Minor Courses

Sem.	Paper Code	Paper Level	Paper	Paper Description	Paper Type	TH	TU	Credit	
								L	T
1	MATHMIN101	100	MIN	Classical Algebra and Matrix Theory	TH	60	20	3	1
2	MATHMIN202	100	MIN	Calculus and Geometry	TH	60	20	3	1
3	----------	200	MIN	Real Analysis	TH	60	20	3	1
4	----------	200	MIN	Abstract and Linear Algebra	TH	60	20	3	1

DETAILED SYLLABUS

of

MINOR COURSES

(semester wise)

SEMESTER-1										
Paper Description	Classical Algebra and Matrix Theory		**Paper Code**				MATHMIN101			
Paper (Type)	Minor Course (Theory)		**Credit**				**Marks**			
Paper Level	**Class Hours**	**Sem. End Exam.**	**L**	**T**	**P**	**Total**	**TH**	**TU**	**PRC**	**Total**
100	4 Hours/week	2 Hr. 30 Min	3	1	-- -	4	60	20	----	80

CLASSICAL ALGEBRA AND MATRIX THEORY

Classical Algebra:

Unit 1: **10 classes**

Complex numbers: Polar representation, De Moivre's theorem for rational indices and its applications. Logarithm, trigonometric, exponential and hyperbolic functions of complex variable.

Unit 2: **15 classes**

Theory of polynomial equations: Fundamental theorem of Classical Algebra (statement only). Location and nature of roots: Descartes' rule of signs. Relation between roots and coefficients. Solution methods for cubic and biquadratic poly. equations: Cardan's and Ferrari's method. Symmetric functions of roots, transformation of equation.

Unit 3: **8 classes**

Inequality: $AM \geq GM \geq HM$, weighted means and m-th power theorem (statement only), Cauchy-Schwarz inequality (statements only) and their applications.

Matrix Theory:

Unit 4: **15 classes**

Matrices: Elementary operations, elementary matrices, row/column equivalent matrix, echelon matrix, row/column reduced echelon matrix, rank of matrix, normal forms, congruence operations, congruence matrices. Systems of linear equations: Consistency, the matrix equation $AX = B$ of a system of linear equations, solution sets of linear systems, solution of linear systems using row reduced form.

Unit 5: **12 classes**

Eigen values and eigen vectors of a square matrix, characteristic equation of a matrix, Cayley-Hamilton theorem (statement only) and its simple applications.

Suggested Reading Books:

- S. Lang, Introduction to Linear Algebra, *Springer.*
- S.K. Mapa, Higher Algebra: Classical, *Levant.*
- S.K. Mapa, Higher Algebra: Abstract & Linear, *Levant.*
- W.S. Burnstine and A.W. Panton, Theory of equations, *Creative Media.*
- S.H. Friedberg, A.J. Insel and L.E. Spence, Linear Algebra, *Pearson Edu. Pub. (Indian).*
- K. Hoffman and R. Kunze, Linear algebra, *Prentice Hall India.*
- V. Sahai and V. Bist, Linear Algebra, *Narosa Pub. House.*

SEMESTER-2										
Paper Description	Calculus and Geometry		**Paper Code**				MATHMIN202			
Paper (Type)	Minor Course (Theory)		**Credit**				**Marks**			
Paper Level	**Class Hours**	**Sem. End Exam.**	**L**	**T**	**P**	**Total**	**TH**	**TU**	**PRC**	**Total**
100	4 Hours/week	2 Hr. 30 Min	3	1	-- -	4	60	20	----	80

CALCULUS AND GEOMETRY

Calculus:

Unit 1: **15 classes**

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int sin^n x\, dx$, $\int \cos^n x\, dx, \int \sec^n x\, dx, \int \tan^n x\, dx$, $\int (logx)^n\, dx$, $\int \sin^n x \cos^m x\, dx$ etc.

Arc length of a curve including parametric curves, area enclosed by a curve, area between two curves. volume and surface areas of solids formed by revolution of plane curve and areas problems only.

Unit 2: **15 classes**

Successive derivatives, Leibnitz rule and its applications. Indeterminate forms, L'Hospital's rule and it's applications.

Concept of simple and closed curves and their parameterizations, envelopes, asymptotes, radius of curvature. Concavity, convexity, and inflection points.

Geometry:

Unit 3: **15 classes**

2D: Rotation of axes and second-degree equations, pair of straight lines, classification of conics using the discriminant, polar equations of conics.

Unit 4: **15 classes**

3D: Spheres, cylindrical surfaces, cones, ellipsoids, paraboloids, hyperboloids, classification of quadrics.

Suggested Reading Books:

- G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer Verlag, New
- S. Goldberg, Calculus and mathematical analysis.
- S. K. Mapa, Introduction to Real Analysis, *Sarat Book House.*
- S. C. Malik and S. Arora, Mathematical Analysis, *New Age International.*
- U. Chatterjee and N. Chatterjee, Advanced Analytical Geometry of Two and Three Dimensions, *Academic Publishers*.
- R.M. Khan, Analytical Geometry of Two and Three Dimensions & Vector Analysis, *New Central Book Agency*.

