PONDICHERRY UNIVERSITY
DEPARTMENT OF MATHEMATICS

5-YEAR INTEGRATED M. Sc., PROGRAMMES

RAMANUJAN SCHOOL OF MATHEMATICAL
SCIENCES
&
SCHOOL OF PHYSICAL, CHEMICAL & APPLIED
SCIENCES

SYLLABI

WITH EFFECT FROM THE ACADEMIC YEAR

2017-18 onwards

Integrated M.Sc. Programme of Ramanujan School of Mathematical Sciences
To come into effect from 2017-18-onwards

Semester	Course Code	Title of the paper	Nos. of Credits	Hard Core Paper (H) (Compulsory) Soft Core Paper (S) (Optional)	
				For Mathematics	For Statistics/ Computer Science
I	MATH 111	Differential Calculus	4	H	H
I	MATH 112	Integral Calculus	4	H	H
II	MATH 121	Multivariable Calculus	4	H	H
II	MATH 122	Analytical Geometry of three Dimensions and Trigonometry	4	H	S
III	MATH 231	Elements of Discrete Mathematics	4	H	H
III	MATH 233	Elementary Number Theory.	4	H	S
IV	MATH 241	Introduction to Real Analysis – I	4	H	H
IV	MATH 242	Abstract Algebra	4	H	S
IV	MATH 243	Elements of Differential Equations	4	H	H
V	MATH 351	Introduction to Real Analysis - II	4	H	S
V	MATH 352	A First Course in Linear Algebra	4	H	S
V	MATH 353	Numerical Methods	4	H	S
VI	MATH 361	Introduction to Graph Theory	4	H	S
VI	MATH 362	Elements of Mechanics	4	S	S
VI	MATH 363	Fundamentals of Complex Analysis	4	H	S
VI	MATH 364	Linear Programming	4	H	S

4th and 5th year Syllabi same as that of M.Sc. Mathematics I & II Year

Courses offered by the Department of Mathematics for the

Integrated M.Sc. Programme of School of Physical, Chemical and Applied Sciences
To come into effect from 2017-18-onwards

Course Code No.	Name of the Course	No. of Credits	Nature of Course
MATH-116	Calculus I	3	Hard Core
MATH-126	Calculus II	3	Hard Core
MATH-127	Analytical Geometry and Trigonometry	3	Soft Core
MATH-236	Calculus of several variables	3	Soft Core
MATH-246	Introduction to Differential Equations	3	Soft Core
MATH-356	Introduction to Linear Algebra	3	Soft Core
MATH-366	Introduction to Complex Analysis	3	Soft Core

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 111: DIFFERENTIAL CALCULUS
(4 Credits)

Unit -I
Derivative of a function- Differentiation rules- Rate of change- Derivatives of trigonometric functions- Chain Rule- Implicit differentiation rational exponents Inverse functions and their derivatives- Hyperbolic function.

Unit -II
Application of Derivatives - Increasing decreasing functions - Maxima minima-Error – Approximation- Optimization-Newton method- Mean value theorems- Taylor theorem- Maclaurins theorem.

Unit- III
Asymptotes- Test of concavity& convexity point of inflexion- Multiple point training curves in Cartesian & Polar co-ordinates.

Unit -IV
Successive differentiation- Leibnitz rule- Problems and examples.

Unit -V
Exponent function a^x, log—functions- Theorems on exponent & Log functions- Partial differentiation- Chain rule- Eulers theorem.

Text Book
   1. George B.Thomas, Maurice D.Weir and Joel Hass, Thomas' Calculus 12th Edition, Pearson Education, 2015.

Reference Books

1) Richard Courant and Fritz John, Introduction to Calculus and Analysis, Vol.I, Springer 1999.

2) Serge Lang A First course in Calculus 5th edition, Springer, 1999.

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 112: INTEGRAL CALCULUS
(4 Credits)

Unit -I
Integrals-Indefinite integrals-Standard forms- Differential equations - Initial value problems - Integration by substitution- Estimating with finite sums.

Unit -II
Definite integrals - Properties of definite integrals - Integral as the limits of a sum- Evaluation of integrals- Area and the mean value theorem-The fundamental theorem- Substitution in definite integrals.

Unit- III
Integration by parts (theorem and examples) – Integration of rational fractions – Irrational fractions-Trigonometric substitutions.

Unit -IV
Reduction formulae for $\sin^n x$, $\cos^n x$, $\tan^n x$, $\cot^n x$, $\sec^n x$, $\csc^n x$, $\cos^m x \cos nx$, $\cos^m x \sin nx$, $\sin^m x \sin nx$, $\sin^m x \cos nx$.

Unit -V
Areas between curves- Finding volume by slicing- Volumes of solids of revolution - Disk and washers- Cylindrical shell- Lengths of plane curves- Areas of surface of revolution.

Text Book

George B.Thomas, Jr. and Ross L. Finney, Calculus, 9th Edition, Pearson Education, 2006.
Unit-I: Sections 4.1-4.4
Unit-II: Sections 4.5-4.8
Unit-III: Sections 7.1-7.4
Unit-IV: Sections 7.5
Unit-V: Sections 5.1-5.6.

Reference Books

1. N. P. Bali, Integral Calculus, Laxmi Publications, Delhi 1991.
2. Richard Courant and Fritz John, Introduction to Calculus and Analysis, Volumes I & II Springer, SIE, 2004.
3. Serge Lang A First course in Calculus 5th edition, Springer, 1999.

