Deccan Education Society's

Fergusson College (Autonomous), Pune

Program Specific Outcomes (PSOs) and Course Outcomes (COs) 2019-20

Department of Mathematics

Programme: B.A. Mathematics

Program Specific Outcomes(PSOs) for B.A. Mathematics	
PSO No.	**Program Specific Outcomes (PSOs)** **Upon completion of this programme the student will be able to**
PSO1	**Academic Competence:** (i) Articulate basic concepts such as limit, continuity, differentiability of real valued and vector valued functions of one and several variables along with the concepts of linear dependence, eigenvalues, eigen vectors. (ii) Apply different methods to solve the differential equations. (iii) Unify structures in Mathematics such as sets, relations and functions, logical structure, relationships among them and explore the more complex structures such as groups, rings and vector spaces.
PSO2	**Personal and Professional Competence:** (i) Apply mathematical problems and solutions in variety of contexts related to science, technology, business and industry, and illustrate these solutions using symbolic, numeric, or graphical methods. (ii) Analyse the data by selecting and using appropriate mathematical formulae or techniques in order to draw the relevant conclusion. (iii) Create proficiency in writing mathematical proofs.
PSO3	**Research Competence:** (i) Apply advanced knowledge on topics in pure mathematics, empowering the students to pursue higher education at reputed academic institutions. Impart analytic and thinking skills to develop initiatives and innovative ideas for R&D in various fields. (ii) Integrate the knowledge of Mathematics to solve problems in different branches of sciences. (iii) Create, select, adapt and apply appropriate techniques and modern computing tools for complex computing activities.
PSO4	**Entrepreneurial and Social Competence:** (i) Employ analytical skills acquired helps to get distinguishing employment opportunities in several fields including IT, Research and Development Department and Teaching field. (ii) Gain awareness about issues related to plagiarism and ethical issues related to protection of intellectual property are copyrights, trademarks and patents.

F.Y. B.A. Semester I		
Title of the Course and Course Code	**Calculus-I MTA 1101**	**Number of Credits : 02**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Outline basic concepts of real numbers and define sequences and series of real numbers.	1
CO2	Interpret inequalities like Geometric Mean-Arithmetic Mean inequality, Bernoulli's inequality.	2
CO3	Apply properties of Real numbers and implement different tests for checking convergence of series.	3
CO4	Explain and apply the statements of different theorems for checking convergence and divergence of sequences and series.	4
CO5	Evaluate limit of a sequence and decide whether given sequence is convergent, divergent, bounded, monotone or Cauchy.	5
CO6	Create counter examples and support the theory with applicable examples to understand the real analysis.	6
Title of the Course and Course Code	**Algebra MTA 1102**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall basic concepts in sets, relations and functions.	1
CO2	Interpret properties of complex numbers and polynomials.	2
CO3	Apply different principles and theorems for understanding, and solving problems on integers and complex numbers.	3
CO4	Explain the geometric concepts of algebraic properties of two complex numbers. Evaluate Division Algorithms and G.C.D. for polynomials.	4
CO5	Evaluate theory of complex numbers and problems on integers and complex numbers.	5
CO6	Create counter examples and support the theory of equivalence relation, equivalence classes, partition to illustrate that every partition gives an equivalence relation and vice-versa.	6

Title of the Course and Course Code	**Financial Mathematics-I MTA1103**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and interpret various mathematical definitions of sequences, series, real numbers, functions, relations, polynomials, complex numbers.	1
CO2	Illustrate different concepts of functions, relations, polynomials.	2
CO3	Interpret and differentiate between various types of functions. Apply equivalence relations on sets and corresponding equivalence classes.	3
CO4	Explain different methods for finding the roots of a given equation and acquire the knowledge of the relationship between coefficients and roots of an equation.	4
CO5	Determine whether the given sequence and series is convergent or not.	5
CO6	Create intuition-forming examples or counter examples and prove Conjectures in sequences and series.	6
F.Y. B.A. Semester II		
Title of the Course and Course Code	**Calculus-II MTA1201**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Outline and recall basic concepts of real numbers, sequences and series.	1
CO2	Interpret properties of continuous and differentiable functions.	2
CO3	Apply different principles, tests and theorems for understanding, evaluating and for solving problems on limit, continuity, differentiation and different aspects of real analysis.	3
CO4	Analyze and examine different principles, tests and theorems on different aspects of real analysis.	4
CO5	Evaluate n-th ordered derivatives of functions.	5
CO6	Create counter examples and support the theory with applicable examples to illustrate the Fundamental Theorem of Calculus.	6

