To
The Dean Academics
Chhatrapati Shahu Ji Maharaj University
Kanpur

Date:- 12/05/2022

Subject:-Report of online meeting conducted by the Board of Studies-Mathematics, CSJMU

Sir,

Following the guidelines received from the U.P. government for the implementation of National Education Policy-2020 at the PG level, Board Of Studies-Mathematics conducted an online meeting on 9th May, 2022 at 2PM. The course structure and syllabus for M.A./M.Sc. Mathematics, CSJMU was passed and approved by the BOS unanimously after some discussion. The following members of the BOS and some special invited members joined the meeting:-

1. Dr. Chandra Shekhar Prasad, D.B.S. P.G. College, Kanpur. (Convenor)
2. Prof. P.N. Pandey, Allahabad University, Prayagraj
3. Prof. Jaya Upreti, S.S.J. University, Almora
4. Prof. Poonam Sharma, Lucknow University, Lucknow
5. Prof. Rekha Bali, H.B.T.U. , Kanpur
6. Dr. R.K. Srivastava, Agra College, Agra
7. Dr. Pushpendra Kumar Tripathi, D.A.V. P.G. College, Kanpur
8. Dr. Arvind Kumar Sharma, K.K.P.G. College, Etawah
9. Dr. R.K. Juneja, Christ Church, P.G. College, Kanpur
10. Dr. Parijat Sinha, V.S.S.D. College, Kanpur
11. Dr. Maninder Singh Arora, P.P.N. College, Kanpur
12. Dr. Ajit Kumar, V.S.S.D. College, Kanpur

C. S. Prasad
Convenor, BOS-Mathematics

(P.N. Pandey)

9.5.2022
(Jaya Upreti)

10/5/2022
(Poonam Sharma)

(Rekha Bali)

(R.K. Srivastava)

(Pushpendra Kumar Tripathi)

(Arvind Kumar Sharma)

(R.K. Juneja)

(Parijat Sinha)

(Maninder Singh Arora)

(Ajit Kumar)

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: M.A./M.Sc., SUBJECT: MATHEMATICS (University Colleges)

Syllabus Developed by		
Name of BoS Convenor / BoS Member	**Designation**	**College/University**
DR. CHANDRA SHEKAR PRASAD	Convenor	D.B.S. COLLEGE, GOVIND NAGAR, KANPUR

SEMESTER / YEAR	COURSE CODE	TYPE	COURSE TITLE	CREDIT	CIA	ESE	MAX. MARKS
IST YEAR / IST SEM	B030701T	CORE	REAL ANALYSIS	5	25	75	100
	B030702T	CORE	TOPOLOGY	5	25	75	100
	B030703T	CORE	ADVANCED COMPLEX ANALYSIS	5	25	75	100
	B030704T	CORE	DYNAMICS OF RIGID BODIES	5	25	75	100
IST YEAR / IIND SEM	B030801T	CORE	ADVANCED REAL ANALYSIS	5	25	75	100
	B030802T	CORE	ADVANCED TOPOLOGY	5	25	75	100
	B030803T	CORE	OPERATIONS RESEARCH	5	25	75	100
	B030804T	ELECTIVE	MATHMATICAL STATISTICS	5	25	75	100
	B030805T		HISTORY AND DEVELOPMENT OF INDIAN MATHAMATICS				
	B030806T		FUZZY SET THEORY				
	B030807T		PROGRAMMING IN C				
	B030808R	PROJECT	RESEARCH PROJECT	8	25	75	100
		MINOR ELECTIVE	FROM OTHER FACULTY (IN 1ST YEAR)	4/5/6	25	75	100
IIND YEAR / IIIRD SEM	B030901T	CORE	ABSTRACT ALGEBRA	4	25	75	100
	B030902T	CORE	FUNCTIONAL ANALYSIS	4	25	75	100
	B030903T	CORE	FLUID DYNAMICS	4	25	75	100
	B030904T	ELECTIVE	SPECIAL FUNCTIONS	4	25	75	100
	B030905T		ADVANCE ORDINARY DIFFERENTIAL EQUATIONS				
	B030906T		VEDIC GANITA				
	B030907T		BIOMECHANICS				
	B030908P	PRACTICAL	COMPUTATIONAL MATHEMATICS WITH PYTHON-I	4	25	75	100
IIND YEAR / IVTH SEM	B031001T	CORE	ADVANCED ABSTRACT ALGEBRA	4	25	75	100
	B031002T	CORE	INTEGRAL EQUATION AND BOUNDARY VALUE PROBLEMS	4	25	75	100
	B031003T	ELECTIVE	ADVANCED FLUID MECHANICS	4	25	75	100
	B031004T		WAVELET ANALYSIS				
	B031005T		SPECIAL THEORY OF RELATIVITY				
	B031006T		DIFFERENTIAL GEOMETRY OF MANIFOLDS				
	B031007T		ADVANCED DISCRETE MATHEMATICS				
	B031008T	ELECTIVE	OPERATOR THEORY	4	25	75	100
	B031009T		CALCULUS OF VARIATIONS				
	B031010T		MATHEMATICAL MODELLING				
	B031011T		COSMOLOGY				
	B031012T		CRYPTOGRAPHY				
	B031013P	PRACTICAL	COMPUTATIONAL MATHEMATICS WITH PYTHON-II	4	25	75	100
	B031014R	PROJECT	RESEARCH PROJECT	8	25	75	100

Convenor, BOS-Mathematics

NOTE:

1. *A MINOR ELECTIVE FROM OTHER FACULTY SHALL BE CHOSEN IN 1ST YEAR (EITHER Ist / IInd SEMESTER) AS PER AVAILABILITY.
2. In both years of PG program, there will be a Research Project or equivalently a research-oriented Dissertation as per guidelines issued earlier and will be of 4 credit (4 hr/week), in each semester. The student shall submit a report/dissertation for evaluation at the end of the year, which will be therefore of 8 credits and 100 marks
3. Research project can be done in form of Internship/Survey/Field work/Research project/ Industrial training, and a report/dissertation shall be submitted that shall be evaluated via seminar/presentation and viva voce.
4. The student straight away will be awarded 25 marks if he publishes a research paper on the topic of Research Project or Dissertation.

M.A./M.Sc. First Semester

Mathematics

Paper 1

Real Analysis

(B030701T)

Credits: 05 **Max. Marks: 100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Real Analysis

Course Type: Core paper

Course Level: PG

Unit I

Countable and uncountable sets, Cardinal numbers, Schroeder-Bernstein theorem, Definition and existence of Riemann-Stieltjes integral, Properties of integral, Riemann Stieltjes integral as a limit of sums, Mean value theorem for RS-Integrals, Integration and differentiation, Fundamental theorem of integral calculus, Integration of vector valued functions, Rectifiable curves.

Unit II

Uniform convergence of sequence and series of functions, M_n-test, Weierstrass M-test, Abel test, Dirichlet test, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Weirerstrass approximation theorem.

Unit III

Power series, Radius of convergence, Uniform convergence of power series, Uniqueness theorem for power series, Abel Theorem, Tauber's theorem, Function of bounded variation, Algebra of function of bounded variation, Jordan decomposition theorem, Absolute continuity.

Unit IV

Concept of functions of several variables, Euclidian's spaces, Linear transformations, Limit of function, Continuous function, Derivatives in an open subset of R^n, Chain rule, partial derivatives. Directional derivative, Repeated partial derivatives, Mean value theorem for vector valued functions, Taylor's theorem, Inverse function theorem, Implicit function theorem, Maxima and Minima of a real valued function defined on a subset of R^n

Recommended books:

1. G.F. Simmons, Topology and Modern Analysis, McGraw-Hill Book company.
2. T.M. Apostol, Mathematical Analysis, Narosa Publishing House.

3. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill Book company.
4. Parijat Sinha, Real Analysis, Kedarnath Ramnath Publications.