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 121: MULTIVARIABLE CALCULUS
(4 Credits)

Unit - I: Differentiation

Graphs and level curves – Limits and continuity – Partial derivatives – Differentiability – The chain rule – Gradients and directional derivatives.

Unit - II: Higher Derivatives and Extrema

Higher order partial derivatives – Taylor's theorem – Maxima and minima – Second derivative test – Constrained extrema and lagrange multipliers.

Unit - III: Multiple Integral

Double integrals – Triple integrals – Change of variables – Cylindrical and Spherical coordinates.

Unit -IV: Integrals over curves and surfaces

Line integrals – Parametrized surfaces – Area of a surface – Surface integral.

Unit - V: The Integral Theorems of Vector Analysis

Green's theorem – Stokes's theorem - Gauss divergence theorem.

Text Book

J.E. Marsden, Trome and A. Weinstein, Basic Multivariable Calculus, Springer- Verlag, 2009.
Unit-I: Sections 2.1-2.5
Unit-II: Sections 3.1-3.5
Unit-III: Sections 5.2-5.5
Unit-IV: Sections 6.1-6.4
Unit-V: Sections 7.1-7.3.

Reference Books

1. George B.Thomas, Jr. and Ross L. Finney, Calculus, 9th Edition, Pearson Education, 2006.
2. Richard Courant and Fritz John , Introduction to Calculus and Analysis, Volumes I & II, Springer, SIE, 2004

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 122: ANALYTICAL GEOMETRY OF THREE DIMENSIONS AND
TRIGONOMETRY
(4 Credits)

Unit -I
Preliminaries: Rectangular coordinates- Distance between two points- Division of a line joining two points in a given ratio - Angle between two lines- Direction cosines and ratios of a straight line- Condition for parallelism and perpendicularity of two lines- Projection of a line segment on another line.

The plane- The general equation of the first degree in three variables always represents a plane surface-Direction cosines of the normal to a plane- Equation of a plane in intercept form- The form $lx + my + nz = p$- Angle between two planes- Pair of planes- Image of a point in a plane- Length of perpendicular from a point to a plane

Unit- II
The equation to a straight line- Symmetrical form- Parametric coordinates of any point on a line- Transformation from un- Symmetrical form to the symmetric form- Condition for a line to be parallel to a plane- Angle between a line and a plane- Coplanar lines intersecting two lines –Skew lines – Shortest distance between two lines

Unit- III
The sphere- The equation of a sphere with given centre and radius- The equation of a sphere on the line joining two given points as diameter- Plane section of a sphere- Equation of a sphere passing through a given circle- The intersection of two spheres- The equation of a tangent plane to a sphere- Length of tangent to a sphere- Orthogonal spheres.

Unit- IV
De Moivre's theorem- Expansions of $\cos n\theta$, $\sin n\theta$ and $\tan n\theta$ - Powers of sines and cosines of θ in terms of functions of multiples of θ. Expansions of $\sin \theta$, $\cos \theta$ in a series of ascending powers of θ – Limits and approximations.

Unit -V
Hyperbolic functions- Inverse hyperbolic functions- Separation into real and imaginary parts.

Text Books
1. T. K. Manickavachagom Pillai and T. Natarajan, A Text Book of Analytical Geometry (Part-II- Three dimensions), S. Viswanathan Printers & Publishers, 2008.
   Unit I: 1.1 to 1.12 and 2.1 to 2.10
   Unit II: 3.1 to 3.8
   Unit III: 4.1 to 4.8
2. S. Narayanan, Trigonometry, S. Viswanathan Publishers, 1995.
   Unit IV: 3.1 to 3.5
   Unit V: 4.1 to 4.2.

Reference Book
1. P.Duraipandian, Analytical Geometry of Three Dimensions, Emarald Publishers 1998.

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5 Year Integrated M.Sc. Program
HARD CORE COURSE
MATH : 231 ELEMENTS OF DISCRETE MATHEMATICS
(4 Credits)

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Unit -I:
Sets – Operations on sets – Binary relations – Equivalence relations – Partial orders – Functions - Inverses and composition – One-to-one correspondence and the cardinality of a set – The principle of inclusion- Exclusion – The addition and multiplication rules.

Unit -II:
Mathematical induction – Recursively defined sequences – Solving recurrence relations-The characteristic polynomials - Solving recurrence relations- Generating functions.

Unit -III:
The pigeonhole principle – Permutations – Combinations –Repetitions – Derangements – The binomial theorem.

Unit -IV:
Catalan numbers – Difference sequences - stirling numbers of the first kind and second kind.

Unit -V:
Partition of numbers – Ferrers diagram – A geometric application – Lattice Paths – Schroder numbers.

Text Books
1. Edgar G. Goodaire, Michael M. Parmentier , Discrete Mathematics with Graph Theory (Third Edition), PHI Learning Private Ltd., New Delhi – 2011.Unit 2, 3, 5, 6, 7.
   Unit I: 2.1 to 2.5, 3.1 to 3.3, 6.1 to 6.2
   Unit II: 5.1 to 5.4
   Unit III: 6.3, 7.1 to 7.3, 7.5 to 7.7
2. Richard A. Brualdi, Introductory Combinatorics, (Fourth Edition), Pearson Education 2004.
   Unit IV: 8.1,8.2
   Unit V: 8.3 to 8.5.

Reference Books
1. Richard Johnsonbauth, Discrete Mathematics – 5th Edition,–, Pearson Education Asia, New Delhi, 2002.
2. Ralph. R. Grimaldi - Discrete and Combinatorial Mathematics: An applied Introduction – 4th Edition, Pearson Education Asia, Delhi, 2002
3. C.L. Lie, Elements of Discrete Mathematics — the Mc Graw-Hill, Inc. India 1985.
4. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, Discrete Mathematical Structure, 4th Edition print Pearson Education Pvt. Ltd., New Delhi 2003.

