliability and Hazard Models: Component reliability from test data, Mean time to failure (MTTF), Mean time between failures (MTBF), Time dependent hazard models. Bath-Tub Curve.

Section-II(Two Questions)

System Reliability Models: Systems with components in series, Systems with parallel components, k-out-of-m systems, Non-series parallel systems, Systems with mixed mode failures. Standby redundancy: Simple standby system, k-out-of-n standby system.

Section-III(Three Questions)

Maintainability and Availability: Maintainability function, Availability function, Reliability and availability analysis of a two-unit parallel system with repair using Markov model, Reliability and availability analysis of single-unit and two- unit cold standby systems with constant failure and repair rates using regenerative point and supplementary variable techniques.

Economics of Reliability Engineering: Manufacture's cost, Customer's cost, Reliability achievement and utility cost models, Depreciation cost models and availability cost model for parallel system.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. E. Balagurusami, Reliability Engineering, Tata McGraw Hill, New Delhi, 1984.
2. L. S. Srinath, Reliability Engineering, Affiliated East West Press, New Delhi, 1991.
3. Elsayed A. Elsayed, Reliability Engineering, Addison Wesley Longman. Inc. Publication
4. A. Birolini, Reliability Engineering: Theory and Practical, Springer-Verlag.
5. Jai Singh Gurjar, Reliability Technology, I.K. International Publishing House Pvt. Ltd.
6. Charles E Ebeling, An Introduction to Reliability and Maintainability Engineering, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.

(w.e.f. January 2017)

17MATMP11DA5: Stochastic Processes

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Define Probability generating function (pgf) and obtain pgf's of Bernoulli, binomial, Poisson and geometric distributions.

CO2 Compute means and variances of the probability distributions using pgf's and be expressed them in terms of Laplace Transforms.

CO3 Understand the concept of Markov chains and can obtain higher transition probabilities.

CO4 Demonstrate the ideas of birth and death process, immigration-emigration process, linear growth process, renewal process, Regenerative stochastic process, Markov renewal process and semi-Markov process.

CO5 Apply the stochastic theory for modeling real systems/ phenomena and study their implications.

Section-I (Three Questions)

Probability generating function: Probability generating function (pgf) of Bernoulli, binomial, Poisson and geometric distributions, Mean and variance of probability distributions using pgf.

Mean and variance of probability distributions in terms of Laplace transforms.

Stochastic Processes: definition, classification and examples.

Markov Chains: definition and examples, transition matrix, order of a Markov chain, Markov chain as graphs.

Section-II (Three Questions)

Higher transition probabilities, classification of states and chains. Determination of higher transition probabilities.

Poisson Process: Introduction, postulates for Poisson process, properties of Poisson process, Poisson process and related distributions.

Section-III (Two Questions)

Pure Birth process. Birth and Death process: Immigration-Emigration process, linear growth process-generating function, mean population size and extinction probability.

Definitions and simple examples of Renewal process in discrete and continuous time, Regenerative stochastic processes, Markov renewal and semi-Markov processes.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. J. Medhi, Stochastic Processes, New Age International Publishers
2. N.T.J. Bailey, Elements of Stochastic Processes.

(w.e.f. January 2017)

17MATMP11DA6: Parametric And Non-Parametric Tests

Max. Marks : 80 **Credit:4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Explain various basic terms used in testing of significance.

CO2 Understand the tests of significance and confidence intervals for single proportion, difference of two proportions, single mean, difference of two means and difference of two standard deviations in case of large samples.

CO3 Learn about Chi-square, Students'-t and Snedcor F-statistics and their distributions and their applications in different fields.

CO4 Apply one-way and two-way analysis of variance (ANOVA) and analysis of covariance (ANCOVA) to real life problems.

CO5 Have knowledge of various non-parametric tests.

Section-I(Two Questions)

Parameter and Statistic: Sampling distribution of a statistic, standard error and its utility.

Tests of significance: Null and alternative hypotheses, Two types of error, Critical region and level of significance, One-tailed and two-tailed tests, Critical values, Procedure for testing of hypothesis.

Large Sample Tests: Tests of significance for single proportion and single mean, for difference of two proportions, two means and two standard deviations, related confidence intervals for population parameters.

Section-II(Three Questions)

Chi-square, t and F statistics : Definition and simple properties of their distributions. Chi-square tests for goodness of fit and for homogeneity for standard distributions. Contingency table, Coefficient of contingency, Test of independence. t-test for single mean, for difference of means and for observed sample correlation coefficient, F-test for equality of two population variances, related confidence intervals.

Analysis of Variance and Co-Variance: ANOVA and its basic principle, Problems on ANOVA for one-way and two-way classified data, ANOCOVA technique and its applications.

Section-III(Three Questions)

Non-parametric tests: Advantages and drawbacks of non-parametric tests over parametric tests, One sample and two sample sign tests, Median test, McNemer test, Willcoxon Matched-pairs test, Rank sum tests: Wilcoxon-Mann-Whitney and Kruskal-Wallis tests, One sample runs test, Spearman's rank correlation and Kendall's coefficient of concordance tests.

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Cramer, H. , Mathematical Methods of Statistics.
2. Mood, A. M., Graybill, F. A. and Boss, D. C., Introduction to Theory of Statistics, McGraw-Hill.
3. Goon, A. M., Gupta, M. K. and Das Gupta, B., Basic Statistics, World Press.
4. Gupta, S.C. and Kapoor, V. K., Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.
5. C. R. Kothari, Research methodology, New Age International Publishers.

(w.e.f. January 2017)

17MATMP11DB1: Advanced Functional Analysis

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Solve problems by using Contraction Mapping and Arzela-Ascoli theorems.

CO2 Understand the concept of normed and Banach algebras with identity, spectrum, Resolvent function and its analyticity.

CO3 Be familiar with Gelfand's theorem, spectral radius, spectral mapping theorem and Gelfand representation for algebras with identity.

CO4 Explain the concept of Bilinear Mappings, sesquilinear mappings and their properties.

Section – I (3 Questions)

Contraction mapping theorem and its applications to differential equation, integral equation and system of linear equations. Equicontinuity, Arzla-Ascoli theorem and its application to differential equations. Weierstrass's Approximation Theorem, Stone-Weierstrass's Approximation Theorem. Semi-continuity and its applications to Arclength.

