Syllabus for M.Sc. Mathematics
(CBCS- Based)
Session 2018-2020 onwards

Purnea University, Purnia

Purnia-854301, Bihar

Head
P.G. Dept. of Mathematics
University, Purnia

PURNEA UNIVERSITY
Estd-2018
PURNIA

Purnea University, Purnia

CBCS-based syllabus for M.Sc. Mathematics (2 years) Programme

General Informations:

1. It is two years Master Degree Programme
2. There shall be four semester to complete programme, i.e. I[st] , 2[nd] , 3[rd] and 4[th] semester
3. Each semester shall consist of 15 weeks of academic work equivalent to 90 actual teaching days.
4. This programme will have five types of courses-
   - Core course (CC),
   - Elective course (EC),
   - General Elective (GE),
   - Discipline Specific Elective Course (DES),
   - Ability Enhancement Course (AEC)/ Skill Enhancement Course
   - Ability Enhancement Compulsory Course (AECC)

Core course- The core courses are those courses whose knowledge is deemed essential for the students registered for a particular Master's degree programme.

Elective course- The elective course can be choosen from a pool of papers in II[nd] and IV[th] semester.

5. Each course will have 100 marks in full and divided into 70 marks for end-semester exam and 30 marks for internal assessment work except AEC, AECC-I, AECC-2. Internal assessment will be in two internal exams of 7.5 marks each, 5 marks for seminar/internal project and 5 marks for attendance/discipline.
6. A student in fourth semester can choose a generic paper or CC-5 paper of any other subject of the faculty as DSE.

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Credits- A unit by which the course work is measured. It determines the number of hours of instruction required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/ field work per week.

Structure of the 2 Yrs (Four Semesters) Post Graduate Degree course under CBCS:

M.Sc. Mathematics (Two years Course)

SEMESTER	No. of Course /Paper	No. of Credit per Paper	Total Credits	Minimum no of Learning Hours	No. of Core Course / Paper	No. of Elective Course/ Paper	Code & Nature of Elective Paper
I	5	5	25	250	4	1	AECC-1
SEMESTER BRAKE							
II	6	5	30	300	5	1	AEC -1
SEMESTER BRAKE							
III	6	5	30	300	5	1	AECC-2
SEMESTER BRAKE							
IV	3	5	15	150	0	3	EC*-1 EC*-2 DSE -1 **OR** GE -1
TOTAL	20		100	1000	14	6	

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M.Sc. 1st Semester

Serial No.	Course Code	Paper Code	Description	Credits	Max. Marks (100)	
					C.I.A.	E.S.E.
1	Core Course I	PUMAT 501	Abstract Algebra	5	30	70
2	Core Course II	PUMAT 502	Real Analysis	5	30	70
3	Core Course III	PUMAT 503	Linear Algebra	5	30	70
4	Core Course IV	PUMAT 504	Discrete Mathematics	5	30	70
5	AECC-I	PUMAT 500	Environmental Sustainability and Swachchhta Bharat Abhiyan Activities	3+2	50	50

M.Sc. IInd Semester

Serial No.	Courses	Code	Description	Credits	Max. Marks (100)	
					C.I.A.	E.S.E.
6	Core Course V	PUMAT 505	General Advanced Mathematics	5	30	70
7	Core Course VI	PUMAT 506	Complex Analysis	5	30	70
8	Core Course VII	PUMAT 507	Differential and Integral Equations	5	30	70
9	Core Course VIII	PUMAT 508	Measure Theory	5	30	70
10	Core Course IX	PUMAT 509	Topology	5	30	70
11	AEC-I	PUMAT 500A, 500B, 500C	Ability Enhancing Elective Paper	5	50	50

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M.Sc. IIIrd Semester

Serial No.	Courses	Code	Description	Credits	Max. Marks (100)	
					C.I.A.	E.S.E.
12	Core Course X	PUMAT 510	Functional Analysis	5	30	70
13	Core Course XI	PUMAT 511	Fluid Dynamics	5	30	70
14	Core Course XII	PUMAT 512	ClassicalMechanics (Rigid Dynamics)	5	30	70
15	Core Course XIII	PUMAT 513	Optimization Techniques	5	30	70
16	Core Course XIV	PUMAT 514	Differential Geometry	5	30	70
17	AECC-2	PUMAT 600	Human values and professional ethics & Gender sensitization	3 + 2	50	50

M.Sc. IVth Semester

Serial No.	Courses	Code	Description	Credits	Max. Marks 100	
					E.S.E.	C.I.A.
18	Elective Course-I	PUMAT 515-519	Choose any one among the list below	5	70	30
19	Elective Course-I	PUMAT 520-524	Choose any one among the list below	5	70	30
20	DSE-I Or GE-I	Discipline Specific Elective Or Generic Elective	CC-05 of same faculty Or Any one from bunch of GE	5	70	30

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ELECTIVE COURSE EC-I and EC -2			
Courses	Description	Courses	Description
PUMAT 515	Fuzzy Sets and Their Application	PUMAT 520	Advanced Topology
PUMAT 516	Mathematical Methods	PUMAT 521	Banach Algebras
PUMAT 517	Operational Research	PUMAT 522	Commutative Algebra
PUMAT 518	Theory of Relativity	PUMAT 523	Programming in C
PUMAT 519	Galois Theory	PUMAT 524	Number Theory

- Candidates should choose any two among the above

SCHEME OF EXAMINATION

Passing of Examination and Promotion Rule:

The Post Graduate Course in Mathematicsshall be of two academic sessions comprising ofFOUR SEMESTERS. Each academic session shall consist of two Semesters - I & III from Julyto December and Semester - II & IV from January to June.