5 Year Integrated M.Sc. Programme
HARD CORE COURSE
MATH- 233 Elementary Number Theory
(4 Credits)

Unit -I
The division algorithm - The greatest common divisor-Euclid's algorithm- The Diophantine equation $ax + by = c$ - The fundamental theorem of arithmetic: Euclid's lemma, canonical prime factorization.

Unit -II
Definitions and basic properties- residue classes- complete residue systems- reduced residue systems- Linear congruences in one variable - Simultaneous linear congruences- Chinese Remainder Theorem Wilson's Theorem Fermat's Theorem.

Unit- III
Arithmetic function- multiplicative functions: definitions and basic examples-The Moebius function- Mobius inversion formula-The Euler phi function- Carmichael conjecture-The number-of-divisors and sum-of-divisors functions -Perfect numbers- characterization of even perfect numbers .

Unit- IV
Quadratic residues and non residues- The Legendre symbol: Definition and basic properties-Euler's criterion- Gauss' Lemma The law of quadratic reciprocity The order of an integer primitive roots: Definition and properties- The primitive root theorem- Characterization of integers for which a primitive root exists.
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Unit -V
Sums of squares, Pythagorean triples, Continued fractions.

Text Book

1. Burton David. M, Elementary Number Theory, 6th Edition, McGraw Hill Education, 2007.
   Unit I : Sections: 2.1 to 2.5 and 3.1 to 3.3
   Unit II : Sections: 4.1 to 4.4 and 5.1 to 5.3
   Unit III: Sections:6.1 to 6.3 and 7.1 to 7.4
   Unit IV: Sections 8.1 to 8.3 and 9.1 to 9.4
   Unit V: Sections: 12.1, 13.1, 13.2, 15.1,15.2 and 15.3

Reference Books

1. Niven Ivan, Herbert S. Zuckerman, and Hugh L. Montgomery, An Introduction to the Theory of Numbers, Wiley, 1991.
2. G.A. Jones and J.M Jones, Elementary Number Theory, Springer, 1998..

5 Year Integrated M.Sc. Program
HARD CORE COURSE
MATH-241: INTRODUCTION TO REAL ANALYSIS – I
(4 Credits)

Unit- I
Definition of sequence and subsequence-Limit of a sequence - Convergent sequence - Boundedence - Monotone sequence - Operation on convergent sequence - Cauchy sequence.

Unit - II
Convergence and divergence - Series with non-negative terms -- Alternating series - Conditional convergence and absolute convergence. Test of absolute convergence -Series whose terms form a non-increasing sequence - Summation by Parts.

Unit -III
Limit of a function on the real line -Functions continuous at a point on the real line - Reformulation - Metric spaces – Functions continuous at a point on the real line – Re formulation – Discontinuous functions on R^1

Unit –IV
Derivatives – Rolle's theorem – The law of mean - Taylor's theorem - Binomioal theorem - L'Hospital's rule.

Unit -V
Hyperbolic functions – The exponential function – The logarithmic function – The trigonometric functions - Pointwise convergence of of sequence of functions – Uniform convergence of sequence of functions.

Text book
Richard R Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi, Indian Edition 1970.
Unit I: Sec 2.1 - 2.10
Unit II: Sec 3.1 - 3.8
Unit III: Sec 4.1, 5.1, 5.2 ,5.6
Unit IV: Sec 7.5- 7.8, 8.5-8.7
Unit V: Sec 8.1 – 8.4, 9.1, 9.2

Reference Books

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, Third Edtion, Wiley India edition ,2000.

2. S. Kumeresan, Topology of Metric spaces, Second edition, Narosa Publishing house, 2005.

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 242: ABSTRACT ALGEBRA
(4 Credits)

Unit- I
Definition of a group-Some examples of groups- Some preliminary lemmas -Subgroups

Unit- II
A Counting principle- Normal subgroups and quotient groups- Homomorphism.

Unit -III
Automorphism – Cayley's theorem- Permutation groups

Unit -IV
Definition and examples of a rings- Some special classes of rings - Homomorphism-Ideals and Quotients rings-More ideals and quotients rings

Unit -V
The Field of quotients of an integral domain- Euclidean rings- A particular Euclidean ring

Text Book

I.N. Herstein, Topics in Algebra, 2nd Edition, John Wiley & Sons, 2003.
Unit-I: Sections 2.1-2.4;
Unit-II: Sections 2.5-2.7;
Unit-III: Sections 2.8-2.10;
Unit-IV: Sections 3.1-3.5;
Unit-V: Sections 3.6-3.8

Reference Books:

1. Neal H. Mc Coy and Gerald J. Janusz, Introduction to Abstract Algebra, Elsevier, 6th Edition, 2005.
2. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa publications, 1998.
3. John B. Fraleigh, A first course in Abstract Algebra, 7th Edition, Pearson publications, 2012.

5 Year Integrated M.Sc. Program
HARD CORE COURSE
MATH 243: ELEMENTS OF DIFFERENTIAL EQUATIONS
(4 Credits)

Unit - I
Exact differential equations- Integrating factors – Linear differential equations- Bernoulli equation – Modeling : Electric circuits – Orthogonal trajectories of curves.

Unit -II
Homogeneous linear equations of second order – Second order homogeneous equations with constant coefficients – Case of complex roots- Complex exponential function – Differential operators – Modeling : Free oscillations – Euler-cauchy equation – Existence and uniqueness theory – Wronskian.