Title of the Course and Course Code	**Geometry MTA1202**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall basic concepts in school geometry.	1
CO2	Interpret geometrical ideas like line, plane, sphere in purely algebraic manner. Explain properties of change of axes, translation of axis, rotation of axes and rectangular Cartesian coordinates of a point in plane.	2
CO3	Apply removal of xy term and linear terms to reduce given conics to its standard form. Use the condition of tangency to get equation of Tangent plane.	3
CO4	Explain and analyze the concepts in conic sections and spheres.	4
CO5	Evaluate different concepts in lines and planes. Test whether given plane passes through the three points. Determine the length of the perpendicular from a point to a plane.	5
CO6	Create counter examples and support the theory with applicable examples to articulate different conditions in the coplanar lines.	6
Title of the Course and Course Code	**Financial Mathematics-II MTA1203**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and interpret various mathematical definitions of limit, continuity, differentiation, planes, lines, spheres.	1
CO2	Illustrate different concepts of limit, continuity, differentiation, planes, lines, spheres.	2
CO3	Apply the properties of conics to solve problems in real life situations.	3
CO4	Differentiate between various types of limits, continuity, differentiation.	4
CO5	Evaluate limits, continuity, derivatives and nth derivatives of functions.	5
CO6	Develop different techniques to find nth derivative of product of two functions.	6

S.Y. B.Sc. Semester III		
Title of the Course and Course Code	**Calculus of Several Variables – MTA2301**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall basic concepts related to real analysis of one variable calculus.	1
CO2	Interpret partial derivatives, chain rule, differentiability of the functions by solving numerical problems.	2
CO3	Use partial derivatives and apply Euler's theorem, Taylor's theorem and Mean value theorem for functions of two or more variables. Apply multiple integrals to find area and volume.	3
CO4	Explain continuity, differentiability of functions of several variables and change of variables in multiple integrals.	4
CO5	Evaluate limit, partial derivatives, extreme values, multiple integrals of functions of several variables.	5
CO6	Develop idea of extreme values of real valued functions of several variables. Create counter examples and support the theory with applicable examples to understand the classical fundamental theorems in integral calculus.	6
Title of the Course and Course Code	**Ordinary Differential Equations – MTS2302**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Define differential equations to analyse real world problems.	1
CO2	Classify the problems and recognize appropriate methods to solve differential equations by manual and technology-based methods.	2
CO3	Apply the methods of solving differential equations to real world problems.	3
CO4	Categorize differential equations and explain methods of solving them.	4
CO5	Evaluate detailed solutions of differential equations by applying differential operators and inverse differential operators.	5
CO6	Create counter examples and support the theory with	6

	applicable examples to understand the differential equations. Formulate real world problems into differential equations.	
Title of the Course and Course Code	**Operations Research – MTA2303**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and articulate basic concepts of LPP. Formulate LPP, Calculate and illustrate graphical solution. Discuss, execute, explain, illustrate, use simplex method.	1
CO2	Construct and solve LPP in equation form, translate, formulate graphical to algebraic solution.	2
CO3	Define, explain, solve dual LPP. Relate, compare primal and dual LPP.	3
CO4	Define, explain, solve transportation model. Use, execute various methods to solve transportation model. Test, verify optimal solution.	4
CO5	Define, explain, solve assignment problem. Use, execute various methods to solve assignment problem. Test, verify optimal solution.	5
CO6	Recall and articulate basic concepts of LPP. Formulate LPP, Calculate and illustrate graphical solution. Discuss, execute, explain, illustrate, use simplex method.	6
Title of the Course and Course Code	**Number Theory - MTA2305**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall, define basic concepts of set of integers and divisibility. Discuss, illustrate theorems on divisibility. Solve and verify problems in divisibility.	1
CO2	Define, discuss congruence relation. Discuss, illustrate theorems on congruences. Solve and verify problems in congruences. Classify, verify, invent different types of congruence equations.	2
CO3	Define, illustrate, examine, verify techniques of numerical calculations	3
CO4	Define, illustrate, examine, verify and invent different number theoretic functions.	4

