# Master of Arts (Mathematics)

## PROGRAMME GUIDE

## INDEX

**PROGRAMME CODE:** 442A

**DURATION OF THE PROGRAMME:**

**Minimum Duration** **2** Years

**Maximum Duration** **5** Years

**MEDIUM OF INSTRUCTION/ EXAMINATION:**

1. The SLM/Text Books will be available in English only.
2. Student is can attempt the examination in English language.

| Scheme | | | | | |
|---|---|---|---|---|---|
| **COURSE CODE** | **COURSE TITLE** | **Cr.** | **CA** | **ETE(Th.)** | **ETE(Pr.)** |
| **FIRST YEAR** | | | | | |
| DMTH401 | REAL ANALYSIS | 8 | 20 | 80 | 0 |
| DMTH402 | COMPLEX ANALYSIS AND DIFFERENTIAL GEOMETRY | 8 | 20 | 80 | 0 |
| DMTH403 | ABSTRACT ALGEBRA | 8 | 20 | 80 | 0 |
| DMTH404 | STATISTICS | 8 | 20 | 80 | 0 |
| **SECOND YEAR** | | | | | |
| DMTH502 | LINEAR ALGEBRA | 8 | 20 | 80 | 0 |
| DMTH503 | TOPOLOGY | 8 | 20 | 80 | 0 |
| DMTH504 | DIFFERENTIAL AND INTEGRAL EQUATION | 8 | 20 | 80 | 0 |
| DMTH505 | MEASURE THEOREY AND FUNCTIONAL ANALYSIS | 8 | 20 | 80 | 0 |
| **TOTAL CREDITS** | | | **64** | | |

| Course Code: | D | M | T | H | 4 | 0 | 1 | Course Title: | **REAL ANALYSIS** |
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| **WEIGHTAGE** | |
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| **CA** | **ETE (Th.)** |
| **20** | **80** |

**COURSE CONTENTS:**

| **Sr. No.** | **Topics** |
|---|---|
| **Set Theory** | |
| **1.** | Finite, Countable and Uncountable sets |
| **2.** | Metric Spaces : Definition and examples |
| **3.** | Compactness of K-cells and compact subsets of Euclidean space RK |
| **4.** | Perfect sets and The Cantor set |
| **5.** | Connected sets in a metric space and connected subsets of real line. |
| **Sequences in Metric Spaces** | |
| **6.** | Convergent sequences and subsequences |
| **7.** | Cauchy sequence |
| **8.** | Complete metric spaces |
| **9.** | Cantor's intersection theorem and Baire's theorem |
| **10.** | Banach Contraction Principle |
| **11.** | Continuity: Limit of functions, continuous functions, continuity and compactness, continuity and connectedness |
| **12.** | Discontinuities and monotonic functions |
| **Sequences and series of functions** | |
| **13.** | Uniform convergence, |
| **14.** | Uniform convergence and continuity, |
| **15.** | Uniform convergence and integration |
| **16.** | Uniform convergence and differentiation |
| **17.** | Equi continuous families of functions, |
| **18.** | Arzela's theorem and Weierstrass approximation theorem. |
| **Reimann Stieltje's integral** | |
| **19.** | Definition and existence of integral |
| **20.** | Properties of integral |
| **21.** | Integration |
| **22.** | Differentiation |
| **23.** | Fundamental theorem of Calculus, |
| **24.** | 1st and 2nd mean value theorems of Riemann Stieltje's integral |
| **25.** | Lebesgue Measure: Outer measure, Measurable sets and Lebesgue Measure. A non-measurable set.1`q |
| **26.** | Measurable functions |
| **27.** | Littlewood's three principles |
| **28.** | Lebesgue integral of bounded function |

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| **29.** | Comparison of Riemann and Lebesgue Integral |
| **30.** | Integral of a non-negative function |
| **31.** | General Lebesgue Integral |
| **32.** | Convergence in measure. |