Section-II (3 Questions)

Definition of normed and Banach algebras with identity. Haar measure. Regular points and spectrum. Compactness of spectrum. Resolvent function and its analyticity in the set of regular points. Gelfand's theorem about isomorphism between Banach algebras and complex numbers. Spectral radius and the spectral mapping theorem for polynomial Ideals and Maximal ideals in commutative Banach algebras with identity. The set C(M) of complex functions on the set M of maximal ideals in a Banach algebra. Gelfand representation for algebras with identity.

Section – III (2 Questions)

Bilinear Mappings, Bounded bilinear mappings, sesquilinear mappings, Hermitian form, bounded sesquilinear mappings, bounded sesquilinear forms in Hilbert space.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Bachman, G. and LawrerieNarici, Functional Analysis, Academic Press.
2. Goffman, C. and G. Pedrick, First Course in Functional Analysis .
3. Berberian, S.K., Introduction to Hilbert Spaces, (Chelsea Publishing Co. N.Y.).
4. Babu Ram, Metric Spaces, Vinayaka Publications, New Delhi.

(w.e.f. January 2017)

17MATMP11DB2: Fixed Point Theory

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Find out fixed points of locally Contractive, ε-Contractive and Contractive mappings.

CO2 Describe Caristi Fixed Point Theorem, Convex Contraction of order n, Fixed Points and Set-Valued Mappings.

CO3 Understand the concept of non expansive mappings, their general properties and approximation of Fixed Points.

CO4 Use the concept of Fixed point Theorems and Contraction mappings in PM spaces.

CO5 Apply Brouwer's Fixed point Theorem and Schauder's Theorem to solve various problems.

Section-I (3 Questions)

Banach Contractions Principle and some consequences of Contraction Principle, A converse of contraction Principle. Retraction mappings, Computation of fixed points of locally Contractive, ε-Contractive and Contractive mappings as defined by Boyd and Wong, Caristi Fixed Point Theorem, Fixed points of local power Contraction. Local radial Contraction and Hardy Roger's type mappings in a Complete metric space, Convex Contraction of order n. Fixed Points and Set-Valued Mappings. Hyperconvex Spaces.

Section-II (3 Questions)

Non expansive mappings, Some general properties of nonexpansive mappings. Approximation of Fixed Points of non expansive and generalized non-expansive mappings, Normal Structure, Some general properties of non expansive mappings in Hilbert and Banach spaces, Fixed points of Pseudo Contractive, Quasi nonexpansive and asymptotically nonexpansive mappings. Fixed point Theorems for mappings on PM spaces, Contraction mappings in PM spaces,

(ε, λ) Chainable mappings Probabilistic Measure of Non-Compactness, sequence of mappings and fixed points.

Section-III (2 Questions)

Fixed point Property, Brouwer's Fixed point Theorems and applications, Schauder's Fixed point Theorem and Consequences of Schauder's Theorem. SchauderTychonoff and Krsnoselkii's fixed point theorems.

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

<u>Books Recommended:</u>

1. Istratescu, V.I., Fixed Point Theory
2. Joshi, M.C. and Bose, R.K., Some Topics in Non-linear Functional Analysis

(w.e.f. January 2017)

17MATMP11DB3: Fuzzy Set Theory

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand the basic concept of Fuzzy Set Theory.

CO2 Describe Operations and Composition of Fuzzy Relations and Fuzzy matrix.

CO3 Familiar with Projection and Cylindrical Extension, Extension by Relation and Extension Principle.

CO4 Get knowledge of α- cut of Fuzzy Graph and Fuzzy Equivalence Relation

CO5 Learn about Operations on General Fuzzy Numbers and properties of Fuzzy Function.

Section-I(3 Questions)

Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T-norms and T- conorms. (Chapter 1of [1])

Product Set, Definition of Relation, Characteristics of Relation, Representation Methods of Relations, Operations on Relations, Path and Connectivity in Graph, Fundamental Properties, Equivalence Relation, Compatibility Relation, Pre-order Relation, Order Relation, Definition and Examples of Fuzzy Relation, Fuzzy Matrix, Operations on Fuzzy Relation, Composition of Fuzzy Relation, α - cut of Fuzzy Relation.

Section-II (3 Questions)

Projection and Cylindrical Extension, Extension by Relation, Extension Principle, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets. (Chapter 2,3 of [1])

Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, α - cut of Fuzzy Graph, Fuzzy Network, Reflexive Relation, Symmetric Relation, Transitive Relation, Transitive Closure, Fuzzy Equivalence Relation, Fuzzy Compatibility Relation, Fuzzy Pre-order Relation, Fuzzy Order Relation, Fuzzy Ordinal Relation, Dissimilitude Relation, Fuzzy Morphism, Examples of Fuzzy Morphism. (Chapter 4 of [1])

Section-III (2 Questions)

Interval, Fuzzy Number, Operation of Interval, Operation of α - cut Interval, Examples of Fuzzy Number Operation,, Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers, Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number.

Function with Fuzzy Constraint, Propagation of Fuzziness by Crisp Function, Fuzzifying Function of Crisp Variable, Maximizing and Minimizing Set, Maximum Value of Crisp Function, Integration and Differentiation of Fuzzy Function. (Chapter 5,6 of [1])

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
3. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

(w.e.f. January 2017)

17MATMP11DB4: Wavelets –I

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand linear spaces, bases and frames, normed spaces, inner product spaces, Hilbert spaces.

CO2 Have knowledge of trigonometric systems, trigonometric Fourier series, convergence of Fourier series and generalized Fourier series.

CO3 Represent Fourier transforms, convolution, Plancherel formula, sampling theorem and Gibbs phenomenon.

CO4 Demonstrate the ideas of Gabor transforms, Zak transforms and their properties.

CO5 Be familiar with concepts and properties of Wavelet transforms.

Section -I (3 Questions)

Definition and Examples of Linear Spaces, Bases and Frames, Normed Spaces, The L^p-Spaces, Definition and Examples of Inner Product Spaces, Hilbert Spaces, Orthogonal and Orthonormal Systems.