CO5	Define, illustrate, examine, verify and invent different congruences laws and , Legendre's symbol.	5
CO6	Recall, define basic concepts of set of integers and divisibility. Discuss, illustrate theorems on divisibility. Solve and verify problems in divisibility.	6
S.Y. B.A. Semester IV		
Title of the Course and Course Code	**Vector Calculus - MTA2401**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Retrieve basic concepts of real analysis and calculus of several variables.	1
CO2	Interpret divergence and Curl, solenoidal and irrotational vector fields.	2
CO3	Apply Green's theorem, Stokes theorem and Divergence theorem and solve the problems.	3
CO4	Explain and apply the concept of curl, gradient and divergence, total differentials.	4
CO5	Evaluate limit and continuity of vector valued functions, line integral, surface integral.	5
CO6	Create counter examples and support the theory with applicable examples to understand the vector calculus.	6
Title of the Course and Course Code	**Linear Algebra - MTA2402**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Retrieve basic concepts of real analysis and calculus of several variables.	1
CO2	Interpret divergence and Curl, solenoidal and irrotational vector fields.	2
CO3	Apply Green's theorem, Stokes theorem and Divergence theorem and solve the problems.	3
CO4	Explain and apply the concept of curl, gradient and divergence, total differentials.	4
CO5	Evaluate limit and continuity of vector valued functions, line integral, surface integral.	5
CO6	Create counter examples and support the theory with applicable examples to understand the vector calculus.	6

Title of the Course and Course Code	**Optimization Techniques – MTA2403**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Define, explain activities, CPM and PERT. Construct, create, design, verify, execute, test critical path, time schedule. Formulate LPP of CPM and PERT	1
CO2	Define, explain, classify, execute, compare different decision criterion. Define, explain, solve game. Discuss properties of game, formulate LPP model.	2
CO3	Define, discuss, explain, execute types of failure. Define, explain, classify, execute, replacement policy of items.	3
CO4	Define, discuss, explain, execute sequencing problem of job. Construct, create, verify optimal sequence.	4
CO5	Define, discuss, explain, and execute unconstrained problems. Discuss, use, solve and construct optimal solution using various methods.	5
CO6	Define, explain activities, CPM and PERT. Construct, create, design, verify, execute, test critical path, time schedule. Formulate LPP of CPM and PERT	6

Title of the Course and Course Code	**Problem course based on MTA 2401 and 2402 - MTA2404**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall basic concepts in Vector Calculus and Linear Algebra	1
CO2	Interpret different concepts by solving numerical problems.	2
CO3	Using different results and solving various problems	3
CO4	Explain different concepts with the help of examples	4
CO5	Evaluate and solve various Mathematical problems	5
CO6	Recall basic concepts in Vector Calculus and Linear Algebra	6

Title of the Course and Course Code	**Graph Theory - MTA2405**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Articulate and retrieve basic concepts of induction, logic and methods of proofs.	1
CO2	Define graph and its basic terminology. Categorize, compare verify, examine, create different examples of graphs.	2
CO3	Define, classify, illustrate, verify, invent paths and cycles. List, carryout, outline and illustrate theorems on these concepts.	3
CO4	Define, classify, illustrate, verify, invent trees. List, carryout, outline and illustrate theorems on these concepts.	4
CO5	Define, classify, illustrate, verify, invent planar graphs.	5
CO6	List, carryout, outline and illustrate theorems on planarity.	6
Title of the Course and Course Code	**Scilab- MTA2406**	**Number of Credits : 02**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Installation and using Scilab for elementary operations	1
CO2	Compute various quantities using scilab such as eigenvalues, eiegenvectors etc.	2
CO3	Manipulate scilab to apply it in various computations such as complex numbers.	3
CO4	Estimate roots of the polynomials and similar concepts	4
CO5	Compare different methods to compute same concepts	5
CO6	Try to write new programmes in Scilab	6
T. Y. B.A. Semester V		
Title of the Course and Course Code	**Real Analysis-I MTA3501**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Retrive the structure of system of real numbers. Define lub axiom, countability of subsets of real numbers, convergence of sequences and series, integrability of functions. Show the convergence of sequences and	1