**READINGDS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


1. Walter Rudin : Principles of Mathematical Analysis (3rd edition), Ch. 2, Ch. 3.(3.1-3.12), Ch. 6 (6.1 – 6.22), Ch.7(7.1 – 7.27), Ch. 8(8.1- 8.5, 8.17 – 8.22).
2. G.F. Simmons : Introduction to Topology and Modern Analysis, Ch. 2(9-13), Appendix 1, p. 337-338.
3. Shanti Narayan : A Course of Mathematical Analysis, 4.81-4.86, 9.1-9.9, Ch.10,Ch.14, Ch.15(15.2, 15.3, 15.4)
4. T.M. Apostol : Mathematical Analysis, (2nd Edition) 7.30 and 7.31.
5. S.C. Malik : Mathematical Analysis.
6. H.L. Royden : Real Analysis, Ch. 3, 4.

| Course Code: | D | M | T | H | 4 | 0 | 2 | Course Title: | **COMPLEX ANALYSIS AND DIFFERENTIAL GEOMETRY** |
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| **WEIGHTAGE** | |
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| **CA** | **ETE (Th.)** |
| **20** | **80** |

**COURSE CONTENTS:**

| **Sr. No.** | **Topics** |
|---|---|
| **1.** | Sequences and functions of complex variables |
| **2.** | Continuity |
| **3.** | Differentiability |
| **4.** | Analytic functions |
| **5.** | Cauchy-Riemann equations |
| **6.** | Cauchy's theorem and Cauchy's integral formula |
| **7.** | Conformal mappings |
| **8.** | Bilinear transformations |
| **9.** | Power Series, Taylor's series and Laurent's series |
| **10.** | Singularities |
| **11.** | Liouville's theorem |
| **12.** | Fundamental theorem of algebra |
| **13.** | Cauchy's theorem on residues with applications to definite integral evaluation |
| **14.** | Rouche's theorem, Maximum Modulus principle and Schwarz Lemma. |
| **15.** | Notation and summation convention, transformation law for vectors, Knonecker delta,Cartesian tensors |
| **16.** | Addition, multiplication, contraction and quotient law of tensors. |
| **17.** | Differentiation of Cartesians tensors, metric tensor, contra-variant,Covariant and mixed tensors, Christoffel symbols |
| **18.** | Transformation of christoffel symbols and covariant differentiation of a tensor. |
| **19.** | Theory of space curves: - Tangent, principal normal, bin ormal, curvature and torsion. |
| **20.** | Serret- frenet formulae. |
| **21.** | Contact between curves and surfaces. |
| **22.** | Locus of centre of curvature, spherical curvature, Helices |
| **23.** | Spherical indicatrix |
| **24.** | Bertrand curves, surfaces, envelopes, edge of regression |
| **25.** | Developable surfaces. |
| **26.** | Two fundamental forms. |
| **27.** | Curves on a surface, Conjugate direction, Principal directions. |
| **28.** | Lines of Curvature, Principal Curvatures, Asymptotic Lines. |

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| **29.** | Theorem of Beltrami and Enneper,Mainardi-Codazzi equations |
| **30.** | Geodesics, Differential Equation of Geodesic. Torsion of Geodesic, Geodesic Curvature,Geodesic Mapping |
| **31.** | Clairaut's theorem,Gauss- Bonnet theorem. |
| **32.** | Joachimsthal's theorem, Tissot's theorem. |

**READINGDS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


**1.** Ahelfors, D.V. : Complex Analysis

**2.** Conway, J.B. : Function of one complex variable

**3.** Pati,T. : Functions of complex variable
**4.** Shanti Narain : Theory of function of a complex Variable

**5.** Tichmarsh, E.C. : The theory of functions

**6.** H.S. Kasana: Complex Variables theory and applications

**7** P.K. Banerji: Complex Analysis

**8.** Serge Lang: Complex Analysis

**9.** H.Lass: Vector & Tensor Analysis

**10.** Shanti Narayan: Tensor Analysis

**11.** C.E. Weatherburn: Differential Geometry

**12.** T.J. Wilemore: Introduction to Differential Geometry

**13**. Bansi Lal: Differential Geometry.

| Course Code: | D | M | T | H | 4 | 0 | 3 | Course Title: | **ABSTRACT ALGEBRA** |
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| **WEIGHTAGE** | |
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| **20** | **80** |

