ST JOSEPH'S COLLEGE FOR WOMEN (AUTONOMOUS)
VISAKHAPATNAM

M.Sc. Pure Mathematics

Program Outcomes

PO1: Proficiency in verbal/ analytical / numerical knowledge gained during the program helps the students achieve good score in national level tests like NET/ SET.

PO2: The program aims to give the students some theoretical inputs and substantial hands-on experience in knowledge making helps them to success as a teacher/ professor/ lecturer.

PO3: On completion of this degree, graduates should have acquired good mathematical knowledge and skill beyond undergraduate level giving enough exposure to go towards research.

PO4: Graduate should have acquired the ability to formulate and communicate logically on problems involving mathematics helps to clear competitive exams.

PO5: Graduates are expected to be able to take advantage of quantitative and analytic exactitude and promote mathematics in scientific development as well as in general education of society.

PO6: Learning through digital classes / ICT learning improves the knowledge in use of technology in teaching effectively making them successful in their profession.

PO 7: In this program they are required to give classes in an education institution making them experienced in teaching.

PO8: The students are involved in peer teaching allowing greater understanding the subject , improving the teaching skills , leadership skills.

PO 9: Motivate the students to acquire curiosity and enthusiasm towards studies of advanced level and choose careers in Research.

PO 10: The students gain ability to understand professional importance and ethics of mathematics.

Program Specific Outcomes

PSO1: Students will be able to create, interpret and analyze graphical representations of data and equations to analyse the solution.

PSO2: To provide understanding the application of mathematics geographically, in physical sciences and chemical sciences.

PSO3: To make the students self sufficient to demonstrate proficiency in writing proofs of concepts by applying the underlying unifying structures of mathematics and the relationships between them.

PSO4 : To improve own learning and performance.

Course outcomes of all the courses offered by P.G. Mathematics Department

Code	Title of the paper	Course Outcomes
M101 (Th.)	Algebra -I	**Students will able to** 1. Describe concepts in normal subgroups. 2. Deduct Isomorphism theorems by recalling the concepts of normal subgroups. 3. Make use of properties of permutation groups to test for simplicity of Alternate groups. 4. Evaluate the fundamental theorem of finitely generated abelian groups using structure theorem on groups. 5. Judge Sylow groups and subgroups of a group with prime order. 6. Define an ideal and classifying the maximal ideals and prime ideals. 7. Analyze the importance of maximal ideal and quotient group to inspect a field. 8. Classify different domains, unique factorization domains and Euclidean domains. 9. Illustrate the interrelation between the domains (PID,UFD, Euclidean domain) with conditions. 10. Discuss Gauss lemma on polynomials by make use if division algorithm in polynomial rings over real numbers.
M102 (Th.)	Real Analysis-I	**Students will able to** 1. Define functions between Sets, equivalent sets , finite , countable and uncountable sets and prove several theorems. 2. Define metric and metric space and certain elementary concepts like open sets, closed sets, dense sets, interior point, limit point with examples and properties of these. 3. Explain the concept of compact set and connected set in metric space and prove several theorems. 4. Summarize convergent, divergent , bounded, Cauchy, monotone, upper and lower limits of sequences and convergent of Series. 5. Prove tests of convergence of series like comparision test, root

		test and ratio tests and apply these for certain series to determine their convergence. Show e is irrational. 6. Summarize the concepts of power series, absolute convergence and non absolute convergence of series. Prove Leibnitz theorem and Merten's theorem. 7. Determine the limit, continuity, differentiability and integrability of functions defined on a subset of the real line. 8. Apply mean value theorem and fundamental theorem of calculus to problems in the context of real analysis. 9. Determine if a function on a metric space is discontinuous , continuous (or) uniformly continuous. 10. Calculate the derivatives of certain functions and show examples of continuous functions which are not differentiable.
M103 (Th.)	Topology -I	**Students will able to** 1. Demonstrate the concept of countable sets and uncountable sets with examples and prove some related results. Demonstrate the concept of partially ordered set and lattice with examples. 2. Explain several standard examples of metric spaces, define diameter of a set, distance between a point and set in a metric space. 3. Determine whether a given metric space has any of the following properties: openness, closedness, completeness. Prove results related to all of the above notions, as well as continuity and uniform continuity. 4. Define cantor set and prove some related results. State and prove Baire's Theorem and Cantor's Intersection Theorem. 5. Explain notion of normed linear space , define Banach space and prove some related results. Define Euclidean and Unitary spaces and prove some related results. 6. Define the notion of topology, construct various topologies on a general set which is not empty by using different kinds of techniques, construct the topology by using the metric and define open set in Topological space. Define closed set, dense, separable, isolated point, limit point and prove some related results to all of the above notions. 7. Explain the notion of base and subbase and identify that a subset of a topology is a base or a subbase for this topology. Construct any arbitrary class of subsets of non empty set X can serve as an open subbase . Define second countable and prove some related results. Explain notion of continuity , weak topology and prove some related results. 8. Demonstrate the basic concepts, theorems and calculations of the concepts of Compactness. 9. Construct the product topology on the cartesian product of topological spaces by using given two or more topological spaces. 10. Prove Tychonoff's Theorem and Generalized Heine- Borel Theorem. Prove several results in compactness for metric spaces. Prove Ascoli's Theorem.