Paper 2
Topology
(B030702T)

Credits: 05 **Max. Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Topology
Course Type: Core paper

Course Level: PG

Unit I

Set, Continuum hypothesis, Axiom of choice, Zorn's lemma, Well ordering principle.

Topological space: Definition through open set axioms, Examples include usual topology, Ray, Lower limit and upper limit topologies on R, Co-finite and co-countable topologies, Weak and strong topologies, The topology of metric spaces, Equivalent metrics, Metrizable spaces, Intersection and union of topologies, Closed sets, Limit points, Derived sets, Adherent points, Dense set, Nowhere dense sets, Perfect sets, Characterization of closed sets in terms of derived sets, The interior of a set, Closure, Exterior, Boundary of a set.

Unit II

Characterization of topologies in terms of closed sets, Kuratowski's closure axioms and characterization of topology in terms of these.

Neighbourhoods, Neighbourhood system and neighbourhood base, Topology through neighbourhood axioms, Interior operator, Exterior operator, Characterization of topological spaces in terms of these, Base and subbase for topology and characterization of topology in terms of base and subbase axioms, Topology generated by a family of subsets.

Unit III

First countable and second countable spaces, Relative topology and subspaces, Hereditary property, Lindelof theorem and separable spaces, Continuous functions and their properties, Continuity in terms of open sets, closed sets, neighbourhoods and closures, Convergence of a sequence, Sequential continuity, Open mapping, Homeomorphisms, Topological invariant properties.

Unit IV

Separation axioms- T_0, T_1, T_2, Regular, T_3, Normal and T_4 spaces, Their comparison and examples, Hereditary and Topological invariant characteristics, Completely regular space, Tychonoff space, Completely normal spaces, Urysohn's lemma and Tietze extension theorem.

Unit

Recommended books:

1. George F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw-Hill Book Company (1963).
2. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York (1995).
3. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. (1983).
4. James R. Munkres, Topology, Prentice Hall of India Pvt. Ltd., New Delhi (2000).
5. S. Willard, General Topology Addison-Wesley, Reading, 1970.
6. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).

Paper 3
Advanced Complex Analysis

Credits: 05 **(B030703T)** **Max. Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Advanced Complex Analysis

Course Type: Core paper

Course Level: PG

Unit I

Stereographic projection, Branch point, Branch cut, Branches of multi-valued functions with special reference to $\arg z$, $\log z$ and z^a, Morera's theorem, Cauchy's inequality, Maximum and minimum modulus principle, Schwarz's lemma, Open mapping theorem, Meromorphic functions.

Unit II

Zeros of analytic functions, Singularities and their classification, Residues, Argument principle, Rouche's theorem, Evaluation of real integrals, Linear and bilinear transformations, Fixed points, Cross ratio, Inverse points and critical points, Conformal transformations involving straight lines, circles and half-planes.

Unit III

Weierstrass' factorization theorem, Gamma function and its properties, Riemann zeta function, Mittag-Leffler's theorem, Analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Natural boundary, Schwarz's reflection principle.

Unit IV

Harmonic functions on a disk, Harnack's inequality and theorem, Canonical products, Jensen's formula, Hadamard's three circle theorem, Entire functions, Order of an entire function, Exponent of convergence, Univalent functions, Bieberbach's theorem (statement only) and ¼ theorem, Convex functions and its properties.

Recommended books:

1. Complex Variables with an Introduction to Conformal Mapping and its Applications, Schaum's Outlines, McGraw-Hill, 2009.
2. John B. Convey, Functions of One Complex Variable, Springer.
3. Walter Rudin, Real and Complex Analysis, McGraw-Hill Co., 1966.
4. H. S. Kasana, Complex Variables: Theory and Applications, PHI Learning.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa Pub.
6. R. V. Churchill & J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, New York, 1990.
7. Shanti Narayan, Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.

Paper 4
Dynamics of Rigid Bodies (B030704T)

Credits: 05 **Max Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Dynamics of Rigid Bodies

Course Type: Core paper

Course Level: PG

Unit I

Moments and product of inertia with examples, Use of Routh's rule, Radius of gyration, Momental ellipsoid and ellipse, Principal axes, Equimomental system.

Unit II

D'Alembert's principle, General equation of motion. Motion of the centre of inertia, Application of D'Alembert's principle to general equation of motion, Motion about fixed axis, Compound pendulum, Simple equivalent pendulum, Centre of percussion.

Unit III

Generalised coordinates. Degrees of freedom, Classification of mechanical systems, Generalized velocities, forces, kinetic energy, Lagrangian equations by D'Alembert's principle, Lagrangian function. Principle of conservation of energy.

Unit IV

Hamilton's principle, Hamilton's equation of motion and Hamiltonian function, Physical significance of the Hamiltonian, Derivation of Lagrange's equation by Hamilton's principle, Principle of least action, Deduction of Lagrange's equations using Hamilton's principle, Euler's dynamical equations, Kinetic energy, Euler's geometrical equations, Deduction of Euler's equations from Lagrange's equation, Deduction of Euler's equations from Hamilton's equation.

Recommended books:

1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House Pvt. Ltd.
2. Principles of Engineering Mechanics, Vol 2 by Millard F. Beatty, Jr, Springer International Edition.
3. Classical mechanics by H. Goldstein, 2nd edition, Narosa Publishing House.
4. Classical Mechanics by Gupta, Kumar and Sharma.
5. Dynamics of Rigid Bodies by B.D. Sharma, B.S. Tyagi, Brahma Nand, Kedar Nath Ram Nath Publishers, India.

Online Source 1.http://math.ucr.edu/home/baez/classical/texfiles/2005/book/classical.pdf

2.http://courses.physics.ucsd.edu/2010/Fall/physics200a/LECTURES/200_COURSE.pdf

Paper 5 (Minor)
Introductory Statistical Methods

(for students of other faculty)

Credits: 04 **Max. Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Introductory Statistical Methods

Course Type: Minor

Course Level: PG

Unit I

Measures of central tendency, Frequency distribution, Graphical representation of frequency distribution, Properties of measures of central tendencies, Probability and examples of probability, Conditional probability, Discrete probability distributions (Binomial and Poisson), Continuous probability distributions (Normal).

Unit II

Dispersion, Various measures of dispersion, Minimal property of mean deviation, Root mean square deviation, Variance and standard deviation.

Moments about mean, origin, and any point, Skewness, Kurtosis, Pearson's β and γ-coefficients, Method of least squares, Curve fitting, Fitting of straight lines, Fitting of second-degree curve, Fitting of a polynomial of k-th degree, Change of origin, Selection of type of curve to be fitted, Exponential curves.

Unit III

Correlation and Regression Analysis: Significance of measuring correlation, Types of correlation, Methods of measuring correlation, Regression analysis, Lines of regression.

Unit IV

Sampling and Hypothesis Testing: Census and sampling method, Merits and limitations of sampling, Sampling and non-sampling errors, Reliability of samples, Standard error of estimate.

t- test for single mean and difference of means, F-test, z-test, Chi-square test.

Recommended books:

1. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
2. Goon A. M., Gupta M. K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Ed.,World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V. K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
4. Mood, A. M. Graybill, F. A. and Boes, D. C. (2007): Introduction to the Theory of statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
5. Hogg, R.V. and Tanis, E. A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.

M.A./M.Sc. Second Semester

Mathematics

Paper 1

Advanced Real Analysis (B030801T)

Credits: 05 **Max. Marks: 100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Advanced Real Analysis

Course Type: Core paper

Course Level: PG

Unit I

Unit I

Algebra of sets, Boral sets, F_σ and G_δ set, Measure, Finite and σ finite measure, Complete measure, Regularity of a measure, Lebesgue outer measure, Lebesgue measure, Measurable sets.

Unit II

Measurable functions, Egoroff's theorem, Borel and Lebesgue measurability, Convergence in measure.