**COURSE CONTENTS:**

| Sr. No. | Topics |
|---|---|
| **1.** | Groups : Definition and examples |
| **2.** | Quotient groups, Cyclic groups, Permutation groups and The alternating groups. |
| **3.** | Subgroups, normal subgroups and the commutator subgroup |
| **4.** | Generating sets |
| **5.** | Homomorphisms and Automorphisms |
| **6.** | Lagrange's Theorem and Cayley's theorem |
| **7.** | Direct products. External and internal direct products |
| **8.** | Structure of finite |
| **9.** | Abelian groups |
| **10.** | Conjugate elements and class equations of finite groups |
| **11.** | Sylow's theorems and their simple applications. |
| **12.** | Solvable groups |
| **13.** | Jordan-Holder Theorem |
| **14.** | Rings, |
| **15.** | Subrings |
| **16.** | Ideals and their operations |
| **17.** | Factor rings and Homomorphisms |
| **18.** | Integral domains |
| **19.** | The field of quotients Euclidean domains |
| **20.** | Principal Ideal Domains |
| **21.** | Unique factorization domain, |
| **22.** | Polynomial rings, |
| **23.** | Prime fields |
| **24.** | finite and algebraic extensions |
| **25.** | Roots of a polynomial, |
| **26.** | splitting fields; existence and uniqueness, |
| **27.** | Separable extensions |
| **28.** | Finite fields; the structure, the existence of GF (pn). |
| **29.** | Galois theory :Normal extensions, Galois groups, |
| **30.** | Symmetric functions, fundamental theorem, |
| **31.** | Constructible polygons. |
| **32.** | Solvability by radicals. |

**READINGDS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


**1.** I.N. Herstein : Topics in Algebra, Ch. 2,3,5, (Section 1, 3 to 6), 7(7.1).

**2.** Dan Saracino : Abstract Algebra; A First Course.

**3.** Mitchell and Mitchell : An Introduction to Abstract Algebra.

**4.** John B. Fraleigh : An Introduction to Abstract Algebra (RelevantPortion).

**5.** Surjit Singh & Qazi : Modern Algebra.Zammeerudin

**6.** I.S. Luther and : Algebra Vol. I – Groups Vol. II Rings.I.P.S. Passi

**7.** D.S. Malik, John N. : Fundamentals of Abstract Algebra, McGraw Hill,Moderson, M.K. Sen 1977.

**8.** I.N. Herstein : Abstract Algebra. Prentice-Hall, 1996

**9.** P.B. Bhattacharya, : Basic Abstract Algebra, Cambridge Univ. Press,S.K. Jain & S.R. Nagpal 1997.

**10.** Vivek Sahai, Vikas Bist : Algebra 1999.

| Course Code: | D | M | T | H | 4 | 0 | 4 | Course Title: | **STATISTICS** |
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| **WEIGHTAGE** | |
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**COURSE CONTENTS:**