Trigonometric Systems, Trigonometric Fourier Series, Convergence of Fourier Series, Generalized Fourier Series.

Section - II (3 Questions)

Fourier Transforms in L^1(R) and L^2(R), Basic Properties of Fourier Transforms, Convolution, Plancherel Formula, Poission Summation Formula, Sampling Theorem and Gibbs Phenomenon.

Definition and Examples of Gabor Transforms, Basic Properties of Gabor Transforms.

Definition and Examples of Zak Transforms, Basic Properties of Zak Transforms, Balian-Low Theorem.

Section - III (2 Questions)

Wavelet Transform, Continuous Wavelet Transforms, Basic Properties of Wavelet Transforms, Discrete Wavelet Transforms, Partial Discrete Wavelet Transforms, Maximal Overlap Discrete Wavelet Transforms.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. K. Ahmad and F. A. Shah, Introduction to Wavelet Analysis with Applications, Anamaya Publishers, 2008.
2. Eugenio Hernandez and Guido Weiss, A first Course on Wavelets, CRC Press, New York, 1996.
3. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
4. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, 1992.
5. Y. Meyer, Wavelets, Algorithms and Applications (translated by R.D. Rayan, SIAM, 1993).

(w.e.f. January 2017)

17MATMP11DB5: Sobolev Spaces –I

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Explain the concept of test function spaces and distributions, convergence distributional derivatives.

CO2 Define L^1-Fourier transform, Fourier transform of a Gaussian, L^2- Fourier transform, Inversion formula, L^p-Fourier transform and Convolutions.

CO3 Learn about the spaces $W^{l,p}{}_{\infty}(\Omega)$, $W^{l,p}(\Omega)$ and their characteristic properties, density results.

CO4 Interpret the space $H^1(\Omega)$ and its properties, density results and Imbedding Theorems.

Section -I (2 Questions)

Distributions – Test function spaces and distributions, convergence distributional derivatives.

Section -II (3 Questions)

Fourier Transform – L^1-Fourier transform. Fourier transform of a Gaussian, L^2-Fourier transform, Inversion formula. L^p-Fourier transform, Convolutions.
Sobolev Spaces - The spaces $W^{l,p}{}_{\infty}(\Omega)$ and $W^{l,p}(\Omega)$. Their simple characteristic properties, density results. Min and Max of $W^{l,p}$ – functions.

Section -III (3 Questions)

The space $H^1(\Omega)$ and its properties, density results.
Imbedding Theorems - Continuous and compact imbeddings of Sobolev spaces into Lebesgue spaces. Sobolev Imbedding Theorem, Rellich – Kondrasov Theorem.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended :

1. R.A. Adams, Sobolev Spaces, Academic Press, Inc. 1975.
2. S. Kesavan, Topics in Functional Analysis and Applications, Wiley Eastern Limited, 1989.
3. A. Kufner, O. John and S. Fucik, Function Spaces, Noordhoff International Publishing, Leyden, 1977.
4. A. Kufner, Weighted Sobolev Spaces, John Wiley & Sons Ltd., 1985.
5. E.H. Lieb and M. Loss, Analysis, Narosa Publishing House, 1997.
6. R.S. Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House, 2001.

w.e.f. January 2017)

17MATMP11DB6: Algebraic Coding Theory

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Design the new algorithms for coding.

CO2 Calculate the parameters of given codes and their dual codes using standard matrix and polynomial operations.

CO3 Compare the error-detecting/correcting facilities of given codes for a given binary symmetric channel.

Section -I (3 Questions)

The communication channel. The Coding Problem. Types of Codes. Block Codes. Error-Detecting and Error-Correcting Codes. Linear Codes. Hamming Metric. Description of Linear Block Codes by Matrices. Dual Codes. Hamming Codes, Golay Codes, perfect and quasi-perfect codes.

Section -II (3 Questions)

Modular Representation. Error-Correction Capabilities of Linear Codes. Tree Codes. . Description of Linear Tree. Bounds on Minimum Distance for Block Codes. Plotkin Bound. Hamming Sphere Packing Bound. Varshamov-Gilbert – Sacks Bound. Bounds for Burst-Error Detecting and Correcting Codes.

Section -III (2 Questions)

Convolutional Codes and Convolutional Codes by Matrices. Standard Array. Bounds on minimum distance for Convolutional Codes. V.G.S. bound. Bounds for Burst-Error Detecting and Correcting Convolutional Codes. The Lee metric, packing bound for Hamming code w.r.t. Lee metric.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.
2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
3. W.W. Petersonand E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.
4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.
5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company.
6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.
7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.

(w.e.f. January 2017)

17MATMP11DB7: Algebraic Number Theory

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand the arithmetic of algebraic number fields.
CO2 Prove theorems about integral bases, and about unique factorization into ideals.
CO3 Factorize an algebraic integer into irreducibles.
CO4 Find the ideals of an algebraic number ring.
CO5 Understand ramified and unramified extensions and their related results.

Section-I (2 Questions)

Algebraic numbers, algebraic integers, countability of set of algebraic numbers, Liouville's theorem and generalizations, transcendental numbers, algebraic number fields, Liouville's Theorem of Primitive elements, ring of algebraic integers, Theorem of Primitive Elements(Chapter 3 of book at Sr. No. 1).

Section-II (3 Questions)

Norm and trace of an algebraic number, non degeneracy of bilinear pairing, existence of an integral basis, Discriminant of an algebraic number field, Ideals in the ring of algebraic integers, explicit construction of integral basis, Sign of the discriminant, cyclotomic fields, calculation for quadratic and cubic cases (Chapter 4 of book at Sr. No. 1)

.

Section-III (3 Questions)

Integral closure, Noetherian ring, characterizing Dedekind domains, fractional ideals and unique factorization, g.c.d. and L.C.M. of Ideals, Chinese remainder theorem, Dedekind's theorem, ramified and unramified extensions. Different of an algebraic number field, factorization in the ring of algebraic integers (Chapter 5 of book at Sr. No. 1).