Unit III

Lebesgue integral of a bounded function, The general Lebesgue integral, Riemann and Lebesgue integrals, Lebesgue bounded convergence theorem, Integration of non-negative measurable functions, Fatau lemma, Lebesgue monotone convergence theorem, Integrable functions, Lebesgue integral of unbounded function, Lebesgue dominated convergence theorem.

Unit IV

The L^P Spaces, Convex functions, Jensen's inequality, Holder and Minkowski inequalities, Risez Fischer theorem, Convergence in measure, Almost uniform convergence

Signed measure, Positive and negative sets, Hahn-decomposition theorem, Jordan-decomposition theorem, Radon-Nikodym theorem.

Recommended books:

1. G. de Barra, Measure theory and Integration, New age International (P) Limited publishers
2. H. L. Royden, Real Analysis, Pearson Education Pvt. Ltd.
3. P. R. Halmos, Measure theory, D Van Nostrand company.
4. Parijat Sinha, Real Analysis, Kedarnath Ramnath Publications.

Paper 2
Advanced Topology (B030802T)

Credits: 05 **Max. Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Advanced Topology
Course Type: Core paper

Course Level: PG

Unit I

Compact sets and their properties, Finite intersection property, Bolzano Weierstrass property, Continuous functions and compactness, Sequential compactness, Countable compactness and their comparison, Locally compact spaces and compactness in real line, ϵ-net, totally bounded sets, Lebesgue numbers for covers, Lebesgue covering lemma, One point compactification.

Unit II

Separated sets, Connectedness in terms of separated sets, Characterization of connected sets in terms of open sets and closed sets, Closure of a connected set, Union of connected sets, Connected sets in R, Continuity of a function and connectedness, Components and partition of space, Locally connected sets, Totally disconnected sets.

Unit III

Nets and Filters: Directed sets, Residual subset, Cofinal subset, Nets and subnets and their examples, Convergence of a net, Characterisation of open sets, closed sets, closure, cluster point and limit point of a set in terms of net convergence, Hausdorffness and continuity of a function in terms of nets.

Definition of filter and its examples, Free and fixed filters, Discrete and indiscrete filters, Neighbourhood filter, Comparison of filters, Filter base and convergence of a filter, Ultrafilters, Continuous functions and filters, Net based on filter and filter based on net.

Unit IV

Quotient topology, Quotient space X/R, Finite product space, Projection mapping, Tychonoff product topology in terms of standard subbase and its characterizations in terms of projection maps, Continuous functions, Product of T_0, T_1, T_2, spaces, Connectedness and compactness, First and second countability for product spaces.

Recommended books:

1. George F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw-Hill Book Company (1963).
2. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York (1995).
3. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. (1983).
4. James R. Munkres, Topology, Prentice Hall of India Pvt. Ltd., New Delhi (2000).
5. S. Willard, General Topology Addison-Wesley, Reading, 1970.
6. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).

Paper 3
Operations Research (B030803T)

Credits: 05 **Max Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks
Course Title: Operations research
Course Type: Core paper

Course Level: PG

Unit I

History and development of operations research, Operations research and its scope, necessity of operations research in industry and management, Role of operations research in decision-making, Development of operations research in India, Job sequencing, Convex set and their Application.

Unit II

Linear Programming: Simplex method, Theory of simplex method, Duality and sensitivity analysis. Integer programming: Branch and bound technique, Transportation and assignment problems.

Unit III

Game theory: Two-person, zero-sum games, Games with mixed strategies, Principle of dominance, Solution of 2x2 games without saddle point, Graphical solution, Solution by linear programming.

Dynamic Programming: Deterministic and probabilistic dynamic programming.

Unit IV

Network Analysis: Shortest path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Project planning and control with PERT-CPM.

Non-linear Programming: One and multi-variable unconstrained optimisation, Kuhn-Tucker conditions for constrained optimisation, Quadratic programming.

Recommended books:

1. Kanti Swarup, P. K. Gupta and Manmohan: Operations Research, S. Chand and Co.
2. H.A. Taha: Operations Research-An introduction, Macmillan Publishing Co. Inc., New York.
3. P. K. Gupta and D. S. Hira: Operations Research-An introduction, S. Chand and Co. Ltd. New Delhi.

Paper 4(I)
Mathematical Statistics (B030804T)

Max Marks: 100

Credits: 05

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Mathematical Statistics

Course Type: Elective paper

Course Level: PG

Unit I

Random variable, Probability mass function, Probability density function, Cumulative distribution function, Two and higher dimensional random variables, Joint distribution. Marginal and conditional distributions, Stochastic independence, Function of random variables and their probability density functions.

Discrete probability distributions: Binomial, Poisson, Geometric, Hyper geometric multinomial. Continuous probability distributions: Exponential, Gamma, Beta, Normal distributions.

Unit II

Mathematical expectations and moments, Moment generating function and its properties. Chebyshev's inequality and its application, Stochastic convergence, Central limit theorem, Partial and Multiple correlation coefficients, Correlation ratio, Association of attributes.

Unit III

Sampling Distributions: Chi-square, t and F-distributions with their properties, Distribution of sample mean and variance, Distribution of order statistics and sample range from continuous populations.

Applications of Sampling Distributions: Test of mean and variance in the normal distribution, Tests of single proportion and equality of two proportions, Chi-square test, t-test, F-test.

Unit IV

Testing of Hypothesis: Null hypothesis and its test of significance, Simple and composite hypothesis, MP test, UMP test, Likelihood tests (excluding properties of likelihood ratio tests).

Point Estimation: Estimators, Properties of estimators, Unbiasedness, Consistency, Sufficiency, Efficiency.

Recommended books:

1. Hogg R.V., Mckean, J. W. and Craig A. T.: Introduction of Mathematical Statistics, Seventh Edition (2013) Pearson India.
2. Hoel P. G: Introduction to Mathematical Statistics, Fourth Edition ((1971), John Wiley & sons.
3. Gupta S. C.and Kapoor V. K.: Fundamentals of Mathematical Statistics, (2019) Kedarnath Ramnath pub., Meerut India

R.Bala P.Sida C.S.Rana

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4. Mukhopadhyay, P. : Mathematical Statistics, (2016) Books and Allied Publications.
5. Goon, A. M.,Gupta M. K. & Das Gupta B.: Fundamental of statistics, Vol. I, (2005), 8th Edition World Press, Kolkata.

Paper 4(II)
History and Development of Indian Mathematics

(B030805T)

Credits: 05 **Max Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks
Course Title: History and Development of Indian Mathematics
Course Type: Elective paper

Course Level: PG

Unit I

Indian contributions to decimal system and place value, The mathematical sophistication of the Harappan culture, The Vedic period and the sulva geometry.

Unit II

Contribution of the Jainas, Chandas Sutras of Pingala and binary arithmetic, The Baksali Manuscript, Aryabhata I, Varahamihir, Brahmagupta, Bhaskara I.

Unit III

Sridharacharya, Mahaveeracharya, Shripati, Aryabhata II, Bhaskaracharya II, Contributions of Kerala school as Madhava, Nilkantha.

Unit IV

Srinivasa Ramanujan, Swami Bharati Krishna Tirthaji, Prasanta Chandra Mahalanobis, Prof. Harishchandra.

Recommended books:

1. B. B. Datta and A. N. Singh, History of Hindu Mathematics, 2 Volumes, Bharatiya Kala Prakashan, Delhi,2001.
2. C. N. Srinivasiengar, The history of Ancient Indian mathematics, World Press, 1988.

Paper 4(III)
Fuzzy Set Theory

(B030806T)

Credits: 05 **Max Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks
Course Title: Fuzzy Set Theory
Course Type: Elective paper

Course Level: PG

Unit I

Fuzzy Sets: Basic definitions, α-level sets, Convex fuzzy sets, Basic operations on fuzzy sets. Types of fuzzy sets, Cartesian products. Algebraic products, Bounded sum and difference, t-norms and t-conorms.