M104 (Th.)	Differential Equations	**Students will able to** 1. Determine the particular solutions of general second order linear differential equations and find general solution of Homogenous second order linear differential equation. 2. Show Wronskian and its relation to linear dependence / linear independence of two functions. 3. Use of two linearly independent solutions to find general solution of Homogenous second order linear differential equation. Find general solution of Homogenous second order linear differential equation with constant coefficients. 4. Solve second order linear differential equation using Methods of undetermined coefficients and variation of parameters. 5. Simplify Sturm - Liouville problems by utilizing Sturm's comparison theorem. 6. Describe Laplace transforms and solve differential equations, derivatives and integrals of Laplace transforms. 7. Show the convolution of piece-wise continuous function is indeed a continuous functions. 8. Analyze systems of first order equations and understand general remarks on linear system and non linear systems. 9. Examine Prey predator equations and their behaviour through an example Fox-Rabbit problem. 10. Deduct Picard's theorem and solve some examples.
M105 (Th.)	Linear Algebra	**Students will able to** 1. Extend a linear operator into a diagonal matrix by finding a suitable ordered basis. 2. Explain the concept of characteristic value, vector and space of a linear operator on a vector space represent over a field. 3. Analyze a class of polynomials which annihilates linear operator. 4. Build minimal and Characteristic polynomials over an operator. 5. Demonstrate invariant subspace and analyze various results on it which helps to understand the characterizations of diagonalizable (triangulable) operators. 6. Change a matrix into Jordan normal form by analyzing minimal and characteristic polynomials of matrix. 7. Simplify various decomposition (primary and cyclic) theorems on matrices. 8. Find equivalent matrix by applying elementary row operations/column operations, and analyzing the relation between equivalent matrices. 9. Define bilinear forms. Assess degenerate and non-degenerate bilinear forms. Design a special pseudo-orthogonal group called Lorentz group. 10. Classify the diagonalization of symmetric bilinear forms.

M201 (Th.)	Algebra-II	**Students will able to** 1. Illustrate different extensions of field such as algebraic, transcendental, normal and seperable extensions. 2. Examine whether a polynomial is reducible or irreducible over rational numbers by establishing Einstein criterion. 3. Construct splitting fields for polynomials over rational numbers and integers. 4. Inspect the multiplicity of roots in polynomials over a field. 5. Elaborate central results of Galois theory. 6. Contrast normal and seperable extensions. 7. Outline Fundamental theorem of Galois theory. 8. Illustrate the one-one correspondence between subgroups and subfileds by using Galois group. 9. Summarize Fundamental theorem of Algebra. 10. Judge a polynomial over a field to be solvable by radicals.
M202 (Th.)	Real Analysis-II	**Students will able to** 1. Demonstrate partitions, refinement of a partition,upper sums, lower sums, upper integrals and lower integrals and obtain relationship between upper and lower integrals. 2. Determine the Riemann-Stieltjes integrability of a bounded function and prove a selection of theorems concerning integration. Know what functions are Riemann-integrable. 3. Prove fundamental theorem of calculus, integration by parts and prove linear properties of vector valued integrals. 4. Define uniform convergence of a sequence functions and prove Cauchy criterion and weierstrass theorem for uniform convergence and uniform limit theorem. 5. Prove the limit of uniformly convergent sequence of integrable functions is integrable and prove the existence of a continuous function on the real line is nowhere differentiable. 6. To integrate (or) differentiate term by term and be able to apply this to examples 7. Define the concepts of point-wise boundedness, uniform boundedness and equicontinuity of families of functions and quote certain examples and counter examples of these. 8. Give the essence of the proof of stone weierstrass theorem , the contraction theorem as well as the existence of convergent subsequences using equicontinuous 9. Understand of how the elementary functions can be defined by power series and ability to deduce some of their easier properties. Illustrate the convergence properties of power series. 10. Prove the Implicit function theorem, Inverse function theorem and Rank theorem and apply inverse and implicit function theorems for functions of several variables.