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Esmonde and M Ram Murty, Problems in Algebraic Number Theory, GTM Vol. 190, Springer Verlag, 1999.
2. Leveque, W.J., Topics in Number Theory – Vols. I, III Addition Wesley.
3. Narasimhan and others, Algebraic Number Theory, TIFR Pamphlet No. 4
4. Pollard, H., The Theory of Algebraic Number, CarusMonogrpah No. 9, Mathematical Association of America.
5. Riebenboim, P., Algebraic Numbers – Wiley Inter-science.
6. Weiss, E., Algebraic Number Theory, McGraw Hill.

SEMESTER-II (Total Credits: 20)

Paper	Title of the Course	Theory Marks	Internal-Assessment Marks	Viva-voce	Total Marks	Time	Credits
*	One paper either from Group A or Group B	80	20	----	100	4Hours/ week	4
*	One paper either from Group A or Group B	80	20	----	100	4 Hours/ week	4
17MATMP12C1	Practical Based on Research Methodology	----	----	----	100	4 Hours/ week	4
17MATMP12C2	Dissertation	150		50	200		8
TOTAL MARKS OF SEMESTER-II					500		20
	*Students are required to opt courses both either from Group A or Group B						

Group A

17MATMP12DA1 : Theoretical Seismology
17MATMP12DA2 : Advanced Mathematical Methods
17MATMP12DA3 : Bio-Fluid Dynamics
17MATMP12DA4 : Network Analysis and Theory of Sequencing
17MATMP12DA5 : Information Theory
17MATMP12DA6 : Industrial Statistics

Group B

17MATMP12DB1 : Fuzzy Sets and Logic
17MATMP12DB2 : Non Linear Functional Analysis
17MATMP12DB3 : Advanced Topology
17MATMP12DB4 : Fuzzy Topology
17MATMP12DB5 : Theory of Operators
17MATMP12DB6 : Wavelets-II
17MATMP12DB7 : Sobolev Spaces-II
17MATMP12DB8 : Cyclic and MDS Codes

Note 1: The marks of internal assessment of each course shall be split as under :

Attendance	:	05 marks
Internal Assessment Test	:	05 marks
Presentation	:	10 marks
Total	:	**20 Marks**

Note 2: The syllabus of each course will be divided into **three or four** sections of **two or three** questions each. The question paper will consist of **eight** questions divided into sections as indicated in the syllabus. The students shall be asked to attempt **five** questions selecting atleast **one** question from each section.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper.

Note 4: Optional courses will be offered subject to availability of requisite resources/ faculty.

SEMESTER-II
(w.e.f. January 2017)

17MATMP12DA1: THEORETICAL SEISMOLOGY

Max Marks (Theory): 80 **Credit: 4**
Time: 3 Hours

Course Outcomes

Students would be able to:

CO1 Interpret the relationship between observations and theories/ models through direct and inverse techniques.

CO2 Help the mankind from disasters with the cooperation and exchange of observations from the different parts of the world.

CO3 Enlighten the exploration of natural resources in the interior of the earth.

CO4 Plan development in non-seismic as well as seismic areas with suitable upgraded technology which is earthquake resistant.

Section-I (3 Questions)

Wave equation for an elastic medium; solutions of the wave equation; displacement, velocity and acceleration, The propagation of energy--the Langrangian formulation, the effect of gravity on wave propagation, plane waves, the geometry of P- and S- waves displacements, particular forms of the potentials, cylindrical waves, spherical waves. Vibrations of an elastic rod-longitudinal vibrations, torsional vibrations.

Surface waves-Love waves and Rayleigh waves.

Section-II (3 Questions)

Snell's law, normal incidence, critical incidence, inhomogeneous waves, reflected and transmitted energy, Reflection and refraction in elastic media-incident SH-waves, incident P-waves and SV-waves. Reflection on a free surface-incident SH-waves, incident P-waves, incident SV-waves, critical reflection of SV-waves. Motion at the free surface –incident P-waves, incident S-waves, apparent angles of incidence and polarization.

Section-III (2 Questions)

Free oscillations of the Earth, Wave propagation and modes of vibration, free oscillations of a homogeneous liquid sphere, free oscillations of an elastic sphere, Toroidal modes, Spheroidal modes, effect on free oscillations, observations.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Peter M. Shearer; introduction to Seismology, Cambridge University press, 1999
2. Agustin Udia; Principles of Seismology, Cambridge University press, 1999
3. T.M. Atanackovic and A. Guran: Theory of Elasticity for Scientists and Engineers, Birkhauser, 2000.

(w.e.f. January 2017)

17MATMP12DA2:Advanced Mathematical Methods

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Have basic skills for applying special mathematical functions appropriately in solving problems in mathematics and physics.

CO2 Learn about the basic structure and properties of various integral transforms and difference between them.

CO3 Apply integral transform methods for solving various problems in science and engineering.

Section-I (3 Questions)

Modified Bessel functions, Ber and Bei functions, Kelvin functions, Hankel and Spherical Bessel functions, Modified spherical Bessel functions, Legendre's associated differential equations, Legendre's associated functions $P_n^m(x)$ and $Q_n^m(x)$, Recurrence relations and integral expression for associated Legendre functions.

Dirac delta function, Heaviside's unit step function and relation between them. Integral representation of delta function. Signum function, Boxar function and impulsive function.

Section-II (Three Questions)

Hankel transform of elementary functions. Operational properties of the Hankel transform. Applications of Hankel transforms to PDE.

Mellin Transform of elementary functions and its basic operational properties. Application of Mellin transform to BVP, integral equations and summation of series.

Definition and basic properties of finite Fourier sine and cosine transforms, its applications to the solutions of BVP's and IVP's.

Section-III (Two Questions)

Hilbert transform and its basic properties. Hilbert transform in the complex plane. Applications of Hilbert transform.

Stieltjes transform and its basic operational properties, Inversion theorem. Applications of Stieltjes transform.

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

<u>Books Recommended:</u>

1. E. D. Rainville; Special Functions.
2. Peter V. O'Neil; Advanced Engineering Mathematics, An International Thomson Publishing Company.

3. J. W. Dettman; Mathematical Methods in Physics and Engineering, McGraw Hill Book Company, 1962.
4. I. N. Sneddon; Special function of Mathematical Physics and Chemistry.
5. LokenathDebnath; Integral Transforms and their Applications, CRC Press, Inc., 1995.
6. Sneddon, I.N., The Use of Integral Transform.