Unit II

The Extension Principle: The elements of fuzzy arithmetic, Zadeh's extension principle, Image and inverse image of fuzzy sets, Fuzzy numbers.

Unit III

Fuzzy Relations and Fuzzy Graphs: Fuzzy relations on fuzzy sets, Composition of fuzzy relations, Min-Max composition and its properties, Fuzzy equivalence relations, Fuzzy compatibility relations, Fuzzy relation equations, Fuzzy graphs, Similarity relation.

Unit IV

Possibility Theory: Fuzzy measures, Evidence theory, Necessity measure, Possibility measure, Possibility distribution, Possibility theory and Fuzzy sets, Possibility theory versus probability theory.

Recommended books:

1. Klir, G. J. and Bo·Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi 1995
2. Zimmermann, H. J., Fuzzy Set Theory and Its Applications, Allied Publishers Ltd, New Delhi 1991
3. Ross, T. J., Fuzzy Logic with Engineering Applications, McGraw Hill Inc., New Delhi
4. Backzinski, M. and J Balasubramanian, Fuzzy Implications, Springer Verlag, Heidelberg 2008.

Paper 4(IV)
Programming in C (B030807T)

Credits: 05 **Max Marks: 100**

Evaluation: Continuous Internal Assessment - 25 marks
Semester End Examination - 75 marks

Course Title: Programming in C

Course Type: Elective paper

Course Level: PG

Unit I

Overview of C: History and importance of C, Sample Programs, Programming Style, Executing a 'C' programme, Constants, Variables and data type.

Operators: Arithmetic, Relational, Logical, Assignment, Increment and Decrement, Conditional, Bitwise, Special. Expressions: Arithmetic expressions, evaluation of expressions, Input and output operators.

Unit 2

Decision Making and Branching: Decision making with if statement, simple if statement, the if-else statement, Nesting of if-elsestatements, The else if Ladder, The Switch statement, The Goto statement.

Unit 3

Decision Making and Looping: The while statement, The do statement, The for statement, Jump in Loop.

Arrays: One and two-dimensional arrays, Declaration of one and two-dimensional arrays, Initializing of one and two-dimensional arrays, Multi-dimensional arrays, Dynamic arrays, Character arrays and strings.

Unit 4

User-defined Functions: Need for user-defined functions, A multi-function program, Elements of user-defined functions, Definition of functions, Functions call, Functions declaration, Category of function, Nesting of functions.

Pointers: Understanding pointers, Declaring pointer variables, Initializing of pointer variables, Accessing a variable through its pointer, Chain of pointers, Pointers and arrays, Pointer as a function argument, File management in C.

Recommended books:

1. E. Balagurusamy: Programming in ANSI C, MacGraw Hill Education (India) Pvt. Ltd., New Delhi.
2. Yashavant Kanetkar, Let us C, BPB Publications, India.

M.A. /M.Sc. Third Semester

Mathematics

Paper 1

Abstract Algebra (B030901T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Abstract Algebra

Course Type: Core paper

Course Level: PG

Unit I

Internal and external direct product of groups and their relationship, Normal and sub normal series of groups, Composition series, Zassenhaus lemma, Schreier theorem, Jordan Holder theorem.

Unit II

Commutator subgroup and commutator series of a group, Solvable groups, Solvability of subgroups and factor groups and of finite p groups, Lower and upper central series, Nilpotent groups.

Unit III

Cauchy theorems, Action of a group G on a set, Stabilizer subgroups and orbit decomposition, Class equation of an action, Sylow subgroups, Sylow's theorem I, II and III, p-groups. Examples and applications, Groups of order $p.q$, Direct and inverse images of Sylow subgroups, Structure theorem for finite abelian groups.

Unit IV

Canonical forms, Similarity of linear transformations, Invariant subspaces, Reduction to triangular forms, Nilpotent transformations, Index of nilpotency, Invariants of a nilpotent transformation, The primary decomposition theorem, Jordan blocks and Jordan canonical forms.

Recommended books:

1. I. N. Herstein, Topics in Algebra, Wiley student edition
2. Ram Ji Lal, Algebra I and Algebra II, Springer
3. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications
4. John B. Fraleign, A First Course in Abstract Algebra, Narosa Publications
5. Vijay K. Khanna, S.K Bhambri, A Course in Abstract Algebra
6. S. Lipschutz, Linear Algebra, Schaum's Outline Series.

per 2

Functional Analysis (B030902T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Functional Analysis

Course Type: Core paper

Course Level: PG

Unit I

Normed linear spaces, Examples of normed linear spaces and its topological properties, Cauchy's inequality, Hölder's and Minkowski's inequality, Convergence in normed linear spaces, Cauchy sequence, Banach space, Examples of Banach space, Quotient space of normed linear space, Equivalent norms, Riesz lemma.

Unit II

Continuous linear transformation, Bounded linear transformations, Norm of bounded linear transformation, Space of bounded linear transformations, Conjugate space (dual space), Functional, Hahn-Banach theorem for real and complex normed linear spaces, Applications of Hahn- Banach theorem, The natural embedding.

Unit III

Open mapping theorem, Projection of Banach space, Closed graph theorem, Baire category theorem, Uniform boundedness principle.

Inner product spaces, Hilbert spaces with examples, Cauchy-Schwarz's inequality.

Unit IV

Orthogonal complement, Orthonormal set and its existence, Bessel's inequality, Complete orthonormal sets and its characterization. Continuous linear functional on Hilbert space, Riesz representation theorem, Reflexivity of Hilbert space. Weak and strong convergence.

Recommended books:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
2. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, New Delhi, 2002.
3. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
4. B. V. Limaye, Functional Analysis, Wiley Eastern Ltd.
5. N. Saran and S. L. Shukla, Functional Analysis, Pragati Prakashan, Meerut.
6. P. K. Jain, O. P. Ahuja and K. Ahmad, Functional Analysis, New Age International (P) Ltd. And Wiley Eastern Ltd., New Delhi, 1997.
7. B. Choudhary and S. Nanda, Functional Analysis with Applications, Wiley Eastern Ltd., 1989.
8. J. N. Sharma and A. R. Vasishtha, Functional Analysis, Krishna Prakashan Media (P) Ltd., 2015.

Paper 3

Fluid Dynamics (B030903T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Fluid Dynamics

Course Type: Core paper

Course Level: PG

Unit I

Types of fluids, Continuum hypothesis, Lagrangian and Eulerian method of describing fluid motion, Equation of continuity in cartesian, Cylindrical polar, Spherical polar and Orthogonal curvilinear coordinates, Vorticity vector, Velocity potential, Stream lines, Path lines and streak lines, Rotational and irrotational motion of fluid, Boundary surface and boundary condition.

Unit II

Euler's equation of motion: conservation of momentum, Bernoulli's equation, Lagrange's equation of motion, Energy equation, Impulsive effects, Helmholtz's vorticity theorem and vorticity equation, Applications of Bernoulli's equation.

Unit III

Two dimensional irrotational motion, Stream or current function, Physical significance of stream function, sources, sinks, doublets and their images in two-dimension, Complex potential, The Milne-Thomson circle theorem, Theorem of Blasius, Flow and circulation, Kelvin's circulation theorem, Permanence of irrotational motion, Kelvin's Minimum Kinetic Energy theorem.

Unit IV

Motion of cylinders: General motion of cylinder in two dimensions, Kinetic energy, Motion of circular, coaxial and elliptic cylinders, Streaming past and circulation for a fixed circular and elliptic cylinder, Kinetic energy of rotating elliptic cylinder, The aerofoil.

Recommended books:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS publishers and Distributors, Delhi, 1988.
2. R.K. Rathy, An introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi; 1976.
3. F. Charlton, A Text Book of Fluid Dynamics, CBC, 1985.
4. S.W. Yuan, Foundations of Fluid Dynamics, Prentice – Hall of India, 1988.