Each theory paper irrespective of their nature and credits shall be of 100 marks out of which theperformance of a student in each paper will be assessed on the basis of Continuous InternalAssessment (CIA) of 30 marks and the End Semester Examination (ESE) consisting of 70marks.

The components of CIA shall be

(a) Two MidSemester Written Tests of one hour duration each	15 Marks
(b) Seminar/Quiz	5 Marks
(c) Assignments	5 Marks
(d) Punctuality & Conduct	5 Marks
Total	30Marks

1. There shall be no supplementary examination in any of the Semester Course (I, II, III & IV).
2. A student who has appeared at the CIA and attended the required minimum percentage (75%) ofthe attendance in theory shall be permitted to appear in the EndSemester Examination (ESE).
3. To be declared passed in ESE in any subject, a students must secure at least 45% marks in eachpaper separately.
   A student has to secure minimum 45% marks in CIA of any paper. In case, a student fails tosecure minimum 50% marks in CIA of any paper, he/she will be declared fail in that

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If students fail to secure minimum 50%o marks in CIA of any paper his result will be declared as fail in that paper. Students shall have to reappear in that paper in the same semester of next academic session.

A promoted candidate, if he has passed in CIA but fails in theory paper/papers, he/she shall retain his/her CIA award and will reappear in the theory paper only of the semester whenever available. However, if a candidate is declared fail in any End Semester Examination, shall retain nothing and will have to redo the course work of failed semester again and he has to appear again in CIA as-well-as in theory paper.

4. If a candidate passes in at least two paper in his/her First, Second and third End Semester Examination, he/she shall be promoted to next higher semester. But he/she will have to clear their backlog papers in the next end semester examination of that semester whenever it is available. Even if a student is promoted to fourth semester his final result will only be declared when he/she has cleared all their backlog papers.
5. Final result of M.Sc. will be published only after he/she has cleared all the 16 paper securing minimum qualifying marks.
6. Student shall be awarded Grade Point (GP) at the end of each semester examination and Cumulative Grade Point (CGP) at the end of final End Semester Examination in 10 point scoring system.

Declaration of Result

The following grading system shall be used by teacher/ Examination department

Letter Grade	Percentage Grade	Number of Letter Grade	Description of Grade
O	90-100	10	Outstanding
A^{++}	80-89	9	Excellent
A^{+}	70-79	8	Very Good
A	60-69	7	Good
B^{+}	50-59	6	Average
B	45-49	5	Pass
F	Less than 45	Less than 5	Fail

A student shall be declared to have passed and promoted to the next semester when he/she earns B or above grade in the semester examination covering continuous evaluation, midterm and end term examination.

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Name of Department	P G Department of Mathematics	
Name of Faculty	Science	
SEMESTER I		
Course Code	Name of Course	
PUMAT 501	Abstract Algebra	CC-1
PUMAT 502	Real Analysis	CC-2
PUMAT 503	Linear Algebra	CC-3
PUMAT 504	Discrete Mathematics	CC-4
PUMAT 500	Environmental Sustainability and Swachchchha Bharat Abhiyan Activities	AECC-1
SEMESTER II		
Course Code	Name of Course	
PUMAT 505	General Advanced Mathematics	CC-5
PUMAT 506	Complex Analysis	CC-6
PUMAT 507	Differential and Integral Equations	CC-7
PUMAT 508	Measure Theory	CC-8
PUMAT 509	Topology	CC-9
Any One Course From the Following		
PUMAT 500 A	Yoga Science	AEC-1
PUMAT 500 B	Tourism and Hospital Management	AEC-1
PUMAT 500 C	Environmental Law	AEC-1
SEMESTER III		
PUMAT 510	Functional Analysis	CC-10
PUMAT 511	Fluid Dynamics	CC-11
PUMAT 512	ClassicalMechanics(Rigid Dynamics)	CC-12
PUMAT 513	Optimization Techniques	CC-13
PUMAT 514	Differential Geometry	CC-14
PUMAT 600	Human values and professional ethics & Gender sensitization	AECC-2
SEMESTER IV		
Elective Course: (Any two of the Following)		
Course Code	**Name of Course**	
PUMAT 515	Fuzzy Sets and Their Application	EC-1
PUMAT 516	Mathematical Methods	EC-2
PUMAT 517	Operational Research	EC-3
PUMAT 518	Theory of Relativity	EC-4
PUMAT 519	Galois Theory	EC-5
PUMAT 520	Advanced Topology	EC-6
PUMAT 521	Banach Algebras	EC-7
PUMAT 522	Commutative Algebra	EC-8
PUMAT 523	Programming in C	EC-9
PUMAT 524	Number Theory	EC-10
Any One Course From the Following Groups		
Discipline Specific Group		
PUMAT 525	Fundamental of Mathematics	DSE-1
PUMAT 526	Environmental Science	DSE-2
OR		
General Elective Group		
PUMAT 527	Graphic Design	GE-1
PUMAT 528	Inclusive Polices	GE-2
PUMAT 529	Human Rights	GE-3

