

Subject: Pure Mathematics (PMAT)				
General				
	Course Units	Status	Pre-requisite	Co-requisite
Year 1 Sem 1	PMAT 11042 Discrete Mathematics I^{1,2}	C		
	PMAT 11083 Topics in Basic Mathematics³	A		
	PMAT 14102 Logic and Reasoning	A		
Year 1 Sem 2	PMAT 12052 Calculus I¹	C	A/L Combined Mathematics	
	PMAT 12062 Discrete Mathematics II²	C	PMAT 11042	
	PMAT 12073 Calculus II	C		PMAT 12052
	PMAT 12093 Introduction to Calculus³	A		
Year 2 Sem 1	PMAT 21035 Linear Algebra	C	PMAT 12062	
Year 2 Sem 2	PMAT 22045 Infinite Series and Series of Functions	C	PMAT 12073	
Year 3 Sem 1	PMAT 31073 Introduction to Functions of Several Variables	O	PMAT 22045	
	PMAT 31083 Algebraic Structures	O	PMAT 21035	
	PMAT 31093 Ordinary Differential Equations	O	PMAT 12073	
	PMAT 31103 Riemann Theory of Integration	O	PMAT 22045	
	PRPL 31012 Professional Placement	O	All PMAT compulsory units offered in levels 1 & 2	
Year 3 Sem 2	PMAT 32113 Complex Variables	O	PMAT 31073	
	PMAT 32123 Geometry	O	PMAT 21035	
	PMAT 32133 Partial Differential Equations and Integral Transforms	O	PMAT 31093 PMAT 22045	

¹ Compulsory for Physical Science students

² Compulsory for Management and Information Technology students

³ Available only for students who have not offered Combined Mathematics for G.C.E. (A/L) Examination

Pure Mathematics

Level-1

Course code : PMAT 11042
Title : Discrete Mathematics I

Learning Outcomes:

At the end of the course the student should be able to demonstrate knowledge of the concepts of Set Theory, Relations and Matrix Algebra and to apply them in Modular Arithmetic and solving systems of linear equations.

Course Contents:

Set theory: Sets, Operation on sets, ordered pairs and Cartesian Products.

Relations: Relations, Order relations, Equivalence relations, Module Arithmetic, Functions.

Matrices: Matrix algebra, Special types of square matrices, Determinant of a matrix.

Systems of Linear Equations: Homogeneous and Non-homogeneous types, Method of solving such systems.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on the tutorials, tests, and end of course examination.

Recommended Reading:

1. Johnsonbaugh, R., (1990). *Discrete Mathematics*, MacMillan.
 2. Lipschutz, S., (1976). *Discrete Mathematics*, McGraw-Hill, New York.
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Course code : PMAT 11083
Title : Topics in Basic Mathematics

Learning Outcomes:

At the end of this course, the student should be able to demonstrate knowledge in basic discrete mathematical concepts stated in the content and apply these concepts in appropriate manner in given problems.

Course Contents:

Set theory, Product sets, Relations, Functions and graphs, Determinants of order two and three, Matrices, Linear Equations. Finite series, Binomial theorem, Exponential, Trigonometric and logarithmic functions.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on the tutorials, tests, and end of course examination.

Recommended Reading:

1. Lipschutz, S., (1976). *Discrete Mathematics*, McGraw-Hill, New York.
 2. Nachman, L.J., (1978). *Fundamental Mathematics*, John Wiley, New York.
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Course code : PMAT 14102
Title : Logic and Reasoning

Learning Outcomes:

At the end of this course, the student should be able to identify valid reasoning and to construct coherent and persuasive arguments themselves.