Paper 4(i)

Special Functions (B030904T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Special Functions

Course Type: Elective paper

Course Level: PG

Unit I

Absolute and uniform convergence of infinite products, The Weierstrass's infinite product and Euler's integral for Gamma function and their equivalence, Beta function, Factorial function, Legendre's duplication formula, Gauss' multiplication theorem, Orthogonal sets of functions, orthogonal sets of polynomials, Gram-Schmidt process of orthonormalization.

Unit II

Hypergeometric function, Integral representation of hypergeometric function and deductions from it, Contiguous function relations, Relations between hypergeometric functions of z and $1-z$, Simple and quadratic transformations of hypergeometric function.

Unit III

Generalised and confluent hypergeometric function, Formation and solution of differential equation for generalised and confluent hypergeometric function and their contiguous function relations, Saalschutz theorems, Whipple's theorems and Dixon's theorem, Contour integrals of Barnes' type, Hypergeometric forms of Legendre's polynomials.

Unit IV

Doubly periodic functions, Elliptic functions and their properties, Weierstrass elliptic function and it's differential equation, Theta functions, Properties of theta functions, Relations involving theta functions and differential equations satisfied by theta functions.

Recommended books:

1. E. D. Rainville: Special Functions, Chelsea Publishing Co., 1971.
2. N. Saran, S. D. Sharma & T. N. Triuedi: Special Functions, PragatiPrakashan, Meerut.
3. M. A. Pathan, V. B. L. Chaurasia, P. K. Banerji & M. C. Goyal : Special Functions and Calculus of Variations, Indus Valley Publications, New Delhi, 2004.
4. Special Functions, Dr. Vinod Kumar, Epsilon Publishing House Pvt. Ltd., Kanpur. 2020.

Paper 4(ii)

Advanced Ordinary differential equations

(B030905T)

Credits: 04 **Max Marks: 100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Advanced Ordinary differential equations

Course Type: Elective paper

Course Level: PG

Unit I

Linear differential equations with constant as well as a variable coefficient, Linear dependence and independence of solutions, Wronskian, Method of undetermined coefficients, Reduction of the order, Initial value problem and equivalent integral equation.

Unit II

Picard's iteration method, Lipschitz condition, Existence and uniqueness theorem, An orthogonal set of functions, Boundary value problem, Strum Liouville problem, Green's functions, Ascoli-Arzela theorems, A theorem on convergence of solutions of a family of initial value problems.

Unit III

Linear systems, Matrix method for homogeneous first order system of linear differential equations, Fundamental set of solutions, Fundamental matrix of solutions, Wronskian of solutions, Basic theory of the homogeneous linear system, Abel-Liouville formula, Nonhomogeneous linear system, Strum theory, Self-adjoint equations of the second order, Abel formula, Strum separation theorem, Strum fundamental comparison theorem.

Unit IV

Nonlinear differential systems, Phase plane, Path, Critical points, Autonomous systems, Isolated critical points, Path approaching a critical point, Path entering a critical point, Types of critical points- Center, Saddle points, Spiral points, Node points, Stability of critical points.

Asymptotically stable points, Unstable points, Critical points and paths of linear systems, Almost linear systems, Nonlinear conservative dynamical system, Dependence on a parameter, Liapunov direct method, Limit cycles, Periodic solutions, Bendixson nonexistence criterion, Poincore-Bendixson theorem(statement only), Index of a critical point.

Recommended books:

1. Coddington, E. A., Levinson, N., Theory of ordinary differential equations, Tata McGraw Hill, 2000.
2. Ross, S. L., Differential equations, John Wiley and Sons Inc., New York, 1984.
3. Boyce, W. E., Diprima, R. C., Elementary differential equations and boundary value problems, John Wiley and Sons, Inc., New York, 4th edition, 1986.
4. Simmon, G. F., Differential Equations, Tata McGraw Hill, New Delhi, 1993.

Paper 4(iii)

Vedic Ganita (B030906T)

Credits: 04 **Max Marks: 100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Vedic Ganita

Course Type: Elective paper

Course Level: PG

Unit I

History of Vedic Ganita, Why Vedic Ganita, Silent features of Vedic Ganita, Vedic Ganita formulas, 16 sutras, 13 sub sutras, Terms and operations, High speed addition by using the concept of computing the whole and from left to right, Superfast subtraction by Nikhilamsutram from basis 100, 1,000, 10,000.

Unit II

Multiplication by Urdhavtrighbhyam sutram, Multiplication by vinculum sutram, Multiplication by Nikhilam sutram, Fast multiplication by 11, Multiplication of numbers consisting of all 9s, Multiplication of numbers nearest to the base 10 and multiplication of numbers with sub base 50,500,5000.

Unit III

Meaning of Ekadhiken sutram and its applications in finding squaring of numbers ending in 5, squares by Anurupeyana sutram, Square by Yavdunam thava dunikritya vargamcha yojyet sutram, Squaring by Dwandvayoga sutram, Squaring numbers nearest 50, Square roots of perfect square, General method of square roots, Cubes by Anurupeyana sutram.

Unit IV

Decimal and fractions, Division by Nikhilam Sutram, Division of 1/19, 1/29 by Ekadhikenpurven sutram, Division by Paravartya sutram, Division by Anurupeyana sutram, Division of polynomials, Factors of general second-degree equation by Lopsthapanabhyam sutram.

Recommended books:

1. Vedic Mathematics, published by Motilal Banarasi Das 1965. ISBN 81-2 08-0163-6.
2. Vedic Ganita: Vihangam Drishti-1, Shiksha Sanskriti Utthan Nyasa, New Delhi

Paper 4(IV)

Bio-Mechanics (B030907T)

Credits: 04 **Max Marks: 100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Bio-Mechanics

Course Type: Elective paper

Course Level: PG

Unit I

Introduction, Definition and scope of Bio-Mechanics, Role of mathematics in bio-sciences, Basic concepts of fluid dynamics: Navier-Stoke's equation for flow of a viscous incompressible flow, Bio-fluid flows: flows in pipes and ducts, Poiseuille's flow, Application of Poiseuille's law for the study of blood flow.

Unit II

Basic concepts about blood, Cardiovascular system and blood flows, Blood flow through artery with mild stenosis, Two-layered flow in a tube with mild stenosis, Pulsatile flow of blood, Peristaltic flow in tubes and channels.

Unit III

Gas exchange and air flow in lungs, Consumption and transport of oxygen, Weibel's model for flows in lung airways, Comparison between flows of blood and flows in lung airways.

Unit IV

Diffusion, Fick's laws of diffusion, Diffusion equation, Modification of the diffusion equation, Diffusion in artificial kidney, Hemodialyser. Types of hemodialyser.

Recommended books:

1. J. N. Kapur: Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd., New Delhi, 1985.
2. Y. C. Fung: Bio-Mechanics, Springer-VerlagNewYorkInc.,1990.
3. Stanley E. Charm and George S. Kurland: Blood Flow and Micro circulation, John Wiley &Sons,1974.
4. S. A. Levin: Frontiers in Mathematical Biology, Springer-Verlag, 1994.
5. S. K. Pundir & R. Pundir: Biomathematics, Pragati Prakashan, 2010.

Paper 5

Computational Mathematics with Python-I

Credits: 04 (B030908P) **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Computational Mathematics with Python-I

Course Type: Practical

Course Level: PG

Python introduction, Technical strength of Python, Introduction to Python interpreter and program execution, Using comments, Installation of Python, Ways to run Python programmes, Simple input and output, Variable and assignments.

Literals, Constants, Numbers (Integers, Floats, Complex Numbers, Real, Sets), Strings (Slicing, Indexing, Concatenation, other operations on strings), Accepting input from console, printing statements, Simple 'Python' programs, Mathematical operators, Permutation and combination. Python as an advanced calculator.