| **Sr. No.** | **Topics** |
|---|---|
| **Introduction to Probability** | |
| **1.** | The sample space, Events, Basic notions of probability |
| **2.** | Methods of Enumeration of Probability |
| **3.** | Conditional Probability and independence, Baye's theorem |
| **Random Variables** | |
| **4.** | General notion of a variable, Discrete random variables, Continuous random variables |
| **5.** | Functions of random Variables |
| **6.** | Two dimensional random variables, Marginal and conditional probability distributions, Independent random variables |
| **7.** | Distribution of product and quotient of independent random variables, n-dimensional random variables |
| **Expected Value and Variance of a Random Variable** | |
| **8.** | Expected value of a random variable, Expectation of a function of a random variable, Properties of expected value |
| **9.** | Variance of a random variable and their properties |
| **10.** | Approximate expressions for expectations and variance |
| **11.** | Chebyshev inequality |
| **Moments Generating Function** | |
| **12.** | The Moment Generating Function: Examples of moment generating functions |
| **13.** | Properties of moment generating function, Reproductive properties |
| **Probability Distributions** | |
| **14.** | Discrete Distributions: Binomial, Poisson, Geometric, Pascal Distributions |
| **15.** | Continuous Distributions: Uniform, Normal, Exponential |
| **Reliability Theory** | |
| **16.** | Basic concepts, The normal failure law, The exponential failure law, Weibull failure law |
| **17.** | Reliability of systems. |
| **Laws of Large Numbers** | |
| **18.** | Weak Law of Large Numbers |
| **19.** | Strong Law of Large Numbers |
| **20.** | Central Limit Theorem |
| **21.** | Confidence Intervals |
| **Correlation and Regression** | |

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| **22.** | The correlation coefficient, Conditional expectation |
| **23.** | Regression of the mean |
| **Sampling Theory and Sampling Distributions** | |
| **24.** | Samples, Sample Statistics |
| **25.** | Sampling Distribution of Sample Mean and Sample Variance |
| **26.** | T-Distribution, Chi Square Distribution |
| **27.** | F- Distribution |
| **Theory of Estimation** | |
| **28.** | Estimation of Parameters: Criteria for estimates |
| **29.** | Maximum likelihood estimates |
| **30.** | Method of least squares |
| **Testing of Hypotheses** | |
| **31.** | T-Test, chi square Goodness of fit test |
| **32.** | Z-Test with examples . |

**READINGDS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**

1. Introductory Probability and Statistical Applications by P.L.Meyer
2. Introduction to Mathematical Statistics by Hogg and Craig
3. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K.Kapoor

| Course Code: | D | M | T | H | 5 | 0 | 2 | Course Title: | **LINEAR ALGEBRA** |
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**COURSE CONTENTS:**

| **Sr. No.** | **Topics** |
|---|---|
| **Review of Vector Spaces** | |
| **1.** | Vector Space over fields |
| **2.** | Subspaces |
| **3.** | Bases and Dimension |
| **4.** | Coordinates |
| **5.** | Summary of Row-Equivalence |
| **6.** | Computation Concerning Subspaces |
| **Linear Transformation** | |
| **7.** | Linear Transformations, the algebra of linear transformations, the transpose of a linear transformation. |
| **8.** | Isomorphism, |
| **9.** | Representation of Transformation by matrices, |
| **10.** | Linear Functional |
| **11.** | The double dual |
| **Elementary Canonical Forms:** | |
| **12.** | Introduction, and Characteristic Values, |
| **13.** | Annihilating Polynomials, |
| **14.** | Invariant Subspaces, |
| **15.** | Simultaneous triangulation; Simultaneous diagonalization. |
| **Elementary Canonical Forms** | |
| **16.** | Direct-Sum Decompositions |
| **17.** | Invariant Direct Sums |
| **18.** | The Primary Decomposition Theorem |
| **The Rational and Jordan Forms** | |
| **19.** | Cyclic Subspaces and Annihilators |
| **20.** | Cyclic Decomposition and the rational Form |
| **21.** | The Jordan Form |
| **The Rational and Jordan Forms** | |
| **22.** | Computation of Invariant Factors |
| **23.** | Semi-Simple Operators |

| Inner Product Space | |
|---|---|
| **24.** | Inner product, Inner Product Space, |
| **25.** | Linear Functional and Adjoints |
| **26.** | Unitary Operators, Normal Operators |
| **Operators on Inner Product Space** | |
| **27.** | Introduction, Forms on Inner Product Spaces, |
| **28.** | Positive Forms, More on Forms |
| **Operators on Inner Product Space** | |
| **29.** | Spectral Theory, properties of Normal operators |
| **Bilinear Forms:** | |
| **30.** | Bilinear Forms, Symmetric Bilinear Forms, |
| **31.** | Skew-Symmetric Bilinear Forms |
| **32.** | Groups Preserving Bilinear Forms |