Course contents:

Argument reconstruction, Validity and soundness, Deductive reasoning and formal logic, Informal logic and everyday reasoning, Basic symbolic logic, Truth tables, Informal fallacies, Conceptual theories, Empirical theories.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Johnsonbaugh, R., (1990). *Discrete Mathematics*, MacMillan.
 2. Lipschutz, S., (1964). *Set Theory and Related Topics*, McGraw-Hill.
 3. Aggarwal, R.S. and Matharu, R.S., (1989). *A text book on Discrete Mathematics*, S. Chands.
 4. Vatssa, B.S., (1988). *Discrete Mathematics*, Wishwa Prakashan.
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Course code : PMAT 12052

Title : Calculus I

Pre-requisites : A/L Combined Mathematics

Learning Outcomes:

On successful completion of the course, the student should be able;

1. to demonstrate knowledge of the axiomatic description of the field of real numbers and prove theorems from the given set of axioms
2. to explain the concepts of limits continuity and differentiation of real-valued functions
3. to use the concepts of limits, continuity and the derivatives to describe the qualitative behavior of a graph of a single variable function
4. to use derivatives to solve applied problems.

Course Contents:

Real Numbers: Supremum and infimum of a set, completeness axioms, symbols $+\infty$ and $-\infty$

Functions and Limits: Limits of Functions, Continuous Functions.

Derivative and Applications: Derivative of a function, Function composition, Chain rule, Implicit functions and Implicit differentiation, Higher order derivatives, Rolle's Theorem, Mean Value Theorem, Monotonicity and first derivative test, Concavity and second derivative test, Absolute extrema, Asymptotes and limits involving infinity, Graph sketching using polar and Cartesian coordinates.

Indeterminate Forms: L'hospital Rule.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on the tutorials, tests, and end of course examination.

Recommended Readings:

1. Ayres, Jr. F. & Mendelson, E., (1990). *Calculus*, McGraw-Hill, New York.
 2. Earl W. Swokowski, (1977). *Calculus A First Course*, Wadsworth International Group.
 3. Arora, S. & Malik, S.C., (1994). *Mathematical Analysis*, Wiley Eastern.
 4. Munem, M.A. & Foulis, D.J., (1984). *Calculus*, Worth Publishers, New York.
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Course code : PMAT 12062

Title : Discrete Mathematics II

Pre-requisites : PMAT 11042

Learning Outcomes:

At the end of the course the student should be able to demonstrate knowledge of the concepts of Mathematical Logic, Methods of Proofs and basic Graph Theory and to apply them in developing mathematical arguments in a logical manner.

Course contents:

Mathematical Logic: Propositional Calculus, Predicate Calculus.

Boolean algebra: Boolean algebra and its properties, Algebra of propositions, Boolean functions, Algebra of electric circuits and its applications.

Methods of Proof: Direct proof, Proof by contrapositive, Proof by contradiction. Mathematical induction, Case analysis, Counter examples.

Cardinality: Finite sets, Denumerable sets, Uncountable sets, Cardinal numbers.

Graph Theory: Graphs and Multigraphs, Subgraphs, Matrices and graphs, Isomorphic and homeomorphic Graphs, Planar graphs, Kuratowski's theorem.

Method of Teaching and Learning: A combination of lectures and tutorial discussions

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Johnsonbaugh, R., (1990). *Discrete Mathematics*, MacMillan.
 2. Lipschutz, S., (1976) *Discrete Mathematics*, McGraw-Hill, New York.
 3. West, D. B., (2002). *Introduction to Graph Theory*, Prentice Hall, India.
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Course code : PMAT 12073

Title : Calculus II

Co-requisites : PMAT 12052

Learning Outcomes:

On successful completion of the course, the student should be able;

1. to carefully define the meaning of convergence of a real sequence of real numbers and use definition to discuss the behavior of a given sequence
2. to use derivatives to solve applied problems
3. to evaluate a definite integral as a limit and using integration techniques
4. to demonstrate knowledge of techniques of integration.

Course Contents:

Sequences: Limits and limit theorems for sequences, Monotone sequences.

Conic sections: Parabolas, Ellipses, Hyperbolas, Translations and rotations of axes.

Transcendental functions: Exponential and logarithmic functions, Hyperbolic functions

Anti-differentiation: Anti-derivatives, Method of change of variable.