Unit -III
Non homogeneous equations – Solution by undetermined coefficients – Solution by variation of parameters – Modeling of electric circuits – Higher order linear differential equations – Higher order homogeneous equations with constant coefficients.

Unit - IV
Introduction: vectors, matrices, eigenvalues – Introductory examples – Basic concepts and theory – Homogeneous systems with constant coefficients, phase plane, critical points – Criteria for critical points, Stability.

Unit- V
Laplace transform- Inverse transform, linearity- Shifting – Transforms of derivatives and integrals- Differential equations – Unit step function- Second shifting theorem- Dirac's delta function – Convolution- Integral equations – Partial fractions- Differential equations – Systems of differential equations.

Text Book
Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, 1999.
Unit-I: Sections 1.5-1.8;
Unit-II: Sections 2.1-2.7;
Unit-III: Sections 2.8-2.10, 2.13, 2.14;
Unit-IV: Sections 3.0-3.4;
Unit-V: Sections 5.1-5.7

Reference Books
1. George F. Simmons, Differential Equations, Tata McGraw-Hill, New Delhi, 1972.
2. Boyce and Di Prima, Differential Equations and Boundary Value Problems, Wiley,10th edition 2012.
3. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India Private Ltd, 1991.

5 Year Integrated M.Sc. Program
HARD CORE COURSE
MATH- 351 Introduction to Real Analysis- II
(4 Credits)

Unit -I: Metric Spaces – Definition – Examples – Holder inequality – Minkowski ionequality – Convergent sequence – Cauchy sequence – Equivalent metric spaces – Continuous functions on a Metric space – open sets – closed sets – limit points.

Unit -II: Oscillation of a function – F_σ set, G_δ set – Dense and nowhere dense subsets –Baire's category Theorem – Subspaces – Connected sets – connected subsets of R – Continuity and connectedness – Homeomorphism.

Unit -III: Bounded sets – Totally bound sets – Complete metric spaces – Cantor intersection theorem – Contraction mapping theorem – Compactness – Sequential compactness – Hein-Borel property – Finite intersection property- Continuity and compactness – Continuity of inverse functions – Uniform continuity.

Unit –IV: Riemann integration - Definition of Riemann integration – Existence of Riemann integration- Properties of Riemann integration – Fundamental theorem of calculus.

Unit -V: Improper Integrals (First and second kind)- Absolute convergence- Conditionally convergence – integral test – Cauchy principal value.

Text Book

R.R. Goldberg, Methods of Real Analysis, Oxford and IBH publishing co. pvt. Ltd., 1970.

Unit I: 4.2, 4.3,5.3 to 5.5
Unit II: 5.6, 6.1,6.2
Unit III: 6.3 to 6.8
Unit IV: 7.2, 7.3, 7.4, 7.8
Unit V: 7.9, 7.10.

Reference Books

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, Third Edtion, Wiley India edition 2000.
2. S. Kumeresan, Topology of Metric spaces, Second edition, Narosa Publishing house, 2005.
3. Pawan K. Jain and Khalil Ahmad, Metric Spaces, (Second Edition), Narosa Publishing House 2004.
4. Kenneth A. Ross, Elementary Analysis, The Theory of Calculus, Springer-Verlag,1980

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH: 352   A FIRST COURSE IN LINEAR ALGEBRA
(4 Credits)

Unit – I
Abstract Algebra Concepts – Groups- Subgroups- Fields- examplesVector space- Subspace-
linear combinations and systems of linear equations- Linear dependence and linear
independence- Basis and dimension.

Unit – II
Linear Transformations- Null spaces- Range spaces- Dimension theorem- Matrix representation
of linear transformation- composition of linear transformations and Matrix multiplication-
Invertability and Isomorphism- The change of coordinate matrix.

Unit – III
Elementary matrix Operations and elementary matrices- The rank of a matrix and matrix
inverses- systems of linear equations- Theory and computation

Unit – IV
Determinants of order 2 and order n- propertie4s of determinants- Important facts about
determinants- Eigen values and Eigen vectors- Diagonalizability- Invariant spaces and Cayley-
Hamilton theorem.

Unit – V
Inner products and norms- The Gram-Schmidt orthogonalisation process and orthogonal
complements.

Text Book
Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, 4th Edition,
Printice Hall of India Pvt. Ltd., 2006
Unit I: 1.2 to 1.6
Unit II: 2.1 to 2.5
Unit III: 3.1 to 3.4
Unit IV: 4.1 to 4.4 and 5.1 to 5.2, 5.4
Unit V: 6.1, 6.2

Reference Books
1. S. Kumaresan, Linear Algebra Geometric Approach, Prentice Hall of India Pvt. Ltd., 2000.
2. I. N. Herstein, Topics in Algebra, 2nd Edition, John Wiley & Sons, 2003.
3. David C.Lay, Linear Algebra and Applications(2nd Edition), Addison Wesley, 1997.
4. John B.Fraleigh, A First Course in Abstract algebra, (7th Edition),Pearson 2013.

5 Year Integrated M.Sc. Program
HARD CORE COURSE
Math-353: Numerical Methods
(4 Credits)

Unit- I:

Introduction: Errors in numerical calculations – Mathematical preliminaries – Solution of

Algebraic and Transcendental equations- The Bisection method – The method of false position.

Unit- II:

Newton- Raphson method – Introduction – The Iteration method – Muller's method – Graffes'

root squaring method.