Relational, Logical, Bitwise operators and their precedence, Conditional statements: if, if-else, if-elif-else, Simple programs, Notion of iterative computation and control flow–range function.

While statement, For loop, Break statement, Continue statement, Pass statement, else, assert.

Suggested List of programmes:

1. Programme to obtain three numbers and print their sum.

2. Programme to obtain the length and breadth of a rectangle and calculate its area.

3. Programme to input a number and print its cube.

4. Programme to input a value in kilometre and convert it into miles. (1 Km = 0.621374 miles)

5. Programme to input a value in tonnes and convert it into quintals and kilogram (1 Ton = 10 quintals=1000 Kg).

6. Write a programme to input two numbers and swap them.

7. Write a programme to input three numbers: 1st number becomes 2nd number; 2nd number become 3rd number and 3rd number becomes 1st number.

8. Write a programme to enter two integers and perform all arithmetic operations on them.

9. Write a programme to obtain temperature in Celsius and convert it into Fahrenheit.

10. Write a programme to input three numbers: 2nd number gets the value 1st +2nd, 3rd number gets the value of 2nd +3rd number

11. Programme to find the roots of quadratic equation.

12. Programme that takes a number and check whether the given number is odd or even.

13. Programme to accept three integers and print the largest of three. Make use of only if statement.

14. Programme that input three numbers and calculate two sums as per this:

Sum1: as the sum of all input numbers

Sum2: as the sum of non-duplicate numbers; If there are duplicate number in the input, ignore them

15. Programme to test the divisibility of a number with another number.

16. Programme that reads three numbers and print them in ascending orders.

17. Programme to print table of a number, say 7.

18. Programme to print sum of natural number between any two positive number.

19. Programme to calculate the factorial of a number.

20. Programme to calculate the sum of even and odd integers of first n natural numbers.

21. Programme to implement 'guess the number' game. Python generates a number randomly in the range [10,50]. The user is given five chances to guess a number in the range.

22. Write a programme to illustrate the difference between break and continue statements.

23. Programme to input a number and test if it is a prime number.

24. Programme that searches for prime number from 15 through 25.

25. Write a programme to input three numbers and display the largest/smallest number.

26. Write a programme to input a 6-digit number and divide it into 2 digits number.

27. Write a programme to input a number and then print its first and last digit raised to the length of the number.

28. Write a programme to find lowest and second lowest number from the 10 numbers input.

29. Write a programme to print Fibonacci series.

30. Write a programme to read an integer>1000 and reverse the number.

31. Write a programme to find the sum of the series: $s = 1 + x + x^2 + x^3 \ldots . x^n$

32. Write a programme to find the sum of the series: $s = 1 - x + x^2 - x^3 + x^4 \ldots . x^n$

33. Write a programme to find the sum of the series: $s = x + \frac{x^2}{2!} - \frac{x^3}{3!} + \frac{x^4}{4!} \ldots \frac{x^n}{n!}$.

34. If a number is equal to the sum the cubes of its each digit, then it is known as Armstrong Number. Write a programme to check if a given number is an Armstrong Number or not.

35. A number is known as palindrome number if it is same as reversed of it. Write a programme to check if a given number is palindrome number or not.

Recommended books:

1. Core Python programming, Dr. R. Nageshwara Rao, Dreamtech Press.
2. Learning with Python, Allen Downney, Jeffrey Elkner and Chris Meyers, Dreamtech Press.
3. Let Us Python, Aditya Kanetkar and Yashwant Kanetkar, BPB Publication.
4. The new python programming for beginners, William J Palmer, Caterina Rosse.
5. Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More!, Amit Saha, No Starch Press.
6. Mathematics and Python Programming, J. C. Bautista, Lulu Press.

M.A. /M.Sc. Fourth Semester

Mathematics

Paper 1

Advanced Abstract Algebra

Credits: 04 (B031001T) **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Advanced Abstract Algebra

Course Type: Core paper

Course Level: PG

Unit I

Field theory, Extension fields, Minimal polynomial of an algebraic element, Algebraic and transcendental extensions, Splitting fields, Primitive elements, Separable and inseparable extensions, Perfect fields.

Unit II

Automorphisms of fields, Fixed fields, Normal extensions, Galois extensions, Fundamental theorem of Galois theory, Algebraically closed fields, Prime fields, Finite fields.

Unit III

Solution of polynomial equations by radicals, Constructible numbers.

Modules, Direct product of modules, Cyclic modules, Sub modules, quotient modules, Fundamental theorem of homomorphism of modules.

Unit IV

Free Modules, Simple modules, Semi-simple modules, Schur's lemma, Noetherian and Artinian modules and rings, Hilbert basis theorem, Wedderburn-Artin theorem, Uniform modules, Primary modules, Noether-Lasker theorem.

Recommended books:

1. I.N. Herstein, Topics in Algebra, Wiley student edition
2. Ram Ji Lal, Algebra I and Algebra II, Springer
3. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications
4. John B. Fraleign, A First Course in Abstract Algebra, Narosa Publications
5. Vijay K. Khanna, S.K Bhambri, A Course in Abstract Algebra, Vikas Publishing House
6. Bhattacharya, Jain and Nagpaul, Basic Abstract Algebra, Cambridge University Press

Paper 2

Integral Equations and Boundary Value Problems

Credits: 04 (B031002T) **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Integral Equations and Boundary Value Problems

Course Type: Core paper

Course Level: PG

Unit I

Definition of integral equations, Types of integral equations, Kernel, Fredholm and Volterra integral equations, Verification of solution of integral equation, Conversion of integral equation to differential equation and vice-versa, Initial value problem & Volterra integral equation, Boundary value problem and Fredholm integral equation.

Unit II

Solution of Fredholm integral equation by method of successive approximation, Resolvent kernel, Solution of Fredholm integral equation by method of resolvent kernel, Solution of Volterra integral equation by method of successive approximation, Solution of Volterra integral equation by method of successive substitution, Fredholm determinant, Convergence of Fredholm series.

Unit III

Solution of integral equations by method of Laplace transform, Convolution type kernel, Solution of integral equation by Fourier transform method, Singular integral equation, Cauchy and Hilbert type kernel, Solution of singular integral equation having kernel of h(s)-h(t) type.

Unit IV

Boundary value problem, Initial value problem, Green's function. Construction of Green's function from given boundary value problem, Applications of Green's function, Modified Green's function, Dirac Delta function.

Recommended books:

1. Linear integral equations theory & techniques, R.P. Kanwal Academic Press New York 1971.
2. Linear integral equation & boundary value problem by M. D. Rai Singhania, S. Chand & Co. 2005.
3. Integral Equation by Shanti Swaroop, Krishna Prakashan, 1989.
4. A first course in integral equation, A M Wazwar, Saint Xavier Univ. USA Dec 1997.

Paper 3(i)

Advanced Fluid Mechanics

(B031003T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Advanced Fluid Mechanics

Course Type: Elective paper

Course Level: PG

Unit I

Three dimensional irrotational flow, Axisymmetric flow, Strokes Stream function, Axisymmetric potential flow, Liquid streaming past a stationary sphere, Uniform motion of a sphere in a liquid at rest at infinity, Concentric sphere (problem of initial motion).

Unit II

Vortex motion, Vortex filament, Complex potential, Image of vortex, Complex potential due to vortex doublet, Spiral vortex, Rankine combined vortex, Rectilinear vortex with elliptic cross-section, Routh's theorem, Motion of any vortex, Kirchhoff vortex theorem.

Unit III

Newton's Law of viscosity, Newtonian and non-Newtonian fluids, Definition of stress, strain and their relations, Relation between stresses and rate of strain, Navier-Stoke's equation, Dissipation of energy, Diffusion of vorticity, Laminar flow of Viscous incompressible fluids.

