APPENDIX-II

PONDICHERRY UNIVERSITY
DEPARTMENT OF MATHEMATICS

5-YEAR M.Sc. INTEGRATED PROGRAMMES

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

SYLLABI

WITH EFFECT FROM THE ACADEMIC YEAR

2011 - 2012

MATER OF SCIENCE
(5 YEAR INTEGRATED)
(CBCS)

Regulations

Eligibility for Admission

Candidates who have passed in +2 with minimum 50% marks and should have studied Mathematics as one of the main subjects. Those who studied only Business Mathematics are not eligible.

Medium

The medium of instruction shall be English

Integrated M.Sc. Programme of Ramanujan School of Mathematical Sciences
From 2011-2012 onwards

Course Code No.	Name of the Course	No. of Credits	Nature of Course
MATH-111	Differential Calculus	3	Hard Core
MATH-121	Integral Calculus	3	Hard Core
MATH-122	Analytical Geometry of Three Dimensions and Trigonometry	3	Hard Core
MATH-231	Multivariable Calculus	3	Hard Core
MATH-232	Elements of Discrete Mathematics	3	Hard Core
MATH-241	Introduction to Real Analysis	3	Hard Core
MATH-242	Abstract Algebra	3	Hard Core
MATH-351	Elements of Differential Equations	3	Hard Core
MATH-352	A First Course in Linear Algebra	3	Hard Core
MATH-361	Fundamentals of Complex Analysis	3	Hard Core
MATH-362	Elements of Mechanics	3	Hard Core
MATH-243	Foundations in Geometry	3	Soft Core
MATH-353	Theory of Equations and Numerical Methods	3	Soft Core

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

Courses offered by the Department of Mathematics for the

Integrated M.Sc. Program of School of Physical, Chemical and Applied Sciences
From 2011-2012 onwards

Course Code No.	Name of the Course	No. of Credits	Nature of Course
MATH-111	Differential Calculus	3	Hard Core
MATH-121	Integral Calculus	3	Hard Core
MATH-122	Analytical Geometry of Three Dimensions and Trigonometry	3	Soft Core
MATH-231	Multivariable Calculus	3	Soft Core
MATH-351	Elements of Differential Equations	3	Soft Core
MATH-352	A First Course in Linear Algebra	3	Soft Core
MATH-361	Fundamentals of Complex Analysis	3	Soft Core

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 111: DIFFERENTIAL CALCULUS
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, and Maclaurians theorem.

Unit- III
Asymptotes, test of concavity& convexity point of inflexion, Multiple point Training curves in cartiean & Polar co-ordinates.

Unit -IV
Successive differation. Leibritz 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, Jr. and Ross L. Finney, Calculus, 9th Edition, Pearson Education, **2006**

2) E.Kreyzgy, Advanced Engineering Mathematics, Wiley, 8th edition, Student edition **1999**

3) Serge Larg, A First course in Calculus, 5th edition Springer, **1999**

5 Year Integrated M.Sc. Program

MATH 121: INTEGRAL CALCULUS
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 $\sin^n x$, $\cos^n x$, $\tan^n x$, $\cot^n x$, $\sec^n x$, $\operatorname{cosec}^n x$, $\cos^m x \cos nx$, $\cos^m x \sin nx$, $\sin^m x \sin nx$, $\sin^m x \cos nx$.

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

HARD CORE COURSE
MATH 122: ANALYTICAL GEOMETRY OF THREE DIMENSIONS 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 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 Books

1. S.L. Loney, The Elements of Coordinate Geometry, Macmillan India, **2010**
2. R.J.T.Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, Macmillan India, **1918**
3 T.K.Manickavachagom Pillai, Analytical Geometry, S. Viswanathan Publishers, **1996**

5 Year Integrated M.Sc. Program

Semester – III
HARD CORE COURSE
MATH 231: MULTIVARIABLE CALCULUS
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, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer, **2009,** (Indian Edition).
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-232: ELEMENTS OF DISCRETE MATHEMTICS

Unit –I Preliminaries:
Relations, Functions, Integers Division algorithm, Euclidean Algorithm, Prim numbers, congruence, Application of congruence.