Unit- III:

 Interpolation: Newton's Formulae for interpolation – Central difference interpolation formulae.

Unit- IV:

Numerical differentiation and integration: Numerical differentiation – Numerical integration

Unit -V:

 Matrices and Linear systems of equations: Solution of Linear systems – Iterative methods – The

Eigen value problem.

Text Book

S. S. Sastry, Introductory Methods of Numerical Analysis (Fifth Edition), EEE,2012

Unit – I : Section 1.1 to 1.5 & 2.1 to 2.3

Unit – II : 2.4 to 2.9

Unit – III: 3.1 – 3.7, 5.1 & 5.2

Unit – IV: 6.1 to 6.8

Unit – V:7.1 to 7.7

Reference Books

1. F. B. Hildebrand , Introduction to Numerical Analysis, MC GRaw-Hill,1936.

2. M.K.Jain, S.R.K Iyengar, R.K.Jain, Numerical Mehods for Scientific and Engineering
   Computation, New age International publishers,6th Edition,2007.

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH -361: INTRODUCTION TO GRAPH THEORY
(4 Credits)

Unit – I:
Graphs and their varieties – complete and complement of graphs – Graph isomorphism – Self complementary graphs – Incidence and adjacency matrices – Sub graphs – Vertex degrees – Walks – Paths – Cycles – Connectedness and components.

Unit – II:
Bipartite graphs and their characterization theorem - Trees– Cut edges and cut vertices – Spanning trees – Cayley formula.

Unit –III:
Connectivity parameters and their related theorem – k connected and k edge connected graphs – Block and blocks of graph – Whitney theorem of 2 – connectivity.

Units – IV:
Konigsberg bridge problem - Euler tours and eularian graphs – Characterization theorems on eulerian graphs – Chinese Postman problem – Fleury algorithm.

Unit – V:
Hamilton game on dodecahedron - Hamilton paths and cycles – Hamiltonian graphs – Dirac theorem – The necessary or sufficient conditions for a graph to be Hamiltonian Closure of graph and related theorems – The travelling salesman problem

Text Books
1. Bondy, J.A and Murthy, U.S.R, Graph Theory with Applications, Macmillan Press Ltd, New Delhi – (1976) - Relevant partitions from Units 1 to 4.
2. Harary F. Graph Theory, Addison – Wesley(1969) – Relevant portions from Unit 7.

Reference Books

1. S.A. Choudum, A First Course in Graph Theory, Macmillan India Ltd, New Delhi (2007).
2. S. Arumugam and S. Ramachandran, Invitation to Graph Theory, Scitech Publishers Pvt Ltd., India (2001).
3. R. J. Wilson, Introduction to Graph Theory, Oliver and Boyd, Edinburgh (1972).
4. G. Chartrand and P Zhang, Introduction to Graph Theory, Tata Mc Graw - Hill Publishing Company Ltd., New Delhi – (2005).

5 Year Integrated M.Sc. Program
SOFT CORE COURSE
MATH 362: ELEMENTS OF MECHANICS
(4 Credits)

Unit – I
Introduction to Statics: Body - Space - Vectors and Scalars - Scalar Product or Dot Product - Vector Product or Cross Product - Force - Force System - Resultant of Force System and Equilibrium - Equilibrium of Coplanar, Concurrent Force System - Moment of a Force about a Point - Moment of Couple - Problems - Equilibrium of Forces - Lami's Theorem - Theorem of Varignon - Equivalence of Force and Force-couple System - Equations of Equilibrium - Problems

Unit – II
Properties of Lines, Surfaces, and Physical Bodies: Centroid and Centre of Gravity - Analytical Expression of Centroid , Centre of Mass and Centre of Gravity – Pappus -Guldinus Theorem - Second Moment of Area Perpendicular and parallel Axis Theorem - Mass Moment of Inertia - Parallel Axis Theorem for Mass Moment of Inertia -Mass Moment of Inertia of Thin Plate.

Unit- III
Kinematics of Particle: Kinematics and Kinetics - Displacement, Velocity, and Acceleration in Linear Motion - Kinematic Equations of Motion with Constant Acceleration - Relative Linear Motion - Displacement, Velocity, and Acceleration in Curvilinear Motion - Velocity and Acceleration in Reference System - Analysis of Projectile Motion

Unit -IV
Kinematics of Rigid Bodies: Properties of Rigid Body Motion - Governing Kinematic Equations of Rigid Body Motion - Fixed Axis Rotation of Rigid Body - Contact of Two Rotating Rigid Bodies - Contact of Rotating Rigid Body with Translating Rigid Body -Instantaneous Centre of Rotation

Unit -V
Principle of Work, Power, and Energy: Work Done and its Variety - Potential Energy - Conservative Force and Potential Energy - Work-energy Principle for Particle - Work Done for Rigid Body - Kinetic Energy of Rigid Body - Work-energy Principle for Rigid Body - Principle of Conservation of Energy - Power

Text Book

Engineering Mechanics –Basudeb Bhattacharyya – Oxford University Press 2008

Unit I – Chapter 1 & 2;   Unit II – Chapter 5   ;   Unit III – Chapter 7;

Unit IV – Chapter 8   Unit V – Chapter 9

Reference Books

1. Mechanics -P. Duraipandian S. Chand Limited, 1995

2. Classical Mechanics : Goldstein ,Pearson Education India 2002

3. Classical Mechanics :Rana & Joag, Rana,Tata McGraw-Hill Education, 2001

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 363: FUNDAMENTALS OF COMPLEX ANALYSIS
(4 Credits)

Unit I
Complex conjugates Exponential form, Products and powers in Exponential form, Arguments of Products and Quotients, Roots of Complex numbers, Regions in the Complex plane, Functions of a complex variable Mappings, Mappings by the exponential function, Limits, Theorems on Limits, Limits involving point at infinity, Continuity, Derivatives, Differentiation Formulas, Cauchy-Riemann Equations, Sufficient conditions for Differentiability, Polar Coordinates.