Unit IV

Fluid pressure: Equation of pressure, Condition of equilibrium, Lines of force, Homogeneous and heterogeneous fluids, Elastic fluids, Surface of equal pressure and density, Rotating fluids.

Fluid pressure on plane surface: Centre of pressure, Resultant pressure on curved surfaces.

Recommended books:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS publishers and Distributors, Delhi, 1988.
2. R.K. Rathy, An introduction to fluid Dynamics, Oxford and IBH Publishing Company, New Delhi; 1976.
3. F. Charlton, A Text Book of Fluid Dynamics, CBC, 1985.
4. S.W. Yuan, Foundations of Fluid Dynamics, Prentice – Hall of India, 1988.
5. B. D. Sharma, Hydro-statics, Kedar Nath Ram Nath Publication.

Paper 3(ii)

Wavelet Analysis

(B031004T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Wavelet Analysis

Course Type: Elective paper

Course Level: PG

Unit I

Fourier transforms, Inverse Fourier transforms, Basic properties of Fourier and inverse Fourier transforms, Convolution and delta function, Fourier transform of square integrable functions, Poisson's summation formula.

Unit II

Construction of wavelets on Z_N, Haar wavelets on Z, Shannon wavelet, The Gabor transform, Heisenberg uncertainty principle, Description of $l^2(Z)$, $L^2[-\pi,\pi]$and $L^2(R)$, Parseval's relation.

Unit III

Multi resolution analysis, MRA wavelets, Scaling functions with finite two scale relations, Direct sum decomposition of $L^2(R)$, Linear phase filtering, Low-pass filters and scaling functions, Compactly supported wavelets, Wavelets and their duals.

Unit IV

Franklin wavelets on **R**, Orthogonal wavelets and wavelet packets, Example of orthogonal wavelets, Identification of wavelet packets, Construction of compactly supported orthogonal wavelets, Orthogonal wavelet packets, Orthogonal decomposition of wavelet series.

Recommended books:

1. C. K. Chui, An Introduction to Wavelets, Academic Press, 1992.
2. I. Daubechies, Ten Lectures on Wavelets, CB5-NSF Regional Conference in Applied Mathematics, 61, SIAM, 1992.
3. M. W. Frazier, An Introduction to Wavelets through Linear Algebra, Springer-Verlag, 1999.
4. E. Hernandez and G. Weiss, A First Course on Wavelets, CRC Press, 1996.

Paper 3(iii)

Special Theory of Relativity

(B031005T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Special Theory of Relativity

Course Type: Elective paper

Course Level: PG

Unit I

Historical background and postulates of special relativity, Relativity of simultaneity. Lorentz transformation and its consequences, Relativistic addition of velocities.

Unit II

Doppler effect, Space-time diagrams, Time order and Space-time separation of events, Null cone, The twin-paradox.

Unit III

Relativistic mass and momentum, The equivalence of mass and energy, The relativistic force law and dynamics of a single particle, Energy momentum tensor of incoherent matter.

Unit IV

Principle of equivalence, Principle of general covariance, Criteria for gravitational field equations, Einstein field equations, Gravity as a geometric Phenomenon. The energy momentum tensor, Inclusion of forces in the field equations and their classical limits.

Recommended books:

1. Rindler W. Special Relativity, 1966.
2. Resnick, R., Introduction to special relativity, Wiley-Eastern, 1990.
3. Special Theory of Relativity, Anshan Publishers-2009.

Paper 3(iv)

Differential Geometry of Manifolds

(B031006T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Differential Geometry of Manifolds

Course Type: Elective paper

Course Level: PG

Unit I

Analysis of curve, Curvatures related to curves, Curvature tensor, Torsion tensor and skew curvature tensor, Examples based on curvature tensor, Torsion tensor and skew curvature tensor, Relation between curvature tensor and their derivatives, Study of surface, Analytical study of first and second fundamental form of surfaces.

Unit II

Tensor space, Dimension and basis of tensor space, Rank of tensor, Quotient law of tensor, Uses of Christoffel symbols in real world, Analysis and uses of gradient, divergence and curl.

Unit III Boolean Algebra

Unit III

C^r-curve, Chart, Atlas, Definition of topological manifold, Differentiable manifold, Examples of manifold, One dimensional manifold, Examples of two-dimensional manifold, three dimensional and n-dimensional manifolds, Tangent space, Tangent bundle, Lie groups, Lie derivative.

Unit IV

Complex manifolds, Examples of complex contact manifolds, Contact manifold, Examples of contact manifolds, Difference of complex and contact manifold.

Recommended books:

1. Elementary Topics in Differential Geometry, Thorpe J.A, Springer 1994.
2. Tensor calculus, De UC, Shaikh AA, Sengupta Joydeep, 2005
3. An introduction to differentiable manifold, Willmore T.J
4. A Course of Tensors with Applications, Mishra R.S, Pothishala Pvt Ltd,1965.
5. Differential Geometry of Manifolds, De.U.C Narosa Publishing House 2005
6. Complex and Contact Manifold, De U.C Narosa Publishing House,2008.

Paper 3(v)

Advanced Discrete Mathematics (B031007T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Advanced Discrete Mathematics

Course Type: Elective paper

Course Level: PG

Unit I

Semigroups and Monoids: Definitions and examples of semigroups and monoids (including those pertaining to concatenation operation), Homomorphism of semigroups and monoids, Congruence relation and quotient semigroup, Subsemigroup and submonoids, Direct products, Basic homomorphism theorem.

Unit II

Lattices: Lattices as partially ordered sets and their properties, Lattices as algebraic systems, Sub-lattices, Direct products and homomorphisms, Some special lattices such as complete, complemented and distributive lattices.

Unit III

Boolean Algebra: Boolean algebras as lattices, Various Boolean identities, The switching algebra example, Sub-algebras, Direct products and homomorphisms, Join-irreducible elements, Atoms and minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of products, Canonical forms, Minimization of the Boolean functions.

Unit IV

Grammars and Languages: Phrase structure grammars, Rewriting rules, Derivations, Sentential forms, Language generated by grammar, Regular, Context free and Context sensitive grammar and languages, Regular sets, Regular expressions and the pumping lemma, Kleene's theorem, Notions of syntax analysis, Polish notations, Conversion of infix expressions to Polish notations, The reverse Polish notations.

Recommended books:

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill Publishing Company Limited.
2. C.L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill Publishing Company Limited.
3. H.K. Pathak & J.P. Chauhan, Advanced Discrete Mathematics, Shiksha Sahitya Prakashan.

Paper 4(i)

Operator Theory (B031008T)

Credits: 04 **Max Marks: 100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Operator Theory

Course Type: Elective paper

Course Level: PG

Unit I

Introduction to real Banach and real Hilbert spaces, Adjoint of an operator on a Hilbert space, Self-adjoint operators, Normal operators and Unitary operators on Hilbert spaces, Projections on a Hilbert space.

Unit II

Compact operators, Spectral theory of linear operators in normed linear space, Spectral theory of linear operators in finite dimensional normed linear spaces, Spectral properties of bounded linear operators.

Unit III

Determinant and the spectrum of an operator, Spectral theorem, Resolvent and its properties, Spectrum and its properties, Residual spectrum, Approximate spectrum, Analyticity of the resolvent operator, Use of complex analysis in spectral theory, Spectral radius and the spectral mapping theorem for polynomials.

Unit IV

Banach algebras, Banach algebras with identity, Division algebra, Further properties of Banach algebra, Compactness of the spectrum, Ideals and maximal ideals of a complex commutative Banach algebra, radicals, Gelfand-Naimark theorem.

Recommended books:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons.
3. G. Bachman and L. Narici, Functional Analysis, Academic Press, New York, 1966.
4. J. B. Convey, A Course in Operator Theory, Springer.
5. N. Saran and S. L. Shukla, Functional Analysis, Pragati Prakashan, Meerut.
6. J. N. Sharma and A. R. Vasishtha, Functional Analysis, Krishna Prakashan Media (P) Ltd., 2015.