Definite Integral and Applications: Definite integral and its properties, Fundamental theorem of calculus, Volumes of solids of revolution, Method of cylindrical shells and slicing, Arc length and surface area.

Techniques of Integration: Integrals of powers of sines and cosines, and of other trigonometric functions, Integration by trigonometric substitution, by parts, by partial fractions for linear and quadric cases and by special substitutions, Reduction formulae.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Ayres, Jr. F. & Mendelson, E., (1990). *Calculus*, McGraw-Hill, New York.
2. Earl, W. Swokowski, (1977). *Calculus A First Course*, Wadsworth International Group.
3. Robert, G. Bartle, Donald, R. Shebert, (2000). *Introduction to Real Analysis*, John Wiley & Sons, Inc.

4. Arora, S. & Malik, S.C., (1994). *Mathematical Analysis*, Wiley Eastern.
 5. Munem, M.A. & Foulis, D.J., (1984). *Calculus*, Worth Publishers, New York.
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Course code : PMAT 12093
Title : Introduction to Calculus

Learning Outcomes:

At the end of this course, the student should be able to demonstrate knowledge in basic mathematical concepts of calculus required for the undergraduate studies and further studies as well.

Course Contents:

Limits, Continuity, Differential Calculus, Maxima and Minima, indeterminate Forms, Methods of Integration, Improper Integrals, Taylor's formula, Newton's methods, Ordinary Differential Equations.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on the tutorials, tests, and end of course examination.

Recommended reading:

1. Ayres, Jr .F. & Mendelson, E., (1990). *Calculus*, McGraw-Hill, New York.
 2. Arora, S. & Malik, S.C., (1994). *Mathematical Analysis*, Wiley Eastern.
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Level – 2

Course Code : PMAT 21035
Title : Linear Algebra
Pre-requisites : PMAT 12062

Learning Outcomes:

At the end of the course the student should be able to demonstrate knowledge of the concepts and theorems of Vector Spaces and Linear Transformations and to apply them to solve problems in diverse areas.

Course Contents:

Vector Spaces: Vector Spaces, Subspaces, Linear independence, Basis and dimension, Linear transformations, Kernel and image of a linear transformation, dimension theorem, Inner product, Gram-Schmidt orthogonalization process, Orthogonal complement, Orthogonal projections.

Eigenvalues and Eigenvectors: Polynomials of matrices and linear operators, Eigenvalues and eigenvectors, Diagonalization, Characteristic polynomial, Cayley-Hamilton theorem, Minimum polynomial, Jordan Canonical Form, Rational canonical form.

Applications of Linear Transformations: Lines and planes, Quadratic forms, Conic sections, Quadratic surfaces, Least squares, Differential equations and other applications.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Johnsonbaugh, R., (1990). *Discrete Mathematics*, MacMillan.
 2. Khanna, V.K. & Bhambri, S.K., (1998). *A Course in Abstract Algebra*, Vikas, India.
 3. Aggarwal, R.S. & Matharu, R.S., (1991). *Linear Algebra*, S. Chands, India.
 4. Narayan, S. & Pal, S., (1992). *A text book of Modern Abstract Algebra*, S.Chands, India.
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Course Code : PMAT 22045
Title : Infinite Series and Series of Functions

Pre-requisites : PMAT 12073

Learning Outcomes:

At the end of this course, the student should be able to demonstrate knowledge of the nature of the convergence of infinite series and conditions under what differentiation and integration can be performed.

Course Contents:

Infinite Series: Properties of infinite series, Series of non-negative terms, Alternating series, Absolute and conditional convergence, Power Series, Taylor and Maclaurine Series, Binomial Series, Fourier Series.