Unit II
Analytic functions, Examples, Harmonic functions, Uniquely determined Analytic functions, The Exponential functions, The Logarithmic Function, Branches and derivatives of Logarithms, Some Identities involving Logarithm, Complex Exponents, Trigonometric Functions, Hyperbolic Functions.

Unit III
Derivatives of functions s(t), Definite Integrals, Some Examples, Upper bounds for Moduli, Anti derivatives, Cauchy Theorem only with not Proof, Multiply Connected Domains, Cauchy Integral Formula, An Extension of the Cauchy Integral Formula, Some Consequences of the Extension, Liouville's Theorm and The Fundamental Theorem of Algebra, Maximum Modulus Principle.

Unit IV
Taylor's Series, Proof of Taylor's Theorem, Examples, Laurent Series, Proof of Laurent's Theorem, Examples.

Unit V
Isolated Singular Points, Residues, Cauchy's Residue Theorem, Residue at Infinity, The Three Types of Isolated Singular Points, Residues at Poles, Examples, Zeros of Analytic Functions, Zeros and Poles, Behavior of Functions Near Isolated Singular Points.

Text Book:

James Ward Brown and Ruel V. Churchill. Complex Variables and Applications,. Tata McGraw - Hill Education., 8th Edition, 2009.

Reference Books :

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2011
2. H.A. Priestley, Introduction to Complex Analysis, Second Edition, Oxford University Press, 2003
3. John B. Conway, Functions of One Complex Variable, Springer, ISE, 1973
4. Serge Lang, Complex Analysis, Springer Publishing Company, 4th Edition, 2009.
5. S. Ponnusamy, Foundations of Complex analysis, (2nd Edition), Narosa, 2011.
6. V.Karunakaran, Complex Analysis, (2nd Edition), Narosa 2005.

5 Year Integrated M.Sc. Program
HARD CORE: MATH 364: LINEAR PROGRAMMING   (4 Credits)

Unit – I : Modelling with Linear Programming
Two-Variable Linear Programming Model, Graphical LP Solution – Solution of a Maximization Model, Solution of a Minimization Model .   Linear Programming Applications – Urban Planning,   Investment, Production Planning and Inventory Control, Man Power Planning (Chapter 2 of [1])

Unit – II :   Simplex Method
LP model in Equation Form – Converting Inequalities into Equations with Nonnegative Right-hand side,   Dealing with Unrestricted variables.   Transition from Graphical to Algebraic Solution,   Interative Nature of Simplex method, Computational Details of Simplex Method. Artificial Starting Solution - M-Method, Two-Phase Method.   Special Cases – Degeneracy, Alternative Optima, Unbounded Solution, Infeasible Solution   Chapter 3 of [1] up to 3.5)

Unit – III : Duality and Post Optimality Analysis
Definition of Dual Problem – Primal – Dual Relationships, Simplex Tableau Layout , Optimal Dual Solution, Simplex Tableau Computations. Economic Interpretations of Dual Variables and Dual Constraints .   Additional Simplex Algorithms – Dual Simplex Method, Generalised Simplex Algorithm.   Post Optimality Analysis – Changes affecting feasibility and Optimality (Chapter 4 of [1])

Unit – IV: Advanced Linear Programming
Simplex Methods Fundamentals – From Extreme Points to Basic Solutions,   Generalised Simplex Tableau in Matrix Form.   Revised Simplex Method – Development of Optimality and Feasibility Conditions, Revised Simplex Algorithm.   Duality – Matrix Definition of the Dual Problem, Optimal Dual Problem.   Parametric Linear Programming   (Chapter 7 of [1])

Unit – V: Integer Linear Programming
Capital Budgeting,   Set-Covering Problem, Fixed-Charge Problem, Either-Or and If-Then Constraints.   Integer Programming Algorithm, Branch-and-Bound Algorithm, Cutting Plane Algorithm, Computational Considerations of Integer Linear Programming   (Chapter 9 of [1])

Text Book:
1. Hamdy   A   Taha   – Operations Research : An Introduction, 8th Edition, Pearson Prentice Hall, 2007.

Reference Books:
   1. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research* (9th Edition), Tata McGraw Hill, Singapore, 2009.

   2. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

Courses offered by the Department of Mathematics for the

Integrated M.Sc. Programme of School of Physical, Chemical and Applied Sciences
To come into effect from 2017-18-onwards

Course Code No.	Name of the Course	No. of Credits	Nature of Course
MATH-116	Calculus I	3	Hard Core
MATH-126	Calculus II	3	Hard Core
MATH-127	Analytical Geometry and Trigonometry	3	Soft Core
MATH-236	Calculus of several variables	3	Soft Core
MATH-246	Introduction to Differential Equations	3	Soft Core
MATH-356	Introduction to Linear Algebra	3	Soft Core
MATH-366	Introduction to Complex Analysis	3	Soft Core

5 Year Integrated M.Sc. Program (SPCAS)

HARD CORE COURSE
MATH 116: CALCULUS – I
(3 Credits)

Unit -I
Derivative of a function- Differentiation rules- Rate of change- Derivatives of trigonometric functions- Chain Rule- Implicit differentiation rational exponents Inverse functions and their derivatives- Hyperbolic function.