	sequences, integrability of functions. State the conditions for lub, convergence of sequences and series, properties of integrable functions, conditions for integrability.	
CO2	Classify countable and uncountable sets. Compare the sets and their subsets in the context of countability. Distinguish convergent and divergent sequences and series. Estimate limit of sequence, series, integral of a function. Give examples to counter the statements/theorems on countability, convergence of sequences and series, integrability of functions. Explain the tests for convergence of sequences and series and illustrate with examples. Interpret properties of integrals, Fundamental theorem of calculus, Mean value theorems geometrically.	2
CO3	Apply countability theorems to test the countability of sets. Use convergence tests/statements to discuss the convergence of sequences and series. Examine the set for its countability, sequences and series for convergence, functions for integrability. Illustrate the statements with supporting examples. Apply calculus to examine the integrability of functions and properties of integrable functions.	3
CO4	Demonstrate the statements with diagrams. Arrange the sets according to their cardinalities. Analyse the sequences and series to apply proper test/technique to discuss the convergence. Invent examples in support of statements and their converses, in counter to the statements. Organise the statements in order to generalise the concepts. Identify the properties of functions to predict their integrability.	4
CO5	Determine supremum, infimum of a set and justify. Determine maps between two sets, equivalent sets and justify. Evaluate limit of sequences and sums of series, integrals. Criticize the statements by arguments and/or counter examples. Discriminate the countable and uncountable set, convergent and divergent sequences and series, integrable and non-integrable functions. Justify the statements by arguments and/or suitable examples.	5
CO6	Produce bijective maps between equivalent sets. Create counter examples to the statements about sequences, series and integrable functions. Modify/rewrite the statements in order to make it valid. State the hypothesis in order to get the desired outcome/result. Rearrange the statements so as to make the valid statement. Generate new statements for the expected outcome.	6

Title of the Course and Course Code	**Group Theory MTA3502**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Articulate and retrieve basic concepts of algebra such as integers and functions. Recall, remember and list all basic algebraic properties of number systems.	1
CO2	Define groups and its basic terminology. Categorize, compare verify, examine, create different types of groups. List, carryout, outline and illustrate basic properties and theorems of groups.	2
CO3	Discriminate, check, evaluate and create different subgroups of a group.	3
CO4	Define, classify, illustrate, verify, invent homomorphism on groups and to study quotient groups and normal subgroups. List, carryout, outline and illustrate theorems on these concepts.	4
CO5	Define, classify, illustrate, verify, invent simple groups, alternating groups and to study permutation groups. List, carryout, outline and illustrate theorems on these concepts and composition of series of groups.	5
CO6	Define, classify, illustrate, verify, invent group actions and related concepts. List, carryout, outline and illustrate theorems on these concepts.	6
Title of the Course and Course Code	**Financial Mathematics-I MTA3503**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and articulate basic concepts of simple Interest, Calculate and illustrate interest with discrete and continuous compounding. Discuss, execute, explain, illustrate, use time value of money.	1
CO2	Construct deterministic cash flows, translate, formulate Internal rate of return, NPV.	2
CO3	Define, explain random cash flows.	3
CO4	Define, explain, solve Markowitz model. Use, execute various methods to solve it.	4

CO5	Define, explain, solve CAPM, Use of Portfolio diagrams	5
CO6	Formulate CAPM, Calculate and illustrate CAPM formula and Discuss, execute, explain, illustrate, use it.	6
Title of the Course and Course Code	**Advanced Linear Algebra - MTA3504**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and state definitions of regarding rank of matrix, determinants, eigenvalues and eigenvectors, canonical forms. Identify proper elementary operation on matrices, eigenvectors, Jordan canonical forms.	1
CO2	Classify canonical forms of matrices, compare nature of matrices, Associate linear transform with matrix. Differentiate matrices, linear transformations according to rank, eigenvalues and eigenvectors, Jordan canonical forms. Predict determinant, canonical forms of matrix and represent matrices into canonical form.	2
CO3	Apply elementary operations to solve system of equations, determinant of matrices. Compute solutions of system, eigenvalues and eigenvectors, canonical forms of matrices. Interpret properties of linear transformation using determinant, eigenvalues, eigenvectors and canonical forms.	3
CO4	Analyse type of matrix to perform elementary operations. Classify and distinguish the matrices according to their eigenvalues, eigenvectors, determinant, and canonical forms. Identify nature of matrix from characteristic polynomial, minimal polynomial.	4
CO5	Test the consistency of system of equations. Reduce matrix to echelon form and get rank of a matrix, evaluate solutions of system of equations. Determine invertible matrix to diagonalize a matrix, diagonalize the matrix and verify its validity. Evaluate canonical form of a matrix and use it to find minimal polynomial.	5
CO6	Hypothesize the conditions for invertibility of matrix, solving system of equations, to get specific canonical forms. Produce the examples and counter examples in support to the theory. Develop the technics to find determinant of matrix, to get canonical form of matrix in specific cases. Write possible matrices form eigenvalue, eigenvectors, determinant and canonical forms.	6