Unit-II Introduction and recursion:
Mathematical induction, Recursively defined sequence, solving recurrence relations, Characteristic polynomials, Generating functions.

Unit-III Principals of counting:
Inclusion, Addition and multiplication rule, Pigeon hole Principle.

Unit-IV Permutation and combination:
Permutation, combination, Repetition, Derangements, Binomial Theorem.

Unit-V Algorithm:
Complexity, Searching and sorting, Enumeration of permutation and combination.

Text Book:
Discrete mathematics with Graph Theory, Second edition, Edgar G. Goodaire and Michael M.Parmenter, Published by Pearson Education (SingaporeP Ptd) Ltd

Reference Book:

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. Program

MATH-241: INTRODUCTION TO REAL ANALYSIS
Hard Core

UNIT- I

Definition of sequence and subsequence-Limit of a sequence - Convergent sequence - Boundedence - Monotone sequence - Operation on convergent sequence - Limit superior and limit inferior - 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 -Metric Spaces – Functions continuous at a point. On the real line – Re formulation – Functions. Continuous on a metric space.

UNIT -IV

Functions continuous at a point on the real line - Reformulation - Functions continuous on a metric space - Open sets and closed sets - More about open sets - Connected sets.

UNIT –V

Open Sets – closed Sets – Discontinuous functions on R' – More about open sets – connected sets – Bounded sets – complete metric spaces.

Text Book

Richard R Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi, Indian Edition **1970**

UNit 1: Sec 2.1 - 2.10
Unit 2. Sec 3.1 - 3.8
Unit 3. Sce 4.1 - 4.3, 5.1 – 5.3
Unit 4. Sec 5.4 – 5.6, 6.1, 6.2, 6.3 (Bounded Set only), 6.4.
Unit 5. Sec 7.5 - 7.7, 8.1 - 8.7

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 242: ABSTRACT ALGEBRA
3 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 Book

I Neal H. Mc Coy and Gerald J. Janusz, Introduction to Abstract Algebra, Elsevier, 6th Edition, **2005**

5 Year Integrated M.Sc. Program
HARD CORE COURSE
MATH 351: ELEMENTS OF 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, Reprinted in, **2010**
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. D George F. Simmons, Differential Equations, Tata McGraw-Hill, New Delhi, **1972**
2. Boyce and Di Prima, Differential Equations and Boundary Value Problems, Wiley, 8th Edition, April, **2004,** ISBN-10-0471433381
3. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India Private Ltd, **1991**

5 Year Integrated M.Sc. Program

MATH: 352 (Hard Core) - A FIRST COURSE IN LINEAR ALGEBRA

UNIT – I
Abstract Algebra Concepts – Groups, Subgroups, Fields, examples

Vector 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, The ad joint of a linear operator, Normal and self-ad joint operators, Unitary and orthogonal operators and their matrices, Orthogonal and their projections, spectral theorems.

TEXT BOOK:

1) Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, 4TH Edition, Printice Hall of India Pvt. Ltd., **2006**
2) I. N. Herstin, Topics in Algebra, 2nd Edition, John Wiley & Sons, **2003**

Reference Book:

S. Kumaresan, Linear Algebra Geometric Approach, Prentice Hall of India PVT. LTD, **2000**

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 361: FUNDAMENTALS OF 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
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. Churchil, Complex Variables and Applications, 4th Edition, McGraw Hill Book Company, Inc **1948**
3. John B. Conway, Functions of One Complex Variable, Springer, ISE, **1973**

5 Year Integrated M.Sc. Program

HARD CORE COURSE
MATH 362: ELEMENTS OF MECHANICS

Unit -I
Newtonian Mechanics in Moving Coordinate Systems: Newton's Equation in a Rotating Coordinate System- Free Fall on the Rotating Earth-Foucault's Pendulum

Unit -II
Mechanics of Particle Systems: Degrees of Freedom- Center of gravity (Scattering theory excluded)