SEMESTER-3										
Paper Description	Real Analysis		**Paper Code**							
Paper (Type)	Minor Course (Theory)		**Credit**				**Marks**			
Paper Level	**Class Hours**	**Sem. End Exam.**	**L**	**T**	**P**	**Total**	**TH**	**TU**	**PRC**	**Total**
200	4 Hours/week	2 Hr. 30 Min	3	1	-- -	4	60	20	----	80

REAL ANALYSIS

Unit 1: **12 classes**

Finite and Infinite sets: Definitions and Examples, well-ordered properties of $\mathbb{N}$ (statement only). Countable, Denumerable and Uncountable sets: Definitions and Examples, countability of union, intersection, product, subset, superset of countable sets, Rational numbers are countable. Uncountable subsets of R.

Unit 2: **18 classes**

Review of Algebraic and order properties of $\mathbb{R}$, ε-neighborhood of a point in $\mathbb{R}$. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima with their properties and supporting examples. Archimedean property, density property , order property of $\mathbb{R}$, Intervals in $\mathbb{R}$, Limit point and isolated point of a set. Open set, closed set, derived set and their properties. Bolzano-Weierstrass theorem on limit point. Nested interval theorem. Examples of Compact sets in $\mathbb{R}$, statement of Heine-Borel Theorem.

Unit 3: **15 classes**

Sequences: Sequence, bounded sequence, convergent sequence. Limit and limit points of a sequence. Uniqueness of limit of convergent sequences. Limit theorems. Monotone sequences, monotone convergence theorem. Sandwich theorem. Subsequences. Monotone subsequence theorem (statement only). Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion. Completeness property of $\mathbb{R}$.

Unit 4: **15 classes**

Series: Infinite series, convergence and divergence of infinite series, Cauchy criterion (only statement). Tests for convergence (only statement and applications): comparison test, limit comparison test, D'Alembert's ratio test, Cauchy's nth root test. Absolutely convergent series (Ratio test, Root test), conditionally convergent series (Leibniz's test) and alternating series. Only problems on power series and its radius of convergence.

Suggested Reading Books:

- R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
- K. A. Ross, Elementary Analysis : The Theory of Calculus, Springer, 2004.
- A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
- S. R. Ghorpade and B. V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006.
- T. Apostol, Mathematical Analysis, Narosa Publishing House.
- Courant and John, Introduction to Calculus and Analysis, ,Voll II, Springer.
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
- T. Tao, Analysis II, Hindustan Book Agency, 2006.

SEMESTER-4										
Paper Description	Abstract and Linear Algebra		**Paper Code**							
Paper (Type)	Minor Course (Theory)		**Credit**				**Marks**			
Paper Level	**Class Hours**	**Sem. End Exam.**	**L**	**T**	**P**	**Total**	**TH**	**TU**	**PRC**	**Total**
200	4 Hours/week	2 Hr. 30 Min	3	1	-- -	4	60	20	----	80

ABSTRACT AND LINEAR ALGEBRA

Abstract Algebra

Unit 1 :

Groupoid, semigroup, monoid, groups, finite and infinite groups, commutative groups. Basic properties of groups. Finite semigroup with cancellation properties, semigroup containing unique solution of $ax = b$ and $xa = b$. Well-known groups: $\mathbb{Z}_n$, U_n, $M_n(R)$, $GL(n, \mathbb{R})$, $SL(n, \mathbb{R})$, Klein's 4 group.

Unit 2: **10 classes**

Subgroups and its basic properties. Union, intersection and product of subgroups, necessary and sufficient condition for a subset of a group to be a subgroup.

Unit 3: **18 classes**

Order of a group, order of an element. Cyclic group and its properties, cosets, normal subgroup & quotient group and their relevant results. Lagrange's theorem and consequences including Fermat's Little theorem. Group homomorphism & isomorphism and their basic properties.

Linear Algebra

Unit 4 :

Vector spaces and its basic properties, subspaces, algebra of subspaces, linear combination of vectors, linear span, linear dependence and linear independence of vectors, basis and dimension, existence, extension and replacement theorems for basis of a finite dimensional vector space. Vector space Isomorphism, Every n dimensional vector space V(F) is isomorphic to F^n. Vector spaces of Matrices over field of real and complex numbers.

Unit 4

Linear transformations, algebra of linear transformations, Range and null space of a linear transformation, rank and nullity of a linear transformation, rank-nullity theorem (statement and its applications), matrix representation of a linear transformation relative to ordered bases.

Suggested Reading Books:

- J. B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- I. Herstein, Abstract Algebra.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- S. H. Friedberg, A. J. Insel, L. E. Spence, Linear Algebra, PHI Pvt. Ltd., New Delhi, 2004.
- J. A. Gallian, Contemporary Abstract Algebra, Narosa Publishing House, New Delhi, 1999.
- S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
- S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
- K. Hoffman, R. A. Kunze, Linear Algebra, Prentice – Hall of India Pvt. Ltd., 1997.