Title of the Course and Course Code	**Complex Analysis-I - MTA3505**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Articulate and retrieve basic concepts of complex numbers. Recall, remember and list all basic properties of complex numbers. Discuss the geometrical interpretation of algebraic properties of complex numbers.	1
CO2	Define calculus related properties in complex. Carryout and outline different maps, illustrate theorems on limit, continuity and differentiation.	2
CO3	Discriminate, check, evaluate and create different types of complex functions on calculus related properties.	3
CO4	Define, classify, illustrate, verify invent different types of elementary functions on field complex numbers.	4
CO5	Define, classify, illustrate, verify invent different types of integration on functions of complex numbers.	5
CO6	Define, classify, illustrate, verify invent different types of series on field complex numbers.	6
Title of the Course and Course Code	**Metric Spaces - MTA3506**	**Number of Credits : 02**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and articulate basic concepts of real numbers, discuss open and explain the open and closed intervals in R. Classify the intervals and sets into, open and closed sets.	1
CO2	Examine continuous functions, compact sets in R, Discriminate, check, evaluate and create different types of functions and compact sets in R.	2
CO3	Define metric spaces. Explain, solve and test different metrices on general metric space. Define different inequalities and apply them to check metrices. Examine the structure of open sets in R.	3
CO4	Define sequences and their properties. Apply it to check and classify compact, connected, dense sets.	4
CO5	Define, classify, illustrate, examine, verify continuous	5

	functions on general metric space. Discriminate, check, evaluate and create different types of functions.	
CO6	Recall and articulate basic concepts of real numbers, discuss open and explain the open and closed intervals in R. Classify the intervals and sets into, open and closed sets.	6
Title of the Course and Course Code	**Real Analysis-II - MTA3601**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall the convergence of sequences and series of functions, Riemann integrability of functions. Identify the function to which sequences and series of functions converge, type of improper integrals, properties of elementary functions. State the convergence tests for sequences and series of functions, conditions for convergence of improper integrals, conditions for DUIS. Show the pointwise or uniform convergence, properties of elementary functions, convergence of improper integrals, identity using DUIS.	1
CO2	Clarify the pointwise or uniform convergence of sequences and series of functions, properties/identities about elementary functions, convergence/divergence of improper integrals, applicability of DUIS. Compare the sequences and series of functions, improper integrals for convergence, elementary functions. Discuss the convergence of sequences and series of functions, domain, range and properties of elementary functions, convergence of improper integrals. Estimate the limit of sequences and series, improper integrals, integrals using DUIS. Illustrate the validity of statements by suitable examples. Restate the statements in order to get the desired conclusion.	2
CO3	Apply tests of convergence for sequences and series for functions, improper integrals. Apply properties of elementary functions to prove identities. Apply DUIS to prove improper integrals, identities such as Fubini's theorem, Schwarz theorem, Euler's formula etc. Compute limit of sequences and series of functions, improper integrals, integrals using DUIS. Demonstrate the proofs of theorems, validity of statements. Generalize the statements for large class of functions/sequences of functions. Manipulate the statements by inserting parameter(s)/conditions in the original statements. Interpret the theorems/statements geometrically.	3
CO4	Analyse the sequence and series of function to test the pointwise or uniform convergence. Analyse properties of elementary functions to prove the identities. Compare function to test the convergence of improper integrals.	4

	Detect the properties of integrand to apply DUIS. Integrate the properties in order to apply the theorem/result. Identify the suitable function to test absolute convergence of series of functions, improper integrals.	
CO5	Evaluate limit of sequence/series of functions, combinations of elementary functions, improper integrals and write the conclusion. Decide the suitable method/test to check the convergence of sequence and series of functions, improper integrals. Criticise the properties of elementary functions analytically and geometrically. Judge the validity of statements by producing supporting example. Justify the validity of statements by arguments/supporting examples.	5
CO6	Produce counter examples for false statements, non-validity of converse of the statement. Combine statements and predict the result. Design the statement form examples. State the hypothesis for validity of statement. Modify the statement/theorem and state the conclusion. Formulate the new statement from given data.	6
Title of the Course and Course Code	**Ring Theory - MTA3602**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Articulate and retrieve basic concepts of integers, polynomials, matrices, functions and group theory.	1
CO2	Define ring and its basic terminology. Categorize, compare verify, examine, create different examples of rings.	2
CO3	List, carryout, outline and illustrate basic properties and theorems of rings.	3
CO4	Define, classify, illustrate, verify, invent ideals, subrings of a ring. List, carryout, outline and illustrate theorems on these concepts.	4
CO5	Define, classify, illustrate, verify, invent different types of domains. List, carryout, outline and illustrate theorems on these concepts.	5
CO6	Define, classify, illustrate, verify, invent polynomial rings and so learn concepts of irreducible polynomials. List, carryout, outline and illustrate theorems on these concepts.	6