(w.e.f. January 2017)

17MATMP12DA3:Bio-Fluid Dynamics

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Understand the basic concepts of physiological and biological fluid dynamics.

CO2 Know about the systematic and pulmonary circulations, specific flow properties of blood and identify diseases related to obstruction of blood flow in human body.

CO3 Get familiar with important models of bio-fluid flows and their applications to duct and pipe flows.

CO4 Able to describe non-Newtonian fluid flow models and peristaltic flows along with their applications in blood flow in human body.

Section I (Three Questions)

Introduction: Viscosity, Laminar and turbulent flow, Compressible and incompressible flow. Basic equation of fluid mechanics : Continuity equation, Equation of motion, Simplification of basic equations, Initial and boundary conditions, Dimensional analysis in fluid mechanics.

Circulatory Bio-Fluid Mechanics : General introduction, The circulatory system : Introduction, Systematic and Pulmonary circulations. The circulation in the heart, Diseases relative to circulation.

Section II (Two Questions)

Blood Rehology properties of flowing blood : General Introduction, Blood composition, Structure of Blood. Flow properties of blood: Viscosity of blood, Yield stress of blood. Blood vessel structure: Arteries and Arterioles, Veins and Venules, Capillary, Diseases related to obstruction of blood flow: Thrombus formation, Embolus, Compieression, Structural defect.

Section III (Three Questions)

Models of bio-fluid flows : Flows in pipes and duct, Models of blood flows: Introduction, Poiseuille's flow, Consequences of Pioseuille's flow: Applications of Poiseuille's flow, Law for study of blood flow, Pulsatile flow, Discussion on pulsatile flow, The pulse wave. Mones-Korteweg expression for wave velocity in an inviscid fluid filled elastic cylindrical tube. Application in the cardiovascular system, Wave propagation, Accounting for viscosity and its applications to cardiac output determination. Flow through a covering and diverging duct.

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Bio-Fluid Mechanics by Jagan N. Mazumdar published by World Scientific Publisher.
2. Blood flow in artery By Donald A. McDonald Published by Edward Arnold Press.
3. Bio-Dynamics by Y. C. Fung published by Springer Verlag.
4. Blood viscosity, hyperviscosity and hyper viscoseamia by L. Dintenfass published by MTP Press USA.

(w.e.f. January 2017)

17MATMP12DA4: Network Analysis And Theory of Sequencing

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Explain general minimal cost flow, shortest path and travelling salesman problems.
CO2 Construct minimal spanning trees and use them in an organization.
CO3 Classify and handle different types of sequencing problems.
CO4 Distinguish between PERT and CPM
CO5 Carry out project crashing, resource levelling and resource scheduling in different situations.

Section-I(Two Questions)

Flows in networks, Distribution and general minimal cost flow problems, Shortest path and travelling salesman problem, Construction of minimal spanning tree and its applications.

Section-II(Three Questions)

PERT and CPM with activity times known and probabilistic, Earliest and latest times, Various types of floats, Updating of PERT charts, Project Crashing, Formulation of CPM as a linear programming problem, Resource levelling and Resource scheduling.

Section-III(Three Questions)

Production, Scheduling and Sequencing: n jobs and two/ three machines flowshop problem, n jobs and m machines flowshop problem, CDS (Campbell, Dudek and Smith) method to obtain near optimal permutation schedule, Mitten's method.

Group Production Scheduling: Concept of equivalent job on two, three and more machines, Solution of Job-block with the concept of equivalent job, Rule for determining equivalent job in $n \times 2$ flowshop problem, Job-block extended to 3-machine flowshop problems, Application of equivalent job in m machine flowshop problem.

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

<u>Books Recommended:</u>

1. L. R. Ford and D. R. Fulkerson, Flows in Network, Priceton University Press, 1962.
2. P. A. Jenson and W. J. Barnes, Network Flows Programming, Johan Wiley and Sons, 1980.
3. R.W. Convey, W. L. Maxwell and L. W. Millar, Theory of Scheduling, Addison Wesley, 1967
4. L. S. Srinath, PERT and CPM
5. S. Fiench, Sequencing and Scheduling, Ellis Horwood Limited, 1982.
6. H. A. Taha, Operation Research-An introduction, Tata McGraw Hill, New Delhi.

(w.e.f. January 2017)

17MATMP12DA5:Information Theory

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand various measures of information and identify appropriate measures
CO2 Provide logical and coherent proofs of important properties of information measures
CO3 Learn the basic concepts of noiseless coding, channel and channel capacity and relation among them.
CO4 Compare different codes and construct optimal codes.
CO5 Explain important discrete memoryless channels and continuous channels.

Section-I(Three Questions)

Measure of information – Axioms for a measure of uncertainty, The Shannon entropy and its properties, Joint and conditional entropies.

Noiseless coding – Ingredients of noiseless coding problem, Uniquely decipherable codes, Instantaneous codes, Condition for uniquely decipherable and instantaneous codes.

Section-II(Three Questions)

Noiseless Coding Theorem. Optimal codes, Construction of optimal codes. Huffman procedure, Shannon-Fano encoding procedure.

Discrete Memoryless Channel: Classification of channels, information processed by a channel, Calculation of channel capacity, Decoding schemes, The ideal observer, The fundamental theorem of Information Theory and its strong and weak converses.

Section-III(Two Questions)

Some intuitive properties of a measure of entropy – Symmetry, normalization, expansibility, boundedness, recursivity, maximality, stability, additivity, subadditivity, nonnegativity, continuity, branching, etc. and interconnections among them.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Robert Ash, Information Theory, Inter-Science Publishers, New York, 1965.
2. F. M. Reza, An Introduction to Information Theory, McGraw Hill Book Company Inc., 1961.
3. J. Aczel and Z. Daroczy, On Measures of Information and their Characterizations, Academic Press, New York, 1975.

(w.e.f. January 2017)

17MATMP12DA6: Industrial Statistic

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Measure trends, seasonal and cyclical variations in a time series using different methods and use them for the forecasting purposes.

CO2 Lean about various Statistical Quality Control (SQC) techniques and construction of various important control charts for variables and control charts for attributes.