Series of Functions: Pointwise convergence of a sequence of functions, Uniform convergence of sequences and series of functions, Consequences of uniform convergence, Differentiation and integration of infinite series.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Ross, K.A., (1980). *The theory of calculus*, Springer-Verlag, New York.
2. Arora, S. & Malik, S.C., (1994). *Mathematical Analysis*, Wiley Eastern.
3. Gupta, S.L. & Rani, N., (1999). *Principles of Real Analysis*, Vikas, India.
4. B.S.Vatsa., (2002). *Principles of Mathematical Analysis*, Oscar Publications, India.

Level – 3

Course Code : PMAT 31073

Title : Introduction to Functions of Several Variables

Pre- requisites : PMAT 22045

Learning Outcomes:

At the end of this course, the student should be able to demonstrate knowledge of extending the ideas and concepts they have studied for functions of a single variable to functions of several variables. Also they shall be able to demonstrate knowledge of limits, partial derivatives and extrema for functions of several variables, and how to compute double integrals.

Course Contents:

Limits, Continuity, Partial derivatives, Differentiability, Sufficient conditions for differentiability, Composite functions and the chain rules, Higher order partial derivatives, Changing the order of differentiation, The mean value theorem, Taylor's formula and series, Extrema for functions of several variables, Lagrange multipliers, Plane transformations, The double integral, Changing the order of integration, The change of variables theorem.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Spiegel, M.R., (1974). *Advanced Calculus*, McGraw-Hill, New York.
3. Arora, S. & Malik, S.C., (1994). *Mathematical Analysis*, Wiley Eastern.

Course Code : PMAT 31083

Title : Algebraic structures

Pre-requisites : PMAT 21035

Learning Outcomes:

At the end of the course the student should be able to demonstrate knowledge of structures in Algebra and to apply the knowledge to solve problems in different areas of algebra.

Course Contents:

Groupoids: Elements of Groupoids.

Group Theory: Groups and subgroups, Normal subgroups, Factor groups, Group Homomorphism.

Rings: Rings and subrings, Characteristic of a ring, Ideals, Quotient Rings, Integral Domains, Euclidean Domains.

Fields: Finite and infinite fields, Field of fractions.

Method of Teaching and Learning: A combination of lectures, tutorial discussions.

Assessment: Based on tutorials, tests, and end of course examination.

Recommended Reading:

1. Fraleigh, J.B., (1994). *A first Course in Abstract Algebra*, Addison Wesley.
2. Khanna, V.K. & Bhambri, S.K., (1999). *A Course in Abstract Algebra*, Vikas, India.
3. Singh, S. & Zameeruddin, Q., (1997). *Modern Algebra*, Vikas, India.
4. Cohn, P.M., (1974). *Algebra*, John Wiley, New York.
5. Johnsonbaugh, R., (1990) *Discrete Mathematics*, MacMillan.

Course Code : PMAT 31093
Title : Ordinary Differential Equations.
Pre-requisites : PMAT 12073

Learning Outcomes:

At the end of this course, the student should be able;

1. to develop mathematical models of some real-life systems or phenomenon from physical, sociological or economical problem, solve the mathematical model and interpret the mathematical results back into the context of the original problem
2. to determine the type of a given differential equation, determine the existence of a solution and if a solution can be obtained, select the appropriate analytical technique for finding the solution.

Course Contents:

Laplace transform method, Euler's equation, Other non-linear equations, Systems of linear equations with constant coefficients, Linear equations with variable coefficients, Method of variation of parameters, Series solutions of ordinary differential equations and the method of Frobenius, Legendre and Bessel equations.

Method of Teaching and Learning: A combination of lectures, tutorial discussions.

Assessment: Based on tutorials, tests, and end of course examination.

Recommended Reading:

1. Raisinghania, M.D., (1991). *Advanced Differential Equations*, S.Chands, India.
2. Mondal, C. R., (2003). *Ordinary Differential Equations*, Prentice Hall, India.

Course Code : PMAT 31103
Title : Riemann Theory of Integration
Pre-requisites : PMAT 22045

Learning Outcomes:

At the end of the course the student should be able to demonstrate knowledge of the basic concepts of Riemann Integration and to apply them in solving integration problems.