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CC-01
(COURSE CODE : PUMAT 501)
Abstract Algebra

Unit 1: Homomorphism: Group actions, Sylow theorems, Normal and subnormal series, composition series of a group, Jordan- Holder Theorem, Solvable groups, commutator subgroup of a group, Nilpotent groups.

Unit 2: Ring homomorphism, isomorphism, quotient rings, ideals, Kernel of ring homomorphism, principal ideal ring and domain, prime and maximal ideal, Euclidean domain.

Unit 3: Extension fields, algebraic and transcendental extension, splitting field of polynomial, separable and inseparable extension, normal extension, constructible real numbers.

Unit 4: Cyclic Modules, simple Modules, semi- simple Modules, Schur's Lemma, Free Modules

Unit 5: Solution of equations by radicals, insolvability of equations of degree 5 by radicals.

References:

1. **I. N. Herstein:** Topics in Algebra
2. **M Artin:** Algebra
3. **L S Luther & I B S Passi:** Algebra Vols I & II Narosa Publishing House
4. **D S Dummit and R M Foote:** Abstract Algebra
5. **N S Gopalkrishnan:** University Algebra

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CC-02
(COURSE CODE : PUMAT 502)
Real Analysis

Unit 1: Sequences and series of functions, point-wise and uniform convergence, Cauchy criterion for uniform convergence, Weirstrass-M test, Abel's and Dirichlet's test for uniform convergence.

Unit 2: Uniform convergence and differentiation, Weirstrass approximation theorem, Power series, Uniqueness theorem for power series, Able's theorem.

Unit 3: Definition and examples of Riemann- Stieltje integral, Property of integral, integration and differentiation, the fundamental theorem of Calculus.

Unit 4: Functions of several variables, linear transformation, Derivatives in an open subset of R^n, chain rule, partial derivatives, interchange of ordr of differentiation, derivative of higher orders, Taylor's theorem.

Unit 5: Inverse function theorem, Implicit function theorem, Jacobians, Extremum Problems with constraints, Lagrange's multiplier methods.

References:

1. **W. Rudin:** Principles of Mathematical Analysis
2. **T M Apostal:** Mathematical Analysis
3. **I P Natanson:** Theory of Function of real Variable
4. **H L Royden:** Real Analysis

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CC-03
(COURSE CODE : PUMAT 503)
Linear Algebra

Unit 1: Finite dimensional vector spaces: Linear transformations and their matrix representative, eigenvalues and eigenvectors, minimal polynomial, Cayley- Hamilton Theorem, Diagonalization.

Unit 2: Hermitian, Skew Hermitian and Unitary matrices, Finite dimensional inner product spaces, Gram- Schmidt orthonormalization process, self-adjoint operators.

Unit 3: Nilpotent transformations, index of Nilpotency, invariants of a Nilpotent transformations, primary decomposition theorem, Jordan Blocks and Jordan forms rational canonical form.

Unit 4: Bilinear form, algebra of bilinear form, Matrix of Bilinear forms, degenerate and Non- degenerate bilinear forms, Alternating Bilinear Forms.

Unit 5: Symmetric and Skew- Symmetric Bilinear forms, Quadratic forms, law of Inertia, Sylvester's theorem, Hermitian forms definition forms.

References:

1. **K B Datta:** Matrix and Linear Algebra
2. **S. Lipschutz:** Linear Algebra, Schaum's outline series
3. **Hoffman and Kunze:** Linear Algebra

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CC-04
(COURSE CODE : PUMAT 504)
Discrete Mathematics

Graph Theory

Unit 1: Definition of graphs, paths, circuits and subgraphs, induced subgroups, degree of a vertex, connectivity, planar graphs and their properties. Trees, and simple applications of graphs.

Lattice Theory

Unit 2: Lattice as partially ordered sets and their properties, Lattices as algebraic system, Sub lattices, direct products and Homomorphism of Lattices. Some special lattices e.g. Complete lattices, Complemented lattices and Distributive lattices.

Boolean Algebra

Unit 3: Boolean algebra as a complemented distributive lattice, Boolean rings, identification of Boolean algebra and Boolean rings, Sub algebra.

Unit 4: Boolean homomorphism and ring homomorphism, Ideals in Boolean algebra and Dual ideals, Fundamental theorem of homomorphism and Stone's representation theorem for Boolean algebra and Boolean rings.