Unit -II
Application of Derivatives- Increasing decreasing functions - Maxima minima-Error – Approximation- Optimization-Newton method- Mean value theorems- Taylor theorem- Maclaurins theorem.

Unit- III
Asymptotes- Test of concavity& convexity point of inflexion- Multiple point training curves in cartiean & Polar co-ordinates.

Unit -IV
Successive differentiation- Leibnitz rule- Problems and examples.

Unit -V
Exponent function a^x , log—functions- Theorems on exponent & Log functions- Partial differentiation- Chain rule- Eulers theorem.

Text Book
1. George B.Thomas, Maurice D.Weir and Joel Hass, Thomas' Calculus 12th Edition, Pearson Education, 2015.

Reference Books

1) Richard Courant and Fritz John, Introduction to Calculus and Analysis, Vol.I, Springer 1999.

2) Serge Lang A First course in Calculus 5th edition, Springer, 1999.

HARD CORE COURSE
MATH 126: CALCULUS - II
(3 Credits)

Unit -I
Integrals- Indefinite integrals- Standard forms- Differential equations - Initial value problems - Integration by substitution- Estimating with finite sums.

Unit -II
Definite integrals - Properties of definite integrals - Integral as the limits of a sum- Evaluation of integrals- Area and the mean value theorem-The fundamental theorem- Substitution in definite integrals.

Unit- III
Integration by parts (theorem and examples) – Integration of rational fractions – Irrational fractions-Trigonometric substitutions.

Unit -IV
Reduction formulae for $\sin^n x$, $\cos^n x$, $\tan^n x$, $\cot^n x$, $\sec^n x$, $\mathrm{cosec}^n x$, $\cos^m x \cos nx$, $\cos^m x \sin nx$, $\sin^m x \sin nx$, $\sin^m x \cos nx$.

Unit -V
Areas between curves- Finding volume by slicing- Volumes of solids of revolution - Disk and washers- Cylindrical shell- Lengths of plane curves- Areas of surface of revolution.

Text Book

George B.Thomas, Jr. and Ross L. Finney, Calculus, 9th Edition, Pearson Education, 2006.
Unit-I: Sections 4.1-4.4;
Unit-II: Sections 4.5-4.8;
Unit-III: Sections 7.1-7.4;
Unit-IV: Sections 7.5;
Unit-V: Sections 5.1-5.6.

Reference Books

1. N. P. Bali, Integral Calculus, Laxmi Publications, Delhi 1991.
2. Richard Courant and Fritz John, Introduction to Calculus and Analysis, Volumes I & II Springer, SIE, 2004.

5 Year Integrated M.Sc. Program (SPCAS)

SOFT CORE COURSE
MATH 127: ANALYTICAL GEOMETRY AND TRIGONOMETRY
(3 Credits)

Unit -I
Preliminaries: Rectangular coordinates- Distance between two points- Division of a line joining two points in a given ratio - Angle between two lines- Direction cosines and ratios of a straight line- Condition for parallelism and perpendicularity of two lines- Projection of a line segment on another line.
The plane- The general equation of the first degree in three variables always represents a plane surface-Direction cosines of the normal to a plane- Equation of a plane in intercept form- The form $lx + my + nz = p$- Angle between two planes- Pair of planes- Image of a point in a plane- Length of perpendicular from a point to a plane

Unit- II
The equation to a straight line- Symmetrical form- Parametric coordinates of any point on a line- Transformation from un- Symmetrical form to the symmetric form- Condition for a line to be parallel to a plane- Angle between a line and a plane- Coplanar lines intersecting two lines –Skew lines – Shortest distance between two lines

Unit- III
The sphere- The equation of a sphere with given centre and radius- The equation of a sphere on the line joining two given points as diameter- Plane section of a sphere- Equation of a sphere passing through a given circle- The intersection of two spheres- The equation of a tangent plane to a sphere- Length of tangent to a sphere- Orthogonal spheres.

Unit- IV
De Moivre's theorem- Expansions of $\cos n\theta$, $\sin n\theta$ and $\tan n\theta$ - Powers of sines and cosines of θ in terms of functions of multiples of θ. Expansions of $\sin \theta$, $\cos \theta$ in a series of ascending powers of θ – Limits and approximations.

Unit -V
Hyperbolic functions- Inverse hyperbolic functions- Separation into real and imaginary parts.

Text Books
1. T. K. Manickavachagom Pillai and T. Natarajan, A Text Book of Analytical Geometry (Part-II- Three dimensions), S. Viswanathan Printers & Publishers, 2008.
2. S. Narayanan, Trigonometry, S. Viswanathan Publishers, 1995.

Reference Book
1. P.Duraipandian, Analytical Geometry of Three Dimensions, Emarald Publishers 1998

SOFT CORE COURSE
MATH 236: CALCULUS OF SEVERAL VARIABLES
(3 Credits)

Unit - I: Differentiation

Graphs and level curves – Limits and continuity – Partial derivatives – Differentiability – The chain rule – Gradients and directional derivatives.

Unit - II: Higher Derivatives and Extrema

Higher order partial derivatives – Taylor's theorem – Maxima and minima – Second derivative test – Constrained extrema and lagrange multipliers.

Unit - III: Multiple Integral

Double integrals – Triple integrals – Change of variables – Cylindrical and Spherical coordinates.

Unit -IV: Integrals over curves and surfaces

Line integrals – Parametrized surfaces – Area of a surface – Surface integral.