Course Contents:

Riemann Integration: The Riemann integral, Properties of the Riemann integral, Fundamental theorem of calculus.

Improper integrals: Properties of Improper Integrals, Leibnitz's rule.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Munem, M.A. & Foulis D.J., (1984). *Calculus*, Worth Publishers.
 2. Somasundaran, D. & Choudhary, B., (1996). *A first Course Mathematical Analysis*, Narosha Publishing House, India.
 3. Malik, S.C. & Arora, S., (1994). *Mathematical Analysis*, Wiley Eastern.
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Course Code : PMAT 32113
Title : Complex Variables
Pre-requisites : PMAT 31073

Learning Outcomes: At the end of this course, the student should be able to demonstrate knowledge of the usage of applications of complex numbers and complex valued functions.

Course Contents:

Algebra and geometry of complex numbers, Curves and regions in the complex plane, Complex valued functions, Limits, Continuity, Derivatives, Analytic functions, Cauchy Riemann equations, Rational functions, Exponential functions, Trigonometric and hyperbolic functions, Logarithm, General power, Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, The derivatives of an analytic function, Taylor and Laurent series, Analyticity at infinity, Zeros and singularities, Residues, The Residue theorem, Evaluation of real integral.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Murray, R.S., (1993). *Complex Variables*, McGraw-Hill, New York.
 2. Churchill, R.V., (1960). *Complex Variables and Applications*, McGraw-Hill, New York.
 3. Ponnasamg, S., (1995). *Foundations of complex variables*, Narosa, ndia.
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Course Code : PMAT 32123
Title : Geometry
Pre-requisites : PMAT 21035

Learning Outcomes: At the end of this course, the student should be able to demonstrate knowledge of two and three dimensional Analytical Geometry involving pairs of straight lines, conics and to apply the standard results to solve problems related to lines, planes and conicoids.

Course Contents:

Analytical Geometry in Two Dimensions: Pairs of straight lines, General equation of second degree, Change of origin and rotation of axes, Joachimsthal's ratio equation, Equations of tangents, Pairs of tangents and chords of contact, Harmonic conjugates, Pole and Polar, Invariance, Reduction to standard forms of conic, Parametric treatment, Degenerate conic, Properties of conic, Matrix methods.

Analytical Geometry in Three Dimensions: Equations of the line, plane, sphere, cone, ellipsoid and hyperboloid, Tangent plane, Normal, Pole and polar, Ruled surfaces, General equation of the second degree, Properties of quadrics.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Gibson, G.A. & Pinkerton, P., (1951). *Analytical Geometry*, MacMillan.
 2. Maxwell, E.A., (1962). *Elementary Coordinate Geometry*, Oxford University press.
 3. Chatterjee, D., (2003). *Analytic Solid Geometry*, Prentice Hall, India.
 4. Jain, P.K. & Ahmad, K., (1994). *Analytical Geometry of Two Dimensions*, Wiley Eastern.
 5. Shanti Narayan, (2005). *Analytic Solid Geometry*, S.Chand and Company.
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Course Code : PMAT 32133

Title : Partial Differential Equations and Integral Transforms

Pre-requisites : PMAT 31093/PMAT22045

Learning Outcomes: At the end of this course, the student should be able to demonstrate knowledge of solving problems involving partial differential equations including integral transform methods.

Course Contents:

Partial Differential Equations: Introduction to first order partial differential equations, geometrical problems, The general solution, Lagrange system, Theory of second order partial differential equations.

Integral Transforms: Laplace, Fourier and other integral transform methods for partial differential equations.

Method of Teaching and Learning: A combination of lectures and tutorial discussions.

Assessment: Based on tutorials, tests and end of course examination.

Recommended Reading:

1. Raisinghania, M.D., (1991). *Advanced Differential Equations*, S.Chand, India.
 2. Pinsky, M.A., (2003). *Partial Differential Equations and Boundary Value Problems with Applications* Waveland Press, New York.
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