Title of the Course and Course Code	**Financial Mathematics-II - MTA3603**	**Number of Credits : 03**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and articulate basic concepts of forwards and futures Calculate and illustrate the value of a future contract discrete and continuous compounding Discuss, execute, explain, illustrate, use of replicating portfolios.	1
CO2	Construct hedging, translate, formulate currency future and stock index futures	2
CO3	Define, explain call and put options and their types, Evaluate them.	3
CO4	Define and explain put-call parity and solve various problems model. Use, execute and explain various factors which affect the stock options	4
CO5	Define, explain, Black Scholes model and use of the formula. Define, Explain and use Greeks.	5
CO6	Formulate BOPM, Calculate and illustrate BOPM formula and Discuss, execute, explain, illustrate, use it.	6

Title of the Course and Course Code	**Dynamical Systems - MTA3604**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall differentiable functions, eigenvalues and eigenvectors of matrix, canonical forms of matrices. Match the system of equations with phase portrait, identify the nature of the solution of system of equations, describe the solutions, stability of equilibrium points.	1
CO2	Classify the linear systems form eigenvalues and eigenvectors of coefficient matrices, discuss the nature of equilibrium points, compare nonlinear system with its linearization, interpret solutions geometrically, produce examples of linear systems conjugate to the linearization of nonlinear system. Differentiate systems according to the equilibrium points, differentiate equilibrium points	2

	according to their stability. Transform nonlinear system to linear system locally. Draw the phase portrait diagrams of continuous and discrete dynamical systems.	
CO3	Calculate eigenvalues and eigenvectors of coefficient matrix of linear systems and classify the systems. Apply basic calculus to understand solutions of differential equations. Examine the nature of the solutions of system from properties of coefficient matrix and coefficient functions. Dramatize the bifurcation by manipulating the arbitrary constants in the system. Predict the nature of the system when the system is modified.	3
CO4	Analyse the nature of solution by the differential equations. Connect nonlinear systems with conjugate linear systems. Discriminate the systems according to the stability, type of critical points, type of bifurcations. Explain the bifurcation in detail. Sketch the phase portrait diagrams locally, globally for linear, non-linear systems and discrete systems.	4
CO5	Evaluate the Poincare map for a first order equation, critical points, eigenvalues and eigenvectors for linear systems, exponential of a matrix, variational equation for nonlinear systems. Determine the nature of critical point of continuous and discrete dynamical systems. Discriminate systems according to the type of critical points, bifurcations. Recommend the appropriate techniques for solving the systems.	5
CO6	Produce examples of systems for the given phase portrait. Create a system conjugate to the given system. Formulate the system for simple problems such as population model, harmonic oscillator, Hamiltonian, Gradient etc. Invent the conditions for bifurcation of continuous and discrete dynamical systems. Modify the system and describe the nature of solution.	6
Title of the Course and Course Code	**Complex Analysis-II - MTA3605**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Articulate and retrieve basic concepts of first semester complex analysis.	1
CO2	Define residues and poles and its basic terminology. Categorize, compare verify, examine, create different types of residues and poles.	2
CO3	List, carryout, outline and illustrate basic properties and theorems of residues and poles.	3
CO4	Apply residues and poles to evaluate improper integrals. List, carryout, outline and illustrate theorems on complex integration.	4
CO5	Define, classify, illustrate, verify, invent mappings by	5

	elementary functions. List, carryout, outline and illustrate theorems on these concepts.	
CO6	Define, classify, illustrate, verify, invent conformal mappings. List, carryout, outline and illustrate theorems on these concepts.	6
Title of the Course and Course Code	**Metric Spaces-II - MTA3606**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and articulate basic concepts of metric spaces, Discuss continuous functions and their properties. Classify connected subsets of R.	1
CO2	Examine connected spaces. Discriminate, check, evaluate and create different types connected spaces, sets.	2
CO3	Define compact metric spaces. Explain, solve and test different compact metric space.	3
CO4	Discuss continuous functions on compact metric spaces. Classify, illustrate, verify, invent different compact metric spaces.	4
CO5	Define complete metric space. Discuss, classify, verify, invent and create different complete metric spaces.	5
CO6	Recall and articulate basic concepts of metric spaces, Discuss continuous functions and their properties. Classify connected subsets of R.	6