Combinatorics

Unit 5: Permutation and Combinations, Pigeonhole Principle, Inclusion-Exclusion Principle, Generating Functions.

References:

1. **K H Rosen:** Discrete Mathematical and its Applications
2. **S Lipschutz and M Lipson:** Discrete Mathematics
3. **C I Liu:** Elements of Discrete Mathematics
4. **E. Mendelson:** Boolean Algebra and Switching Circuits
5. **Kolman, Bushi and Ross:** Discrete Mathematical Structure

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CC-05
(COURSE CODE : PUMAT 505)
General Advanced Mathematics

Set Theory:

Unit 1: Elementary set theory, finite, countable and uncounted sets, Real number system as a complete ordered field, Archimedean property, Supremum and Infimum

Fuzzy Set Theory:

Unit 2: Fuzzy Sets versus Crisp Sets, Basic definitions, types, properties and representation of Fuzzy Sets, Convex Fuzzy Sets, Basic operations on Fuzzy Sets, α- Cuts, Decompositions theorem, Complements, t-norm and t-conorms, Extension Principles and Simple Applications of Fuzzy Sets.

Graph Theory:

Unit 3: Definition of graphs, paths, circuits and subgraphs, induced subgraphs, degree of a vertex, connectivity, planar graphs and their properties, Trees, simple applications of graphs.

Number Theory:

Unit 4: Divisibility theory in the Integers: Division Algorithm, the Greatest Common Divisor, The Euclidean Algorithm, The Diophantine Equations $ax + by = c$, Fundamental Theorem of Arithmetic.

References:

1. **Discrete Mathematical Structure:** Kolman, Bushi and Ross
2. **Fuzzy Sets and their Application:** Pundir and Pundir
3. **Fuzzy Sets:** G J Klir & B Yuyan
4. **Graph Theory:** F. Harare, Addison Wesley.
5. **A Concise introduction to the Theory of Numbers:** A. Baker

CC-06
(COURSE CODE : PUMAT 506)
Complex Analysis

Unit 1: The complex plane, transcendental function such as exponential, trigonometric and hyperbolic functions, Analytic functions, Cauchy-Riemann Equations.

Unit 2: Contour Integral, Cauchy's Theorem, Cauchy's Integral Formula, Liouville's Theorem.

Unit 3: Taylor's Theorem, Laurent Series, Maximum Modulus Principle, Schwarz's Lemma, Isolated singularities, Meromorphic function. Rouche's theorem. Fundamental theorem of algebra, Power series, the argument principle.

Unit 4: Residues, Cauchy's residue theorem, Evaluation of integral, Branches of any valued functions with special references to argz, logz.

Unit 5: Bilinear transformations, their properties. Definition and examples of Conformal Mappings.

References:

1. **Functions of Complex Variables:** J B Conway
2. **Complex Analysis:** L V Ahlfors

CC-07

(COURSE CODE : PUMAT 507)

Differential and Integral Equation

Unit 1: Picard's method of successive approximations to the initial value problems, Concept of local existence, Lipschitz condition, existence and uniqueness of solution with examples. Linearly dependent and independent solutions, The Wronskian.

Unit 2: General properties of solution of linear differential equation of order n. Strum-Liouville's boundary value problems, Gronwall's inequality, maximal and minimal solution, Differential inequalities.

Unit 3: Integral Equations and their classifications. Types of kernels, Eigen values and Eigen functions. Relation between differential and integral equations. Fredholm integral equations of second kind, iterative scheme.

Unit 4: Method of successive approximations for Fredholm and Volterra equations. Green's Function, Construction of the green function for boundary value problems, solutions of boundary value problems, reducing boundary value problems to an integral equation.

References:

1. **P. Hartman:** Ordinary Differential Equation
2. **E. A. Coddington:** An introduction to Ordinary Differential Equations
3. **S. G. Mikhlin:** Linear Integral Equation
4. **R P Kanwal:** Linear Integral Equations, Theory and Techniques

CC-08
(COURSE CODE : PUMAT 508)
Measure Theory

Unit 1: Lebesgue outer measure, Measurable sets, Measuribility, Measurable functions, Borel and Lebesque measurability, non-measurable sets.

Unit 2: Integration of non-negative functions, the general integral, integration of series, Riemann and Lebesgue integrals.

Unit 3: The four derivatives, function of bounded variation, Lebesgue differentiation theorems. Differentiation and Integration.

Unit 4: Measure and outer measure, extension of measures, uniqueness of extension. Completion of a measure, measurable spaces, Integration with respect to a measure.

Unit 5: The L^p – spaces, convex functions, Jensen inequality, Holder's and Minkowski's Inequalities, completeness of L^p – spaces.

References:

1. **G. de Barra:** Measure Theory and Integration
2. **P K Jain and V P Gupta:** Lebesgue Measurable and Integration
3. **I K Rana:** An Introduction to Measure and Integration
4. **P R Halmos:** Measure Theory

CC-09
(COURSE CODE : PUMAT 509)
Topology

Unit 1: Definition and examples of Topological spaces. Closed sets, Dense sets, Neighborhood, Interior, Exterior, Boundary and Accumulation points. Derived Sets, Bases and Sub- bases, Subspaces and Relative Topology.