**READINGS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


1. K. Hoffman and Ray Kunje: Linear Algebra (Prentice - Hall of India private Ltd.)
2. M. Artin: Algebra (Prentice - Hall of India private Ltd.)
3. A.G. Hamilton: Linear Algebra (Cambridge University Press (1989))
4. N.S. Gopalkrishanan: University algebra (Wiley Eastern Ltd.)
5. J.S. Golan: Foundations of linear algebra (Kluwer Academic publisher (1995) )
6. Henry Helson: Linear Algebra (Hindustan Book Agency (1994) )
7. I.N. Herstein: Topics in Algebra, Second edition (Wiley Eastern Ltd.)

| Course Code: | D | M | T | H | 5 | 0 | 3 | Course Title: | **TOPOLOGY** |
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| **WEIGHTAGE** | |
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**COURSE CONTENTS:**

| Sr. No. | Topics |
|---|---|
| **1.** | Topological Spaces. |
| **2.** | Basis for Topology |
| **3.** | The order Topology |
| **4.** | The Product Topology on X * Y |
| **5.** | The Subspace Topology |
| **6.** | Closed Sets and Limit Points |
| **7.** | Continuous Functions |
| **8.** | The Product Topology |
| **9.** | The Metric Topology |
| **10.** | The Quotient Topology |
| **11.** | Connected Spaces, Connected Subspaces of Real Line |
| **12.** | Components and Local Connectedness |
| **13.** | Compact Spaces, Compact Subspaces of Real Line |
| **14.** | Limit Point Compactness |
| **15.** | Local Compactness |
| **16.** | The Count ability Axioms |
| **17.** | The Separation Axioms |
| **18.** | Normal Spaces, Regular Spaces, Completely Regular Spaces |
| **19.** | The Urysohn Lemma |
| **20.** | The Urysohn Metrization Theorem |
| **21.** | The Tietze Extension Theorem |
| **22.** | The Tychonoff Theorem |
| **23.** | The Stone-Cech Compactification |
| **24.** | Local Finiteness, Paracompactness |
| **25.** | The Nagata-Smirnov Metrization Theorem |
| **26.** | The Smirnov Metrization Theorem |
| **27.** | Complete Metric Spaces |
| **28.** | Compactness in Metric Spaces |
| **29.** | Pointwise and Compact Convergence |
| **30.** | Ascoli's Theorem |

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| **31.** | Baire Spaces |
| **32.** | Introduction to Dimension Theory |

**READINGS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


1. James R. Munkres: Topology 'A First Course' Prentice Hall of India.
2. T.O Moore: Elementary General topology, chapters 2, 3, 4, 5, 6, 7, 8, 9 relevant portion.
3. J.L. Kelley: General Topology, chapters 1 to 5 (relevant portions).

| Course Code: | D | M | T | H | 5 | 0 | 4 | Course Title: | **DIFFERENTIAL AND INTEGRAL EQUATION** |
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| **20** | **80** |

**COURSE CONTENTS:**

| Sr. No. | Topics |
|---|---|
| **1.** | Bessel functions |
| **2.** | Legendre polynomials, Hermite polynomials and laguerre polynomials. |
| **3.** | Recurrence relations |
| **4.** | Generating functions |
| **5.** | Rodrigue formula and orthogonality |
| **6.** | Existence theorem for solution of the equationdy/dx= f (x,y)(Picard's methods as in Yoshida). |
| **7.** | General properties of solutions of linear differential equations of ordern. |
| **8.** | Total differential equations, simultaneous differential equations. |
| **9.** | Adjoint and self-adjoint equations. |
| **10.** | Green's function method. |
| **11.** | Sturm liouville's boundary value problems |
| **12.** | Sturm comparison and Separation theorems. |
| **13.** | Orthogonality of solutions. |
| **14.** | Classification of partial differential equations |
| **15.** | Cauchy's problem and characteristics for first order equations |
| **16.** | Classification of integrals of the first order partial differential equations |
| **17.** | Lagrange's methods for solving partial differential equations |
| **18.** | Charpit’s method for solving partial differential equations |
| **19.** | Jacobi's method for solving partial differential equations |
| **20.** | Higher order equations with constant coefficients and Monge's method. |
| **21.** | Classification of second order partial differential equations. |
| **22.** | Solution of Laplace. |
| **23.** | Wave and diffusion equations by separation of variable (Axially symmetric cases). |
| **24.** | Integral equations and algebraic system of linear equations. |
| **25.** | Volterra equation & L2_Kernels and functions. |
| **26.** | Volterra equations of the first kind. |
| **27.** | Volterra integral equations and linear differential equations. |
| **28.** | Fredholm equations |