Paper 4(ii)

Calculus of Variations (B031009T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Calculus of Variations

Course Type: Elective paper

Course Level: PG

Unit I

Evolution of calculus of variations and contribution of Bernoulli.

Functional, Euler's equation of extrema for functionals involving first order derivative, Functional dependent on more than one dependent variables, Functional dependent on two independent variables: Euler Ostrogradsky equation, Generalised Eular's Ostrogradsky Equation. Functional dependent on higher order derivative: Euler Poisson's equation.

Unit II

Weierstrass function, Sufficient condition of Extrema: Legendre condition, Isoperimetric problem, Local maxima, Invariance of Euler's equation under coordinate transformation, Problems based on Legendre condition.

Unit III

Moving boundary value problem, Condition of extrema: Transversality condition, Variational problem with movable boundary for a functional dependent on two functions, One sided variation, Reflection & refraction of extremals, Diffraction of light rays.

Unit IV

Field extremal, Jacobi condition, Second variation, Canonical equations, Applications of calculus of variations in Lagrarge's equation, Application of calculus of variations in the Hamilton's equation, Hamiltons variational principle.

Recommended books:

1. Calculus of Variations with Applications, AS Gupta, Printice Hall of India,1997.
2. Calculus of Variations, I.M. Gelfand and S.V. Fomin, Dover Publication, 2000.
3. Calculus of Variations, Mukesh Singh, Krishna Publications, 2015.

Paper 4(iii)

Mathematical Modelling (B031010T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Mathematical Modelling

Course Type: Elective paper

Course Level: PG

Unit I

Introduction to mathematical modelling: need, classification, modelling process, Elementary mathematical models; Role of mathematics in problem solving. Single species population model: The exponential model and the logistic model, Harvesting model and its critical value.

Unit II

Modelling with ordinary differential equations: Overview of basic concepts in ODE and stability of solutions: steady state and their local and global stability, Linear and non-linear growth and decay models. Compartment models. Mathematical modelling of geometrical problems, reaction kinetics. Some applications in economics, ecology, Modelling in epidemiology (SIS, SIR, SIRS models) and basic reproduction number.

Unit III

Mathematical models through difference equations, Some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modelling through difference equations in economics and finance, Mathematical modelling through difference equations in population dynamics.

Unit IV

Mathematical modelling through partial differential equations, Situations giving rise to of partial differential equation models. The one-dimensional heat equation: derivation and solution. Wave equation: derivation and solution.

Recommended books:

1. J.N. Kapur, Mathematical Modelling, New Age Intern. Pub.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press.
3. Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer.
4. Frank R. Giordano, William Price Fox, Maurice D. Weir, A First Course in Mathematical Modelling, 4th Ed., Charlie Van Wagner. 5. Walter J. Meyer, Concept of Mathematical Modelling, McGraw-Hill.
5. Zafar Ahsan: Differential Equations and Their Applications, PHI learning Private Limited, New Delhi.
6. Steven H. Strogatz, Nonlinear dynamics and chaos, With Applications to Physics, Biology, Chemistry, and Engineering.

Paper 4(iv)

Cosmology (B031011T)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Cosmology

Course Type: Elective paper

Course Level: PG

Unit I

Mach's principle, Einstein modified field equations with cosmological term, Static cosmological model of Einstein and De-Sitter, Their derivation, Properties and comparison with the actual universe.

Angular size versus redshift relation and source counts in Robertson [illegible]

Unit III

Friedmann models, Fundamental equation of dynamical cosmology, Critical density, Closed and open Universe, Age of the Universe, Matter dominated era of the Universe, Einstein- De-Sitter model, Particle and even horizons.

Unit IV

Eddington-Lamaitre models with Λ- term, Perfect Cosmological principle, Steady state Cosmology.

Recommended books:

1. R. C. Tolman, Relativity, Thermodynamics and Cosmology, Clarendon Press, Oxford, 1934.
2. S. Weinberg, Gravitation and Cosmology, John Wiley, 1972.
3. J. V. Narlikar, Introduction to Cosmology, Cambridge University Press, 1998.
4. J. N. Islam, An Introduction to Mathematical Cosmology, Cambridge University Press, 1999.
5. J. A. Peacock, Cosmological Physics, Cambridge University Press, 1999.

Paper 4(v)

Cryptography (B031012T)

Max Marks:100

Credits: 04

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Cryptography

Course Type: Elective paper

Course Level: PG

Unit I

Definition of a cryptosystem, Symmetric cipher model, Classical encryption techniques- Substitution and transposition ciphers, Caesar cipher, Play fair cipher, Block cipher Principles, Shannon theory of diffusion and confusion, Data encryption standard (DES).

Unit II

Polynomial and modular arithmetic, Introduction to finite field of the form GF(p) and GF(2n), Fermat theorem and Euler's theorem (statement only), Chinese remainder theorem, Discrete logarithm.

Unit III

Advanced Encryption Standard (AES), Stream ciphers, Introduction to public key cryptography, One-way functions, The discrete logarithm problem, Diffie-Hellman key exchange algorithm, RSA algorithm and security of RSA, The ElGamal public key cryptosystem, Introduction to elliptic curve cryptography.

Unit IV

Information/Computer Security: Basic security objectives, security attacks, security services, Network security model, Cryptographic hash functions, Secure hash algorithm, SHA-3. Digital signature, ElGamal signature, Digital signature standards, Digital signature algorithm.

Recommended books:

1. William Stallings, Cryptography and Network Security, Principles and Practice, 5th ed., Pearson Education, 2012.
2. Douglas R. Stinson, Cryptography: Theory and Practice, CRC Press, 3rd ed., 2005.
3. J.A. Buchmann, Introduction to Cryptography, 2nd ed., Springer 2003.
4. W. Trappe and L.C. Washington, Introduction to Cryptography with Coding Theory, Pearson, 2006.
5. J. Hoffstein, J. Pipher, and J. H. Silverman, An Introduction to Mathematical Cryptography, 2nd ed., Springer, 2014.

Computational Mathematics with Python-II

(B031013P)

Credits: 04 **Max Marks:100**

Evaluation: Continuous Internal Assessment – 25 marks

Semester End Examination – 75 Marks

Course Title: Computational Mathematics with Python-II

Course Type: Practical

Course Level: PG

Introduction and application of SymPy for symbolic computing, Matplotlib Package Application of NumPy for plotting and visualisation, Application of SciPy for Vectors, Matrices, multidimensional array and numerical analysis.

Suggested List of programmes:

1. Plotting one or multiple Curve (Cartesian, Polar and Parametric).
2. Plotting Curve from Data.
3. Plotting Points.

4. Plotting bar Chart.
5. Plotting Pie Chart.
6. Plotting Histogram.
7. Linear Regression.
8. Matrices and Vectors Operations.
9. Solution of simultaneous equation by
   I. Matrix Inversion
   II. Cramer's Rule
   III. Gauss Elimination
   IV. Gauss Jordan
   V. Jacobi Iterative
   VI. Gauss Seidel
10. Solution of Ordinary and Partial differential equation and plotting the solution as curve or surface.
11. Find the root of algebraic/transcendental equation by using
   I. Fixed point iterative method
   II. Bisection's Method
   III. Newton Raphson's Method
   IV. Secant Method
   V. Muller's Method
   VI. Regula Falsi Method

Recommended books:

1. Numerical Python, Robert Johansson, Apress publication.
2. Practical Numerical computing using Python, Mahendra Verma.
3. Matplotlib Plotting Cookbook, Alexandra Devert, Packt publishing.
4. Pyton Programming and Numerical Methods guides for Engineers and Scientist, Qiningkai Kong, Timmy Siauw and Alexandre M. Bayen, Academic Press.
5. Numerical Method in Engineering with Python, Jaan Kiusalaas, Cambridge University Press.