M203 (Th.)	Topology-II	**Students will able to** 1. Define the concepts of a T_1-space and a Hausdorff spaces and give examples and counter examples of these spaces, prove certain important properties of T_1 -space and a Hausdorff spaces. 2. Define the concept of a completely regular space and normal space, prove that every compact Hausdorff space is normal and also every metric space is normal. 3. Use the Tietze extension theorem to prove the Urysohn's lemma. 4. Define the concept of a connected space and characterise the connected subsets of the real line. 5. Define the concept of a component of a space, totally disconnected space and give certain examples. 6. Define the concept of locally connected spaces with examples and prove some related theorems. 7. State and prove the weierstrass Approximation Theorem and The Real Stone Weierstrass Theorem 8. Demonstrate locally compact Hausdorff space, Describe the one point compactification of a locally compact Hausdorff space. 9. Define the concept of function vanishing at infinity and state and prove extended stone weierstrass theorem. 10. Define the concept of a Topological group with examples and prove several related theorems.
M204 (Th.)	Complex analysis-I	**Students will able to** 1. Compute the radius of convergence for complex power series. 2. Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra. Find the harmonic conjugate to a harmonic function. 3. Show analytic functions in terms of power series on their domains. Explain Branch of the complex logarithm. Calculate the image of circles and lines under Mobius Transformation. 4. Describe basic properties of complex integration and having the ability to compute such integrals. 5. Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions. 6. Apply (the proof of) Cauchy's Theorem and Cauchy's Integral Formula. 7. Define singularities of a function, know the different types of singularities, and be able to determine the points of singularities of a function 8. Find Laurent series about isolated singularities and determine residues.

		9. Prove the Cauchy Residue Theorem and use it to evaluate integrals. 10. Prove the argument Principle and the Rouche's Theorem. Find the number of zeros and poles within a given curve using the argument principle or Rouche's Theorem.
M205 (Th.)	Discrete Mathematics	**Students will able to** 1. Define graph, different types of graph and the concept of a bipartite graph and prove that a graph is bipartite iff it contains no odd cycles. 2. Explain the concept of tree, rooted tree, binary tree and prove some related theorems. 3. Define the concept of Spanning tree, Eulerian graph, Unicursal and prove some related theorems. 4. Demonstrate the concept Hamiltonian cycle and Hamiltonian graph and prove some related theorems. 5. Analyze J.B.Kruskal's Algorithmand R.C.Prim's Algorithm. 6. Prove that the concept of lattice ordered set and algebraic lattice are same. 7. Demonstrate the concept of modular and distributive lattice and prove some necessary and sufficient conditions for a lattice L to be a distributive (modular). 8. Define the concept of a Boolean Algebra and prove one –to –one correspondence between the class of Boolean Algebras and the class of Boolean rings. 9. Demonstrate the concept of Boolean polynomials, Disjunctive and conjunctive normal form. 10. Explain the concept of prime implicant, Determine the minimal polynomial of Boolean polynomial by using Quine-McCluskey algorithm. Use Karnaugh diagram to simplify the Boolean polynomial. Construct Switching Circuits.
M301 (Th.)	Functional Analysis	**Students will able to** 1. Explain normed linear space and by using this norm obtain a metric of the desired type, know important properties of norm continuity. 2. Define Banach , Hilbert spaces and Self adjoint operators. Examine a linear space is a Banach space. Construct new banach space from the given banach space. 3. Prove Hann Banach theorem, Open mapping theorem and Closed graph theorem. 4. Deduct Uniform boundedness theorem. Define conjugate T* of an operator T on a normed linear space N. 5. Define Hilbert space and provide certain examples. Determine a condition for which a Banach space is a Hilbert space. 6. Summarize orthogonal vectors in a Hilbert space, orthogonal complement of a subset of a Hilbert space , orthonormal set and a complete orthonormal set. 7. Classify different operators on Hilbert space, which commute