CO3 Know how to obtain various terms used in acceptance sampling plans.

CO4 Develop single and double sampling plans and find their OC functions.

CO5 Understand theory of regression for single equation, simultaneous equations models and concepts of distributed lag-model and multi-collinearity being used in Econometrics.

Section-I(Two Questions)

Time Series: Components of time series, Measurement of trend, seasonal and cyclical components, Forecasting techniques.

Section-II(Three Questions)

Statistical Quality Control : Meaning and uses of SQC, Causes of variations in quality, Product and process control. Control charts for variables: charts for mean, range and standard deviation. Control charts for attributes: charts for number of defectives per unit and proportion of defectives.

Acceptance sampling : Problem of lot acceptance, stipulation of good and bad lots. Producer's and consumers risks, Concepts of AOL, LTPD, AOQL, average amount of inspection and ASN function.

Section-III(Three Questions)

Sampling inspection plans, single and double sampling plans, their OC functions.

Econometrics: Theory of regression for single equation models and simultaneous equation models, Distributed lag-models, Multi-collinearity.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. D.C. Montegomory and L.A., Johnson, Forecasting & Time Series Analysis, McGraw Hill, 1990.
2. A.J. Duncan, Quality Control and Industrial Statistics, D.B. Taraporevala and Sons, 1965.
3. E. L. Grant and R.S. Leavenworth, Statistical Quality Control, Tata McGraw Hill, 2000.
4. J. Johnston, Econometric methods, 3rd Edn, McGraw Hill, 1984.

(w.e.f. January 2017)

17MATMP12DB1:Fuzzy Sets and Logic

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Describe Probability Distribution, Comparison of Probability and Possibility and Measure of Fuzziness.

CO2 Model Fuzzy sets, Arithmetic of Fuzzy quantities and Fuzzy Rule.

CO3 Understand the concept of Fuzzy Composition, Fuzzy Implications, Fuzzy Inference and various methods.

CO4 Know about Fuzzy Logic Controller, Fuzzification Interface Component and practical examples of Fuzzy Set Theory.

Section-I(2 Questions)

Probability Theory, Probability Distribution, Comparison of Probability and Possibility, Fuzzy event, Crisp Probability of Fuzzy Event, Fuzzy Probability of Fuzzy Event, Uncertainty Level of Element, Fuzziness of Fuzzy Set, Measure of Fuzziness, Measure using Entropy, Measure using Metric Distance. (Chapter 7 of book at serial no. 1)

Section-II(3 Questions)

Proposition Logic, Logic Function, Tautology and Inference Rule, Predicate Logic, Quantifier, Fuzzy Expression, Operators in Fuzzy Expression, Some Examples of Fuzzy Logic Operations, Linguistic Variable, Fuzzy Predicate, Fuzzy Modifier, Fuzzy Truth Values, Examples of Fuzzy Truth Quantifier, Inference and Knowledge Representation, Representation of Fuzzy Predicate by Fuzzy Relation, Representation of Fuzzy Rule.

Extension Principle and Composition, Composition of Fuzzy Sets, Composition of Fuzzy Relation, Example of Fuzzy Composition, Fuzzy if-then Rules, Fuzzy Implications, Examples of Fuzzy Implications, Decomposition of Rule Base, Two- Input/ Single-Output Rule Base, Compositional Rule of Inference, Fuzzy Inference with Rule Base, Inference Methods, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method. (Chapter 8,9 of book at serial no. 1)

Section-III(3 Questions)

Advantage of Fuzzy Logic Controller, Configuration of Fuzzy Logic Controller, Choice of State Variables and Control Variables, Fuzzification Interface Component, Data Base, Rule Base, Decision Making Logic, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method, Mean of Maximum Method, Center of Area Method(COA), Bisector of Area, Lookup Table, Design Procedure of Fuzzy Logic Controller, Application Example of FLC Design, Fuzzy Expert Systems. (Chapter 10 of book at serial no. 1)

Applications of Fuzzy Set Theory in Natural, Life and Social Sciences, Engineering, Medicine, Management and Decision Making, Computer Science, System Sciences. (Chapter 6 of book at serial no. 2).

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

<u>Books Recommended:</u>

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall of India Private Limited, New Delhi-110 001, 2005.
3. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
4. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

(w.e.f. January 2017)

17MATMP12DB2:Non Linear Functional Analysis

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Use the mean value theorems and its applications.

CO2 Learn about the continuous linear and multi-linear mappings.

CO3 Have in-depth knowledge of characterization of maximality for single valued and multivalued monotone operators.

CO4 Describe the concept of isomorphism and equivalence of norms in normed linear spaces.

Section-I(3 Questions)

Normed Spaces, Banach Spaces, Notions of convergence, Isomorphism and equivalence of Norms in Normed Linear Spaces, Continuous Linear and Multi-Linear Mappings, Natural Isometry, Gautex and Frechet differentiable mappings in Banach Spaces.

Section-II(3 Questions)

Differentiable Mappings, Derivative of a Compound Function, Derivative of a Bilinear Continuous mapping, Functions with Values in a Product of Banach spaces, Mean Value theorems and applications. Local inversion of mappings in C, Implicit Functions Theorem, Derivatives of higher order and Taylor's theorem.

Section-III(2 Questions)

Monotone Operators, Sufficient Conditions for monotonicity of a Operator in Banach Spaces, Continuity and boundedness property of monotone operators, Maximal monotone operator and its properties, characterization of maximality for single valued and multi-valued monotone operators, Kirzbraum Theorem and surjectivity Theorems for monotone operators. Subdifferential and monotonicity

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Carten, N., Differential Calculus
2. Flett, T.M., Differential Analysis
3. Joshi, M.C. and Bose, R.K., Some Topics in Non-linear Functional Analysis

(w.e.f. January 2017)

17MATMP12DB3:Advanced Topology

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Learn about the uniformity of compact spaces and compactness in a uniform space.
CO2 Understand the characterizaton of paracompact spaces in regular and normal spaces.
CO3 Have knowledge of seminorms and local convexity in topological vector spaces.
CO4 Describe the concept of locally compact topological vector spaces.