Unit - V: The Integral Theorems of Vector Analysis

Green's theorem – Stokes's theorem - Gauss divergence theorem.

Text Book

J.E. Marsden, Trome and A. Weinstein, Basic Multivariable Calculus, Springer- Verlag, 2009.
Unit-I: Sections 2.1-2.5;
Unit-II: Sections 3.1-3.5;
Unit-III: Sections 5.2-5.5;
Unit-IV: Sections 6.1-6.4;
Unit-V: Sections 7.1-7.3.

Reference Books

1. George B.Thomas, Jr. and Ross L. Finney, Calculus, 9th Edition, Pearson Education, 2006.
2. Richard Courant and Fritz John , Introduction to Calculus and Analysis, Volumes I & II, Springer, SIE, 2004.

5 Year Integrated M.Sc. Program (SPCAS)

SOFT CORE COURSE
MATH 246: INTRODUCTION TO DIFFERENTIAL EQUATIONS
(3 Credits)

Unit - I
Exact differential equations- Integrating factors – Linear differential equations- Bernoulli equation – Modeling : Electric circuits – Orthogonal trajectories of curves.

Unit -II
Homogeneous linear equations of second order – Second order homogeneous equations with constant coefficients – Case of complex roots- Complex exponential function – Differential operators – Modeling : Free oscillations – Euler-cauchy equation – Existence and uniqueness theory – Wronskian.

Unit -III
Non homogeneous equations – Solution by undetermined coefficients – Solution by variation of parameters – Modeling of electric circuits – Higher order linear differential equations – Higher order homogeneous equations with constant coefficients.

Unit - IV
Introduction: vectors, matrices, eigenvalues – Introductory examples – Basic concepts and theory – Homogeneous systems with constant coefficients, phase plane, critical points – Criteria for critical points, Stability.

Unit- V
Laplace transform- Inverse transform, linearity- Shifting – Transforms of derivatives and integrals- Differential equations – Unit step function- Second shifting theorem- Dirac's delta function – Convolution- Integral equations – Partial fractions- Differential equations – Systems of differential equations.

Text Book:
Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, 1999.
Unit-I: Sections 1.5-1.8
Unit-II: Sections 2.1-2.7
Unit-III: Sections 2.8-2.10, 2.13, 2.14
Unit-IV: Sections 3.0-3.4
Unit-V: Sections 5.1-5.7

Reference Books:
1. George F. Simmons, Differential Equations, Tata McGraw-Hill, New Delhi, 1972.
2. Boyce and Di Prima, Differential Equations and Boundary Value Problems, Wiley,10th edition 2012.
3. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India Private Ltd, 1991.

SOFT CORE COURSE
MATH 356 : INTRODUCTION TO LINEAR ALGEBRA
(3 Credits)

Unit – I
Abstract Algebra Concepts – Groups- Subgroups- Fields- examplesVector space- Subspace-linear combinations and systems of linear equations- Linear dependence and linear independence- Basis and dimension.

Unit – II
Linear Transformations- Null spaces- Range spaces- Dimension theorem- Matrix representation of linear transformation- composition of linear transformations and Matrix multiplication-Invertability and Isomorphism- The change of coordinate matrix.

Unit – III
Elementary matrix Operations and elementary matrices- The rank of a matrix and matrix inverses- systems of linear equations- Theory and computation

Unit – IV
Determinants of order 2 and order n- propertie4s of determinants- Important facts about determinants- Eigen values and Eigen vectors- Diagonalizability- Invariant spaces and Cayley-Hamilton theorem.

Unit – V
Inner products and norms- The Gram-Schmidt orthogonalisation process and orthogonal complements.

Text Book
Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, 4th Edition, Printice Hall of India Pvt. Ltd., 2006
Unit I: 1.2 to 1.6
Unit II: 2.1 to 2.5
Unit III: 3.1 to 3.4
Unit IV: 4.1 to 4.4 and 5.1 to 5.2, 5.4
Unit V: 6.1, 6.2

Reference Book
1. S. Kumaresan, Linear Algebra Geometric Approach, Prentice Hall of India Pvt. Ltd., 2000.
2. I. N. Herstin, Topics in Algebra, 2nd Edition, John Wiley & Sons, 2003.

5 Year Integrated M.Sc. Program (SPCAS)

SOFT CORE COURSE
MATH 366: INTRODUCTION TO COMPLEX ANALYSIS
(3 Credits)

Unit - I
Complex numbers- Complex plane - Polar form of complex numbers- Powers and roots – Derivative- Analytic function - Cauchy- Riemann equations. Laplace's equation - Geometry of Analytic Functions- Conformal mapping.

Unit - II
Exponential function - Trigonometric functions- Hyperbolic functions – Logarithm- General power - Linear fractional transformation.

Unit- III
Line integral in the complex plane - Cauchy's integral theorem - Cauchy's integral formula - Derivatives of analytic functions.

Unit - IV
Sequences- Series- Convergence tests - Power series - Functions given by power series - Taylor series and maclaurin Series

Unit -V
Laurent series - Singularities and zeros, Infinity - Residue integration method evaluation of real integrals.

Text Book

Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons,1998.
Unit-I: Sections 12.1-12.5;
Unit-II: Sections 12.6-12.9;
Unit-III: Sections 13.1-13.4;
Unit-IV: Sections 14.1-14.4;
Unit-V: Sections 15.1-15.4

Reference Books

1. L. Ahlfors, Complex Analysis, McGraw-Hill International Edition, 1979.
2. R.V. Churchill, Complex Variables and Applications, 4th Edition, Mc Graw –Hill, 1948.