Unit 2: First and second countable Topological spaces, Lindelof's theorem, Separable spaces, Second Countability and Separability.

Unit 3: Separation axioms T_0, T_1 *and* T_2 spaces and their basic properties, compactness, continuous function and compact sets, basic properties of compactness.

Unit 4: Connectedness, continuous function and connected sets, characterization of connectedness in terms of a discrete two point space, connectedness on real line.

Unit 5: Regular and Normal spaces, T_3 *and* T_4 spaces, characterization and basic properties.

References:

4. **G F Simmons:** Introduction to Topology and Modern Analysis
5. **K K Jha:** Functional Analysis, Advanced General Topology
6. **Futton:** Algebraic Topology First Choice

CC-10
(COURSE CODE : PUMAT 510)
Functional Analysis

Unit 1: Normed Linear Spaces, Banach Spaces, Quotient Space of Normed Linear Spaces and its completeness, equivalent norms, Riesz Lemma, Basic properties of finite dimensional normed linear spaces and compactness.

Unit 2: Weak convergence and bounded linear transformation, normed linear spaces of bounded linear transformations, dual spaces with examples.

Unit 3: Open mapping theorem and Closed graph theorem, Hahn-Banach theorem on Real linear spaces, Complex linear spaces and Normed linear spaces.

Unit 4: Inner product spaces, Riesz lemma on Hilbert Space, Orthonormals sets and Parseval's identity, structure of Hilbert Spaces.

Unit 5: Adjoint of an operator on a Hilbert Space, Reflexivity of Hilbert Spaces, Self adjoint operators, Positive operator, Projection, Normal and Unitary operator.

References:

1. **G F Simmons:** Introduction to .Topology and Modern Analysis
2. **K K Jha:** Functional Analysis, Advanced General Topology

CC-11
(COURSE CODE : PUMAT 511)
Fluid Dynamics

Unit 1: Lagrangian and Eulerian methods, Equation of continuity, Boundary Surfaces, Stream lines, Path lines, and Streak lines, Velocity potential, Irrotational and Rotational motions, Vortex lines.

Unit 2: Lagrange's and Euler's Equations of motion, Bernoulli's theorem, Equation of motion by flux method, Equation referred to moving axis, Implusive actions.

Unit 3: Irrotation motion in two dimensional, stream, function, complex velocity potential, sources, sinks, doublets and their images.

Unit 4: Two dimensional irrotational motion produced by motion of a circular coaxial and elliptic cylinder in an infinite mass of liquid, kinetic energy of a liquid, Theorem of Blasius, motion of a sphere through a liquid at rest at infinity.

Unit 5: Vortex motion and its elementary properties, Kelvin's proof of permanence, Motion due to circular and rectilinear vertices.

References:

1. **F Chorton:** A Text Book of Fluid Dynamics
2. **M D Raisinghania:** Fluid Dynamics

CC-12
(COURSE CODE : PUMAT 512)
Classical Mechanics (Rigid Dynamics)

Unit 1: Generalised Co- ordinates, Holonomic and Non Holonomic Systems, Lagrange's Sequations of motion, Energy Equations for Conservative Fields.

Unit 2: Hamilton's Canonical Equations, Rouths equations, Hamilton's principle, Principle of Least Action.

Unit 3: Small Oscillations, Normal Co- ordinates, Normal mode of vibration.

Unit 4: Contact transformations, Lagrange Brackets and Poisson Brackets, the most general infinitesimal contact transformation, Hamilton- Jacobi Equation.

Unit 5: Motivating problem of Calculus of Variation, Euler- Lagrange equation, Shortest distance, minimal surfaces of revolution.

References:

1. **A S Ramsey:** Dynamics Part II
2. **S L Loney:** Dynamics of Particle and Right Bodies

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CC-13
(COURSE CODE : PUMAT 513)
Optimization Techniques

Linear Programming:

Unit 1: Simplex Method for unrestricted variables, Two phase method, Dual Simplex method, Parametric Linear Programming, Upper Bound technique.

Unit 2: Integer Programming, Branch and Bound Techniques, Gomory's Algorithm.

Non- Linear Programming:

Unit 3: One and multi variable unconstrained optimization, Kuhn- Tucker condition for constrained optimization, Wolfe's and Beale's Methods.

Unit 4: Game theory, two person zero sum game, mixed strategies, Graphical solution by expressing as a linear programming problem.

Unit 5: Inventory theory, Different costs of inventory model, Deterministic Economic lot size model, EOQ with uniform demand and several productions of unequal length,.

References:

1. **H A Taha:** An Introduction to Operation Research
2. **Kanti Swarup, P K Gupta and ManMohan:** Operations Research
3. **P K Gupta and D S Hira:** Operations research

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CC-14

(COURSE CODE : PUMAT 514)

Differential Geometry

Unit 1: Curves in Spaces, parameters other than are lengths, tangent principal normal, binormal and three fundamental planes, Curvature and Torsion of space curves, Serret- Frenet formulae, Fundamental theorem on spaces curves, Helices, Spherical, Indicatrix, Involutes and Evolutes, Bertrand curves.