		with their adjoints. 8. Define orthogonal projection and find that they are self adjoint. 9. Recall eigen values and eigen vectors of an operator on Hilbert space, translate an operator into matrices on hilbert space. Establish important theorems. 10. Prove Spectral theorem and its applications.
M302 (Th.)	Number Theory-I	**Students will able to** 1. Classify different types of arithmetical functions such as Mobius function, Euler-Totient function and multiplicative functions. 2. Distinguish relations between these arithmetical functions and examine which arithmetical functions are multiplicative and completely multiplicative. 3. Examine Dirichlet's product of arithmetical functions. 4. Simplify the average of arithmetical functions by developing partial sums. 5. Deduct Dirichlet's asymptotic formula for the partial sums of divisor function. 6. Examine the distribution of lattice points in the plane which are visible from the origin. 7. Show the applications of theory of congruencies to simplify many problems concerning divisibility of integers. 8. Examine the condition that Dirichlet proposed for an arithmetical progressions to contain infinitely many primes. 9. Test whether a given Fermat number is prime or composite using properties of congruencies. 10. Identify the special case where any system of two or more linear congruencies which can be solved separately with unique solutions can also be solved simultaneously.
M303 (Th.)	Lattice Theory-I	**Students will able to** 1. Define poset with examples. Define length of a poset, Greatest lower bound, Lower upper bound, minimum and maximum chain condition, prove several related Theorems. 2. Show Jordan-Dedikind Chain condition, dimension function and height of an element in a poset. Give sufficient condition for poset to have a dimension function. 3. Explain the concept of lattice, sublattices, Ideals, atoms and dual atoms, prove several related Theorems. 4. Summarize complemented lattices, irreducible and Prime elements of a lattice. 5. Explain concept of complete lattice, complete sublattice, conditionally complete lattice, prove some related theorems. 6. Define the concept of compact element, compactly generated lattice and prove certain elementary properties 7. Summarize Closure operation , Galois connections and Dedekind cuts. 8. Categorize the distributive lattices and analyse the characteristics of modular and distributive lattices.

		9. Deduct Dedekind's modularity criterion and Birkhoff's distributive criterion. 10. Summarize covering conditions and meet representations in modular lattices.
M304 (Th.)	Commutative Algebra-I	**Students will able to** 1. Explain the various elementary operations which can be performed on ideals. 2. Distinguish different types of ideal (prime ideal and maximal ideal) with related examples and theorems. 3. Summarize the concept of Extension and contraction of ideals and outline the properties with theorems. 4. Define Modules, sub modules and module homomorphism with examples. 5. Explain Tensor product between modules and examine their behaviour in exact sequences. 6. Demonstrate the properties of extended and contracted ideals in rings of fractions. 7. Discover a property of rings called Local property and outline some propositions to give examples of local properties. 8. Define primary ideals, primary decomposition of ideals and rephrase the relationship between prime ideal and primary ideal. 9. Classify P-primary ideals and construct propositions which establish variation in primary ideals and p-primary ideals. 10. Establish the first and second Uniqueness theorem on decomposition of ideals.
M305 (Th.)	Calculus of variation	**Students will able to** 1. Fully understand the concept of functional and Euler's equations 2. Describe the branchistochrone problem mathematically and solve it. 3. Solve simple initial and boundary value problems by using several variable calculus. 4. Discuss some application to problems of mechanics : Hamilton's principle. 5. Calculate variational problems with a moving boundaries. 6. Compute one sided variations, reflection and reflection of estremals. 7. Formulate important results and Clairaut's theorem and Noether's theorem. 8. Solve Isopermetric problems of standard type. 9. Be through with methods for solving Elastic bodies and Electro statics problems.