Section-I (Three Questions)

Definition of uniform structures, Fundamental system of entourages, Topology of uniform spaces, Characterization of uniform space in terms of Hausdorff space, Uniform continuous functions, Inverse image of uniformity, Complete spaces, and Cauchy criteria, Minimal Cauchy filters. Subspaces of complete spaces, Uniformity of compact spaces, Compactness in a uniform space. Pre-compact uniform space.

Section-II (Three Questions)

Covering of spaces, paracompact spaces, Michael Theorem on characterization of paracompactness in regular spaces, Metric spaces as paracompact spaces, Michael Theorem on invariance of paracompactness under continuous closed surjection, Types of refinements, Barycentric refinements, Star refinements, Stone's Theorem of characterization of paracompact spaces by Barycentric refinements, Nagata Smirnov Metrization Theorem, Characterizaton of paracompact spaces in regular and normal spaces, Countably paracompact spaces.

Section-III (Two Questions)

Definition of topological vector spaces, Types of Topological vector spaces, Convex and balanced neighbourhoods, Continuity properties of linear mappings, Finite dimensional spaces, Locally compact topological vector space, Metrizability, Cauchy sequences, Boundedness, Bounded linear transformations, Seminorms and local convexity, Space of measurable functions.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Engelking, R., Outline of General Topology
2. Nagata, J., Modern General Topology
3. Willards, S., General Topology
4. Kelley, J.L., General Topology.
5. Introduction to General Topology, K.D. Joshi, Wiley Eastern Limited.
6. NicolarBourbaki, Elements of Mathematics General Topology, Springer.

(w.e.f. January 2017)

17MATMP12DB4:Fuzzy Topology

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Understand basic notions of fuzzy and topological spaces.

CO2 Get knowledge about the concept of connectedness, separation in relating with fuzzy topological concept.

CO3 Learn the concept of topology related with fuzzy points and level sets, local base, closure and Kuratowski's theorem.

CO4 Understand the concept of accumulation points with fuzzy bases.

Section I (2 Questions)

Fuzzy sets-Basic Concepts, Union and intersection of Fuzzy sets, Fuzzy topological spaces, concept of a fuzzy point and its neighbourhood structure, fuzzy points and level sets, local base, closure and Kuratowski's Theorem, Accumulation points, generalization of C. T.Yang's Theorem, Fuzzy subspace, Fuzzy continuity.

Section II (3 Questions)

Fuzzy metric spaces, fuzzy pseudo metric space, Fuzzy Metrization Theorem, Fuzzy Continuous functions,Quasi- Fuzzy compact spaces, weakly fuzzy-compact spaces, a-compact spaces, strong fuzzy compact spaces, fuzzy compact spaces.

Initial fuzzy topologies, Fuzzy Product Topology, Final Fuzzy Topologies, A comparison of different compactness notions in fuzzy topological spaces.

Section III (3 Questions)

Connectedness in fuzzy topological spaces, fuzzy connectedness, fuzzy separation axioms, separated sets, separation in fuzzy neighbourhood spaces, separation properties, Regularity and Normality.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended :

1. Fuzzy topology, Liu Xing Ming and Luo Mao Kang, World Scientific (1979).
2. Fuzzy Topology, N. Palaniappan, Narosa Publishing House (2002).

(w.e.f. January 2017)

17MATMP12DB5:Theory of Operators

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

<u>Course Outcomes</u>

Students would be able to:

CO1 Learn about the compact linear operators on normed spaces and operator equations involving compact linear operators.

CO2 Understand the spectral representation of bounded self adjoint linear operators, extension of the spectral theorem to continuous functions.

CO3 Learn about the spectral representation of unitary operators and self adjoint operators.

CO4 Describe the concept of Fredholm alternative for integral equations.

Section-I(3 Questions)

Spectral theory in normed spaces, resolvent set and spectrum, Special properties of bounded linear operators, Properties of resolvent and spectrum, Spectral mapping theorem for polynomials, Spectral radius of a bounded linear operator on a complex Banach space.

Compact linear operators on normed spaces. The separability of the range and spectral properties of compact linear operators on normed spaces, Operator equations involving compact linear operators, Fredholm type theorems. Fredholm alternative theorem. Fredholm alternative for integral equations. (scope as in Chapter -7 and 8 of Functional Analysis with Applications by E.Kreyszig).

Section-II(3 Questions)

Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space. Positive operators, Square roots of a positive operator, Projection operators Spectral families, Spectral families of a bounded self-adjoint linear operator, Spectral representation of bounded self adjoint linear operators, Extension of the Spectral theorem to continuous functions, Properties of the spectral family of a bounded self adjoint linear operator. (scope as Chapter -9 of Functional Analysis with Applications' By E.Kreyszig).

Section-III(2 Questions)

Unbounded linear operators and their Hilbert-adjoint operators, Hellinger -Teoplitz theorem. Symmetric and self adjoint linear operators. Closed linear operators and theirs closures. Spectral properties of self adjoint linear operators. Spectral representation of unitary operators. Wecken's lemma, spectral theorem for unitary operators. Spectral representation of self adjoint linear operators. Cayley transform, spectral theorem for self adjoint linear operators. Multiplication operator and differentiation operators.

Unbounded linear operators in quantum mechanics. Basic ideas, States, Observables, position operator. Momentum operator, Heisenberg uncertainty principle, Time independent Schorordinger equation. Hamilton operator. (The scope as in Chapter 10 and 11 of E.Kreyszig: Introductory Functional Analysis with Applications, John Willey & Sons, 1978).

<u>Note</u>: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. G. Bachman and L.Narici, Functional Analysis, Academic Press, New York, 1966.
2. P.R.Halmos, Introduction to Hilbert Space and the Theory of Spectral, Multiplicity, Second Edition, Chelsea Pub. Co., New York, 1957.
3. N. Dunford and J.T. Schwartz, Linear Operator 3 Parts, Interscience / Wiley, New York, 1958-71.
4. Akhiezer, N.I and I.M.Glazmant : Theory of Linear Operators in Hilbert space, FreerickUngar, Pub. Co., New York Vol.-I (1961) and Vol.-II (1963).
5. P. R.Halmos, A Hilbert Space Problem Book, D.VanNostreavd Co. Incl., 1967.
6. M.Schecter, Principles of Functional Analysis, Academic Press, Students Edition, 1971.