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| **29.** | Solutions by the method of successive approximations. |
| **30.** | Neumann's series. |
| **31.** | Fredholm's equations with Poincere Goursat Kernels, |
| **32.** | The Fredholm theorem |

**READINGS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


**1.** Yoshida, K. : Lectures in Differential and Integral Equations.

**2**. N.M. Kapoor : Differential Equation (Pitamber Publications, New Delhi).

**3.** Tricomi, : F.G. Integral equations (Ch. I and II).

**4.** Rainuile : Special functions

**5.** Piaggio : Differential equations

**6.** Sneddon L N. : Elements of partial differential equations, Ch.I Art 1,3,4,5,6,

ch.II. Art 1,2,3,4,5,6,7,9,10,13 Ch.III Art 1,4,5,11, Ch.IV. Art 5,6,11, Ch.V Art 2,3,5,7, Ch. VI Art 4,6

| Course Code: | D | M | T | H | 5 | 0 | 5 | Course Title: | **MEASURE THEORY AND FUNCTIONAL ANALYSIS** |
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| **WEIGHTAGE** | |
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| **20** | **80** |

**COURSE CONTENTS:**

| Sr. No. | Topics |
|---|---|
| **1.** | Differentiation and Integration: Differentiation of monotone functions |
| **2.** | Functions of bounded variation |
| **3.** | Differentiation of an integral |
| **4.** | Absolute continuity |
| **5.** | Spaces, Holder |
| **6.** | Minkowski inequalities |
| **7.** | Convergence and Completeness |
| **8.** | Bounded linear functional on the *Lp* spaces. |
| **9.** | Measure spaces |
| **10.** | Measurable Functions |
| **11.** | Integration |
| **12.** | General Convergence Theorems |
| **13.** | Signed Measures |
| **14.** | Radon-Nikodym theorem. |
| **15.** | Banach spaces: Definition and some examples |
| **16.** | Continuous linear transformations. |
| **17.** | The Hahn-Banach theorem, |
| **18.** | The natural imbedding of N in N**. |
| **19.** | The open mapping theorem |
| **20.** | The closed graph theorem |
| **21.** | The conjugate of an operator |
| **22.** | The uniform boundedness theorem |
| **23.** | Hilbert spaces : The definition and some simple properties |
| **24.** | Orthogonal complements |
| **25.** | Orthonormal Sets. |
| **26.** | The conjugate space H* |
| **27.** | The Adjoint of an Operator |

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| **28.** | Self Adjoint Operators |
| **29.** | Normal and Unitary Operators |
| **30.** | Projections |
| **31.** | Finite dimensional spectral theory : the spectrum of an operator on a finite dimensional Hilbert space, the Spectral theorem |

**READINGS:** SELF LEARNING MATERIAL.

**ADDITIONAL READINGS:**


1. G.F. Simmons : Introduction to Topology and Modern Analysis. Ch. 9,10, relevant portions of Chap. 11

2. H.L. Royden : Real Analysis, Ch. 5 (excluding section 5), Ch. 6 and Ch 11.
3. E. Kreyszig: Introductory Functional Analysis with applications, John- Wiley & Sons, New York, 1978.