Unit 2: Representation of surfaces, Curves on surfaces in R^3 Spaces, Tangent Plane and Normal, Envelope, characteristic and edge of regression, developable surface of revolution, directions on a surface.

Unit 3: Parametric curves, angle between them, first order and second order magnitudes, principal directions and lines of curvature, Normal Curvature, Euler's theorem and Meunier's theorem, Theorem of Beltrami and Enneper, Gauss Characteristic equation, Mainardi-Codazzi equations.

Unit 4: Conjugate directions, Isometric lines, Asymptotic lines and Geodesics-their equations and properties, curvature and torsion, their structures on surfaces of revolution, Bonnet's theorem.

References:

1. **C E Weatherburn:** Differential Geometry in Three Dimension
2. **J A Thorpe:** Elementary topics in Differential Geometry
3. **A Gray:** Differential Geometry of three dimensions, Cambridge University Press

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ELECTIVE COURSE
EC-01 & EC-02

1. Fuzzy Sets and Their Application
2. Mathematical methods
3. Operational Research
4. Theory of Relativity
5. Galois Theory
6. Advanced Topology
7. Banach Algebras
8. Commutative Algebra
9. Programming in C
10. Number Theory

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EC-01
(COURSE CODE : PUMAT 515)
Fuzzy set and their applications

Fuzzy set theory:

Unit 1: Fuzzy sets versus Crisp sets, Basic definitions, types, properties and representations of Fuzzy sets, Convex Fuzzy sets. Basics operation on Fuzzy set, α- Cuts. Decompositions theorem, Complements, t– norms and t– conorms. Extension principles and Simple applications of Fuzzy sets.

Unit 2: Fuzzy logics– An overview of classical logic, Multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic variable and hedges, inference from conditional fuzzy propositions, the compositional rule of inference.

Unit 3: Approximate Reasoning- an overview of Fuzzy expert system, Fuzzy implication and their selection, Multiconditional approximate reasoning the role of fuzzy relation equation.

Unit 4: An introduction to Fuzzy Control– Fuzzy controllers, Fuzzy rule base, Fuzzy inference engine Fuzzification, Defuzzification and the various defuzzification method.
(The centre of maxima and the mean of maxima methods)

Unit 5: Decision making in fuzzy Environment individual decision making. Multiperson decision Making, Multicriteria decision making, Multistage decision making Fuzzy ranking methods, Fuzzy Linear programming.

References:

1. **G J Klir and B Yuan**: Fuzzy sets and Fuzzy Logics.
2. **H J Zimmermann**: Fuzzy Set Theory and its Applications.
3. **G J Klir and T A Folger**: Fuzzy Sets, Uncertainty and Information.
4. **Pundir and Pundir**: Fuzzy sets and their Applications.

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EC-02
(COURSE CODE : PUMAT 516)
Mathematical Methods

Unit 1: Orthogonalisation, Bessel's Inequality, Weierstrass approximation theorem, polynomials of Legendre, Hermite and Bessel, generating function, orthogonality, recurrence relation and Rodrigue's fomula

Unit 2: Partial Differential Equation and properties, concept of well posed problems, Reduction of P.D.E in two independent variables to the canonical forms, classification in to elliptic, hyperbolic and parabolic equation, Lapiace's equations in Cartesian, Cylindrical and Spherical co-ordinates, Equipotential surfaces, Interior and exterior Dirichlet's problem for a circle.

Unit 3: Wave equation in one dimension and two dimension, vibrations of struck and plucked string with fixed ends. Homogeneous rectangular and circular membranes, Eigen vibrations, D'Alembert's solution wave equation.

Unit 4: Tensors- Transformations of co-ordinates, contravariant and covariant vectors Symmetric and Skew – symmetric tensors, addition and multiplication of tensors, Contraction and Composition of tensors, Quotient law.

Unit 5: Reciprocal symmetric tensors of the second order, Christoffel's symbols, covariant derivative of a contravariant vector, Co-variant derivative of a covariant vector, Curl of a vector, Divergence of a covariant vector.

Reference:

1. **I. N Sneddon:** Elements of partial differential equations
2. **R. courant and D. Hibbert:** Methods of Mathematical Physics Vol I & vol II
3. **C.E. Weatherburn:** Riemannian Geometry and Tensor calculus
4. **Smirnov and Tychonoff:** Partial Differential Equations.

EC-03
(COURSE CODE : PUMAT 517)
Operations Research

Queuing Theory:

Unit 1: Poisson probability law, Distribution of inter- arrival time. Distribution of time between successive arrivals, Differential difference equation of M[M]1:∞[F]FO, M[M]1:N[F]FO, M[M]C:∞[f]FO, M[M]C: N[F]FO

Information theory:

Unit 2: Description of communication system, Mathematical definition of information. Axiomatic approach to information, Measures of uncertainty, Entropy in two Dimensions- property, conditional entropy.