(w.e.f. January 2017)

17MATMP12DB6: Wavelets –II

Max. Marks: 80 **Credit: 4**
Time : 3 hours

Course Outcomes

Students would be able to:

CO1 Understand the orthonormal wavelet bases and Haar MRA.

CO2 Identify the relationship between wavelets packets and multiwavelet packets.

CO3 Apply wavelets in financial mathematics: stock exchange, statistics, neural networks and biomedical sciences.

CO4 Describe generalized multiresolution analysis, frame multiresolution analysis and AB-multiresolution analysis.

Unit -I (2 Questions)

Definition and Examples of Multiresolution Analysis, Properties of Scaling Functions and Orthonormal Wavelet Bases, The Haar MRA, Band- Limited MRA, The Meyer MRA.

Unit - II (3 Questions)

Haar Wavelet and its Transform, Discrete Haar Transforms, Shannon Wavelet and its Transform.

Haar Wavelets, Spline Wavelets, Franklin Wavelets, Battle- Lemarie Wavelets, Daubechies Wavelets and Algorithms.

Biorthogonal Wavelets, Newlands Harmonic Wavelets, Wavelets in Higher Dimensions.

Unit -III (3 Questions)

Generalized Multiresolution Analysis, Frame Multiresolution Analysis, AB- Multiresolution Analysis, Wavelets Packets, Multiwavelet and Multiwavelet Packets, Wavelets Frames.

Applications of Wavelets in Image Processing, Integral Opertors, Turbulence, Financial Mathematics : Stock Exchange, Statistics, Neural Networks, Biomedical Sciences.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. K. Ahmad and F. A. Shah, Introduction to Wavelet Analysis with Applications, Anamaya Publishers, 2008.
2. Eugenio Hernandez and Guido Weiss, A first Course on Wavelets, CRC Press, New York, 1996.
3. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
4. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, 1992.
5. Y. Meyer, Wavelets, Algorithms and Applications (translated by R.D. Rayan, SIAM, 1993).

(w.e.f. January 2017)

17MATMP12DB7: Sobolev Spaces –II

Max. Marks: 80 **Credit: 4**
Time : 3 hours

Course Outcomes

Students would be able to:

CO1 Learn about the dual spaces, fractional order Sobolev spaces and trace theory.

CO2 Understand the Holder's condition, partition of unity, the class $K(x_0)$ including cone property.

CO3 Describe the concept of the Hardy-Littlewood-Sobolev inequality and its various versions.

Unit -I (3 Questions)

Other Sobolev Spaces - Dual Spaces, Fractional Order Sobolev spaces, Trace spaces and trace theory.

Weight Functions -Definiton, motivation, examples of practical importance. Special weights of power type. General Weights.

Unit -II (3 Questions)

Weighted Spaces - Weighted Lebesgue space $P(\Omega, \sigma)$, and their properties.

Domains - Methods of local coordinates, the classes C^o, $C^{o,k}$, Holder's condition, Partition of unity, the class K (x_0) including Coneproperty.

Unit -III(2 Questions)

Inequalities – Hardy inequality, Jensen's inequality, Young's inequality, Hardy-Littlewood - Sobolev inequality, Sobolev inequality and its various versions.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. R.A. Adams, Sobolev Spaces, Academic Press, Inc. 1975.
2. S. Kesavan, Topics in Functional Analysis and Applications, Wiley Eastern Limited, 1989.
3. A. Kufner, O. John and S. Fucik, Function Spaces, Noordhoff International Publishing, Leyden, 1977.
4. A. Kufner, Weighted Sobolev Spaces, John Wiley & Sons Ltd., 1985.
5. E.H. Lieb and M. Loss, Analysis, Narosa Publishing House, 1997.
6. R.S. Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House, 2001.

(w.e.f. January 2017)

17MATMP12DB8:Cyclic and MDS Codes

Max. Marks : 80 **Credit: 4**
Time : 3 Hours

Course Outcomes

Students would be able to:

CO1 Design the cyclic codes and descibe the error correction and detection capabilities of these codes.

CO2 Derive codes using Hadamard matrices.

CO3 Decode RS and BCH codes.

CO4 Obtain classical bounds on the number of codewords, the minimum distance and length of code including the Griesmer bound and singleton bound.

Section-I(3 Questions)

Cyclic Codes. Cyclic Codes as ideals. Matrix Description of Cyclic Codes. Hamming and Golay Codes as Cyclic Codes. Error Detection with Cyclic Codes. Error-Correction procedure for Short Cyclic Codes. Short-ended Cyclic Codes. Pseudo Cyclic Codes. Quadratic residue codes of prime length.

Section-II(3 Questions)

Hadamard Matrices and non-linear Codes derived from them. Product codes. Concatenated codes. Code Symmetry. Invariance of Codes under transitive group of permutations. Bose-Chaudhary-Hoquenghem (BCH) Codes.

BCH bounds. Reed-Solomon (RS) Codes. Majority-Logic Decodable Codes. Majority-Logic Decoding. Singleton bound. The Griesmer bound.

Section-III(2 Questions)

Maximum – Distance Separable (MDS) Codes. Generator and Parity-check matrices of MDS Codes. Weight Distribution of MDS code. Necessary and Sufficient conditions for a linear code to be an MDS Code. MDS Codes from RS codes. Abramson Codes. Closed-loop burst-error correcting codes (Fire codes). Error Locating Codes.

Note: The question paper will contain three sections and eight questions in all. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Books Recommended:

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.
2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
3. W.W. Petersonand E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.
4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.

5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company.
6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.
7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.

17MATMP12C1: Practicals based on Research Methodology

Max. Marks : 100
Time 4 hours

The practical examination will be held Using SPSS and MSExcel for analysing the given data applying various statistical techniques; and using MATLAB and MATHEMATIKA for the solution of given mathematical problems.

i)	Practical record	: 20 marks
ii)	Viva-voce	: 20 marks
iii)	Written & practical work	: 60 marks

The examiner shall set a question paper consisting of **five** questions and the students will be required to attempt any **three** questions. They will write the steps/procedure to carry out the analysis and run the same on computers.