Unit -III
Mechanical Fundamental quantities of Systems of Mass Points-Linear and angular momentum-Energy law- Transformation to center of mass coordinates- Transformation of the kinetic energy-Vibrations of Coupled Mass Points- The vibrating chain- The Vibrating String-Solution of the wave equation- Normal vibration

Unit -IV
Mechanics of Rigid Bodies: Rotation About a Fixed Axis-Moment of inertia-The physical pendulum-Rotation About a Point-Tensor of inertia- Kinetic energy of a rotating rigid body-The principal axes of inertia-Existence and orthogonality of the principal axes-Transformation of the tensor of inertia-Tensor of inertia in the system of principal axes-Ellipsoid of inertia

Unit- V
Theory of the Top: Free top-Geometrical and analytical theory-The heavy symmetric top and application-The Euler angles-Motion of the heavy symmetric top

Text Book
Walter Greiner, Classical Mechanics: Systems of Particles and Hamiltonian Dynamics, Springer, ISE, **(2004)**
Unit I: Sections 1-3;
Unit II: Sections 4-5;
Unit III: Sections 6-8;
Unit IV: Sections 11-12;
Unit V: Section 13

Reference Books

1. H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, **1985**
2. K. Sankara Rao. Classical Mechanics, Prentice-Hall of India Private Ltd, New Delhi, **2005**
3. S.L. Loney, Dynamics of a Particle and of Rigid Bodies, Cambridge University Press, **1927**

5 Year Integrated M.Sc. Program

Soft Core
MATH 243: FOUNDATIONS IN GEOMETRY

Unit -I
Curves – Arc – length, Reparametrization – Level curves – Curvature –
Plane curves – Space curves – Torsion – Serret – Frenet equations.

Unit-II
Length of cuve – Area contained in a simple closed curve. The Isoperimetric inequality – Four vertex theorem.

Surfaces

Unit-III
Definition and basic properties – Smooth surfaces – reparametrization – Level surfaces – tangent, Normal and orientability – Examples of smooth surfaces like ruled surfaces, surfaces or revolution – Quadric surfaces – Triply orthogonal systems.

Unit-IV
Lengths of curves on surfaces – first fundamental form – Isomerties of surfaces – Characterization of isometrics in terms of first fundamental form – Conformal mappings of surfaces – Characterization of conformal mappings in terms of first fundamental form – Stereographic projection.

Unit-V
Surface area – Second fundamental form – Curvature of curves on a surface – Meusnier theorem – Principal curvatures – Umplics – Euler's theorem.

Text Book:
1. Andrew Pressley, Elementary Differential Geometry, Springer International Edition, Springer India Private Ltd., **2001.** Indian Reprint, **2004**
   (Relevant sections from Chapters 1 to 6)

Reference Book:
W. Klingenberg, A course in Differential Geometry, Springer, Springer-Verlag, New York, **1978**

5 Year Integrated M.Sc. Program

SOFT CORE COURSE
MATH 353: THEORY OF EQUATIONS AND NUMERICAL METHODS
3 Credits

Unit- I
Relations between roots and coefficients of an algebraic equation - Imaginary roots-Irrational roots-Symmetric functions of the roots in terms of the coefficients

Unit- II
Reciprocal equations– Descartes' rule of signs – Transformations of equations

Unit- III
Numerical solutions of algebraic equations – Bisection method – Regula falsi method – Iteration method – Newton –Raphson method

Unit- IV
System of linear equations – Gauss elimination method – Jordan method – Jacobi's method – Gauss-Seidel method

Unit -V
Finite difference operators – Newton's forward difference formula – Newton's backward difference formula – Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's 1/3 rule.

Text Book:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India Private Ltd, New Delhi.3rd Edition, **2000**
2. Chadrika Prasad, Text Book on Algebra and Theory of Equations, Pothiskola Private Ltd., Allahabad **2001**

Reference Books:

1. H.S. Hall and S.R. Knight, Higher Algebra, H.M. Publications, **1994**