Unit 3: Channel capacity, Efficiency and Redundancy, Encoding, Fano-encoding procedure, Necessary and sufficient condition, average length of encoded message.

Replacement Model:

Unit 4: Introduction concepts of present value, replacement of items whose maintenance cost increase with time and value of money also changes, Replacement of item that fail completely, individual and group replacement policy.

Sequeneing:

Unit 5: N jobs and 2 machines, N jobs and 3 machines, N jobs M machines.

References:

1. **H.A. Taha:** Operations Research – An introduction
2. **Kanti swarup, P.k. Gupta and man mohan:** Operations Research
3. **P.k gupta and D.S. Hira:** Operations Research.

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EC-04
(COURSE CODE : PUMAT 518)
Theory of Relativity

Unit 1: General theory of Relativity– Principal of equivalent and general covariance, Einstein field equations and its Newtonian approximation.

Unit 2: Schwarz Schild external solution and its isotropic form. Birkhoff theorem, planetary orbits and analogous of Kepler's laws in general relativity.

Unit 3: Advance of perihelion of a planet, bending of light rays in a gravitational field, Gravitational shift of spectral lines, Einstein theory.

Unit 4: Energy Momentum of tensor of a perfect fluid, Schwarz Schild internal solution, Energy Momentum tensor of a electromagnetic field, Einstein Maxwell equation, Reissner- Nordstrom solution.

Unit 5: Cosmology- Einstein modified field equation with cosmological term static cosmological models of Einstein and De-Sitter, their derivation properties and comparison with the actual universe.

References:

1. **C. E. Weatherburn:** An Introduction to Riemannian Geometry and The Tensor Calculus.
2. **A. D. Eddington:** The Mathematical Theory of Relativity.
3. **Goyal and Gupta:** Theory of Relativity
4. **R. Alder, M.Bazin, M. Schiffer:** Introduction to General Relativity.
5. **J. J. Synge:** Special Theory of Relativity and General Theory of Relativity.

EC-05
(COURSE CODE : PUMAT 519)
Galois Theory

Unit 1: Rings, examples of rings, ideals prime and maximal ideals. Integral domains, Euclidean Domains, Principal ideal Domains and Unique Factorizations Domains.

Unit 2: Fields, Characteristic and prime subfields, field extensions, finite algebraic and finitely generated field extensions, algebraic closures.

Unit 3: Splitting fields, normal extension, Multiple roots, Finite fields, Separable extension.

Unit 4 : Galois group, Fundamental Theorem of Galois Theory, Solvability by radicals, Galois theorem on solvability. Cyclic and abelian extensions. Classical ruler and compass constructions.

Reference:

1. **D.S Dummit and R.M Foote:** Abstract algebra
2. **Joseph Rotman:** Galois Theory
3. **N. Jacobson:** Basic Algebra 1,2, hindustan publishing co 1984
4. **S. Lang:** Algebra I, III Edition, Addison Wesley, 2005

EC-06
(COURSE CODE : PUMAT 520
Advanced Topology

Unit 1: Countably compact spaces, sequentially compact spaces, totally bounded metric spaces.

Unit 2: Lebesgue's covring lemma, spaces of continuous functions, Arzela-Ascoli Theorem, Uniform spaces, topology of uniform spaces.

Unit 3: Stone Weierstrass's theorem, metrizable spaces and meztrization theorems, uniform spaces, topology of uniform spaces.

Unit 4: Uniform continuity, uniform metrizable topological spaces and metrizable uniform spaces.

Unit 5: Some properties of completely regular spaces. The Stone Chech compactification.

Reference:

1. **S. Willard:** General Topology, Addison – wesley 1970
2. **S.W . Davis:** Topology, TMH 2006
3. **K.K.Jha:** Advanced General Topology, Nav Bharat Prakashan, patna
4. **G.F. Simmons:** An Introduction to Topology and Modern Analysis

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EC-07
(COURSE CODE : PUMAT 521)
Banach Algebras

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Unit 1: Elementary properties and Examples of Banach Algebras, Ideal Quotients, the spectrum of an element, dependence of spectrum on algebra, Abelian Banach Algebras.

Unit 2: Elementary properties of C*- Algebras and examples, Abelian Algebras and functional calculus, positive elements.

Unit 3: Ideals and quotients, representations of C*- algebras and the Gelfand Naimark construction.

Unit 4: Spectral measures and representations of Abelian C*- Algebras, Special theorem.

Unit 5: Topologies on B (H). the double commutant rem and Abelian Von Neumann Algebras.

Reference:

1. **J.B. Conway:** A Course in Functional Analysis springer 1990
2. **R.V. Kadision and J.R. Ringrose :** Fundamentals of the theory of operator Algebras, AMS 1997
3. **G. Murphy:** C* Algebras and Operator theory, Acadmic press 1990

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EC-08
(COURSE CODE : PUMAT 522)
Commutative Algebra

PURNEA UNIVERSITY Estd-2018 PURNIA

Unit 1: Ring and ring homomorphisms, ideals. Quotient rings, Zero divisors, Nilpotent elements units, Prime ideals and maximal ideals. Nil radical and Jacobson radical, operations on ideals, extension and contraction.