M401 (Th.)	Measure and Integration	**Students will able to** 1. Classify Lebesgue measure on measurable sets. Deduct some theorems on properties of measurable functions. 2. Summarize little wood's three principles and Egoroff's theorem. 3. Define Riemann integral on bounded real valued functions, step function, characteristic function and simple functions on sets. 4. Explain Bounded convergence theorem on bounded measurable functions. 5. Make use of almost everywhere definition to deduct Fatous lemma. Establish theorems on bounded variation functions and monotone real valued functions. 6. Survey the absolute continuity of functions and examine the conditions of function to be bounded variation and constant functions. 7. Discuss Jensen's inequality on convex functions. 8. Define Vitali and conclude Vitali lemma. 9. Define L-p space, Normed linear space and Banach space and examine approximation in L-p. 10. Build Riesz- Fisher theorem and Riesz reprensentation theorem.
M402 (Th.)	Number Theory-II	**Students will able to** 1. Explain the distribution of any arithmetical function modulo integer as finite Fourier series. 2. Examine the existence of finite Fourier series for arithmetical functions. 3. Classify Ramanujan sums and Gauss sums and their generalisations. 4. Assess Legendre's symbol and Jacobi symbol and their quadratic reciprocity laws. 5. Explain the existence and non-existence of primitive roots for different moduli. 6. Demonstrate Dirichlet character is completely multiplicative and periodic with the use of properties of indices. 7. Examine the absolute convergence of a Dirichlet series in half-plane. 8. Explain analytic version of the fundamental theorem of arithmetic. 9. Prove Perron's formula for expressing the partial sums of a Dirichlet series as an integral of the sum function. 10. Explain Riemann Zeta function and the Dirichlet L-functions obtain the analytic continuations.

M403 (Th.)	Lattice Theory-II	**Students will able to** 1. Explain the concept of Boolean algebra, Boolean ring and complete Boolean algebra. Construct a Boolean ring from Boolean algebra and vice versa. 2. Define additive and completely additive valuation of lattices and of measurable algebras, prove some related theorems. 3. Define the concept of Birkhoff's lattices and semi modular lattices and prove some related theorems. 4. Explain about equivalence lattices and linear dependence and prove several theorems. 5. Summarize the concept of ideals and ideal lattices. 6. Prove that every distributive lattice is isomorphic to a ring of sets and so is every Boolean algebra to a field of sets. 7. Define congruence relation on algebra and prove there is a correspondence between the congruence relations of an algebra A and the homomorphism on A. 8. Define permutable congruence relation on an algebra A. Prove some related theorems. Prove Schreier refinement theorem in arbitary algebras. 9. Give different characterisations of the minimal congruence θ_{ab} for any two elements a,b of a distributive lattice. 10. Define the concept of kernel of a congruence relation θ. Prove some related theorems.
M404 (Th.)	Commutative Algebra-II	**Students will able to** 1. Define the concept of Integral dependence, integrally closed, valuation ring with related examples. 2. Deduct the proof of Going up theorem and Going down theorem. 3. Define the concept of chain condition on rings and modules with related examples and theorems. 4. Define Noetherian and Artinian modules and related theorem. 5. Examine the concept of Primary decomposition of Noetherian Ring with related examples and theorems. 6. Define Artin rings and construct structure theorem for Artin rings. 7. Test for equivalent conditions of ideals in Artin local ring. 8. Illustrate Discrete valuation rings with related theorems. 9. Define the concept of Dedekind domains with examples. 10. Summarize the concept of Fractional ideals with examples and inspect the properties of fractional ideals.

M405 (Th.)	Partial Differential Equations	**Students will able to** 1. Classify first order partial differential equations and classify integrals of first order partial differential equations . 2. Find general integral for a Quasi linear equation and find a complete integral of a first order partial differential equations by using Charpits method and Jacobi's method. 3. Demonstrate the concept of Pfaffian differential equation and find the integral of Pfaffian differential equation. 4. Evaluate the concept of compatibility of first order partial differential equations and find the one parameter family of common solutions. 5. Find the integral surface of the partial differential equation containing the curve. 6. Classify second order partial differential equations and transform into canonical form. 7. Demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDE's. 8. Solve analytically via the method of separation of variables, the heat and wave equations (in one space variable) and Laplace's equation (in two space variables), on rectangular and circular domains. 9. Find solutions of the heat equation, wave equation and Laplace equations subject to boundary conditions. 10. Demonstrate the concept of monge cone, characteristic strip, initial strips and prove related theorems