Unit 2: Modules and module homomorphisms sub modules, quotient modules. Operations on sub-modules, Direct sum and products, Finitely generated modules, exact sequences.

Unit 3: Tensor product of modules, restriction and extension of scalars, exactness properties of tensor product, Algebras, Tensor product of algebras.

Unit 4: Local properties, extended and contracted ideals in ring of fractions, primary decompositions, Integral dependence, the going up theorem integrally closed integral domains, the going down theorem, chain conditions.

Unit 5: Primary decomposition in Noetherian ring, Artin rings, discrete valuation rings, Dedekind domains, Fractional ideals.

Reference:

1. **M.F. Atiyah and I.G. Macdonald:** Introduction to Commutative Algebra- Addison Wesley
2. **H. Matsumura:** Commutative Ring Theory, Camb,Univ,Press
3. **N.S Gpala krishnam:** Commutative Algebra
4. **S. Lang:** Algebra, Springer
5. **D.P Patil storch:** Introduction to Algebraic Geometry and Commutative Algebra, Anshan Publishers.

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EC-09
(COURSE CODE : PUMAT 523)
Programming in C

Theory:

1. Introduction to programming languages, C language and it's features.
2. Understanding of Structure of Programme in C.
3. Basic data types, Library in C.
4. Operators and Expression in C.
5. Functions used for input and output in C.
6. Conditional Branching in C, use of if - then.
7. Looping in C, Use of for loop, while loop, do while loop, nested loops.
8. Algorithm and Flow Charts.

Practical

1. Some Simple Programmes Use in C
2. Leap- Year
3. Generate First n- Primes
4. Roots of Quadratic Equation
5. Convert a Number to Any Given Base
6. Generate First n- Perfect Numbers.
7. Sine and Cosine by Taylors Series.
8. Addition and Multiplication of Matrices
9. Transpose of a Matrix
10. Inverse of a Matrix.

References

1. **Y.kanitkar:** Let's C
2. **Robert lafore:** C Programming
3. **E. Balaguruswami:** Programming in ANSI C

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EC-10
(COURSE CODE : PUMAT 524)
Number Theory

Unit 1: Divisibility, G.C.D. and L.C.M., Primes, Fermat numbers, Congruences and residues, theorem of Euler, Fermat and Wilson, solution of congruences, linear congruences, Chinese remainder theorem.

Unit 2: Arithmetical functions $\varphi(n)$, $\mu(n)$, $d(n)$ and $\sigma(n)$. Moebius inversion formula, congruences of higher degree, congruences of prime power modulli and prime modulus, power residue.

Unit 3: Quadratic residue, Legendre symbols, lemma of Gauss and reciprocity law, Jacobi symbols, Farey series, rational approximation, Hurwitz theorem, irrational numbers, irrationality of e and π, Representation of the real numbers by decimals.

Unit 4: Finite continued fractions, Simple continued fractions, Infinite simple continued fractions, periodic continued fractions, approximation by convergence, best possible approximation, Pell's equations, Lagrange four sphere theorem.

Reference:

1. **Theory of Numbers:** G H Hardy and E M Wright, Oxford Science Publications
2. **Introduction to the Theory of Numbers:** I Niven and H S Zuckerman, John Willey & Sons
3. **Elementary Number Theory:** D M Burton, Tata McGraw Hill Publishing House
4. **Higher Arithmetic:** H Davenport, Cambridge University Press
5. **Introduction to Analytic Number Theory:** T M Apostal, Narosa Publishing House

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Fundamental of Mathematics

Linear Algebra:

Unit 1: Representation of linear transformations by matrices, Rank-nullity theorem, duality and transpose. Inner product spaces, Gram-Schmidt ortho-normalization, orthogonal projections, linear functionals and adjoints.

Numerical Analysis:

Unit 2: Lagrange interpolation, Newton interpolation and divided differences, Error of the interpolating polynomials, Piecewise linear and cubic spline interpolation.

Unit 3: Some basic rules of integration, adaptive quadratures, Gaussian Rules, Composite rules, Error formula
Euler method, Runga-Kutta Method, Predictor-Corrector methods, Stability and convergence.

Partial Differential Equations:

Unit 4: Classification of second order semi linear partial differential equations, Solutions of Heat Equations, Wave Equations and Laplace Equations by method of separation of variables. Boundary conditions associated with heat conduction and vibrating string problems.

References:

1. **Linear Algebra:** K. Hoffman and R. Kunze, Pearson Education.
2. **Numerical Analysis:** R L Burden and J D Faires, Thomson 2001.
3. **An Introduction to Numerical Analysis:** K. E. Atkinson, Wiley-India.
4. **N. Sneddon:** Elements of Partial Differential Equations

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