Course Outcomes (CO) of Major Course (NEP 2020)

Paper: Major-1 (CC1)

Title: *Classical Algebra, Analytical Geometry (2D) & Calculus*.

Course Outcomes (CO): The whole course will have the following outcomes.

Upon successful completion of this course, students will be able to

CO1: solve tangent and area problems using concepts of limit, derivatives and integrals.

CO2: calculate higher order derivatives and find limit of functions which are of indeterminate form using L'Hospital's rule.

CO3: find the rate in which a curve curves, further to find Asymptotes of curves, envelopes etc.

CO4: find length of a curve & volume and surface area of revolution.

CO5: understand the transformation rule of rectangular axes.

CO6: acquire knowledge on angle between pair of straight lines, bisectors etc. acquire concepts of poles and polar.

CO7: find polar equations of straight line, circle and conics.

CO8: learn concepts of complex numbers, De' Moivre's theorem and its application.

CO9: find number of real (positive & negative) and complex roots of algebraic equations using Descarte's rule and learn the methods to solve cubic and bi-quadratic equations.

CO10: acquire knowledge of inequalities.

Paper: Major-2 (CC2)

Title: *Algebra-I & Real Analysis-I*

Course Outcomes (CO): The whole course will have the following outcomes.

CO1: Objective of this course is the revision of their previous lessons of relation, equivalence relation, mapping, inverse mapping and their properties.

CO2: Group theory is one of the building blocks of modern algebra. The objective of this course is to introduce the students with basic concepts of group and their properties.

CO3: Upon successful completion of the course, students will have the knowledge and skills to solve problems in elementary number theory and in congruence.

CO4: After successful completion, the students will be able to think about the basic proof techniques and fundamental definitions related to the real number system. They can demonstrate some of the fundamental theorems of analysis. The students will gradually develop analysis skills in sets, sequences and infinite series of real numbers.

CO5: This course offers to the students, the concepts on limit, continuity and differentiability of functions of single variables. Also, after completion of this course students will be able to solve various types of problems on mean value theorems and intermediate value properties.

Paper: Major-3 (CC3)

Title: *Ordinary Differential Equations & Linear Algebra-I*

Course Outcomes (CO): The whole course will have the following outcomes.

Upon successful completion, student will be able to

CO1: solve first order differential equations utilizing the standard techniques for exact, linear, homogeneous, or Bernoulli cases.

CO2: solve first order nonlinear differential equations using the standard techniques and get an idea of singular solution.

CO3: find the complete solution of a non-homogeneous differential equation as a linear combination of the complementary function and a particular solution.

CO4: find the complete solution of a differential by variation of parameters.

CO5: solve the Pfaffian and simultaneous equations with constant coefficients.

CO6: have a working knowledge of basic application problems described by second order linear differential equations.

CO7: identify and construct linear transformations of a matrix.

CO8: solve linear systems represented as linear transforms.

CO9: express linear transforms in other forms, such as matrix equations, and vector equations.

CO10: characterize a set of vectors and linear systems using the concept of linear independence.

Paper: Major-4 (CC4)

Title: *Abstract Algebra-I & Multivariate Calculus*

Course Outcomes (CO): The whole course will have the following outcomes.

Upon successful completion of this course, the students will be able to

CO1: acquire knowledge of group such as permutation group, symmetric group, quaternion group etc.

CO2: understand Lagrange's, Fermat's, Cayley's. First, second and third isomorphism theorems and its applications.

CO3: analyse group, cyclic group, normal subgroups, Quotient group etc. understand preliminary concepts of ring and field.

CO4: acquire knowledge the limit and continuity of functions of two or more variables.

CO5: acquire concepts of partial and total differentiability, directional derivatives, gradients etc.

CO6: find extrema of functions of two variables.

CO7: calculate double and triple integral, volume by triple integral in spherical and polar coordinates.

Paper: Major-5 (CC5)

Title: *Analytical Geometry (3D), Vector Calculus & Partial Differential Equations*

Course Outcomes (CO): The whole course will have the following outcomes.

Upon successful completion of this course the students will be able to

CO1: understand the three-dimensional geometry of planes, straight lines, spheres, cones and cylinders.

CO2: acquire knowledge of cylindrical and spherical coordinates. Obtain the product of three or more vectors.

CO3: analyse the concepts limit and continuity and differentiability of vector valued functions.

CO4: calculate line, surface and volume integrals.

CO5: apply Green, Gauss and Stoke's theorems in finding various integrals.

CO6: understand linear & non-linear partial differential equations of first order.

CO7: learn Lagrange's and Charpit's method to solve a no n-linear partial differential equations.

Paper: Major-6 (CC6)

Title: *Dynamics of a Particle and System of Particles*

Course Outcomes (CO): The whole course will have the following outcomes: After successful completion of the course, students will be able to

CO1: get a basic knowledge of forces and moments that covers concepts of particle dynamics.

CO2: understand the construction of different free-body diagrams under the action of forces and their analysis.

CO3: calculate position, velocity and acceleration of particle using principles of kinematics.

CO4: make relationship between displacement, velocity, and acceleration.

CO5: to organize the knowledge about various concepts such as force, motion, work, power, energy, impulse, and momentum, among others.

CO6: apply derivatives and develop motion of equations of a particle under various external conditions.

CO7: determine the relations among the Work, Power, Energy.

CO8: determine Newton's 2nd Law of motion and its integration over time and displacement.

CO9: apply Kepler's laws to solve the various planetary motion problems.

CO10: understand the difference between a single particle motion and the connected particle motion.

Paper: Major-7 (CC7)

Title: *Real Analysis-II*

Course Outcomes (CO): The whole course will have the following outcomes:

CO1: Upon successful completion, the students will be familiar with open cover and functions of bounded variation in $\mathbb{R}$.

CO2: Objective of this course is the introduction of some new type of integrations viz. Riemann Integrals, Riemann-Stieltjes integrals.

CO3: After successful completion, Students will have the clear knowledge on Riemann integration and their properties and also students will be able to integrate functions in the sense of Riemann.

CO4: Upon successful completion of the course students will determine the type of improper integration and will develop the capacity to examine the convergence of the improper integral.

CO5: After successful completion of the course the students will acquire the ability to solve the problems in sequence of functions, series of functions and Fourier series. Also, they will be able to find the radius of convergence of the power series and their properties in the relevant field.

CO6: This course offers to the students, the basic ideas of point set topology and rigorous understanding of fundamental concepts in Mathematics. This will be helpful to the students in understanding pure mathematics and in research.

Paper: Major-8 (CC8)

Title: *Linear Programming Problems & Game Theory*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, the students will be able to

CO1: solve linear programming problems (LPP) using appropriate techniques and optimization solvers, interpret the results obtained.

CO2: determine optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products using various methods.

CO3: find the initial basic feasible and optimal solution of the LPP and Transportation problems.

CO4: construct linear integer programming models and discuss the solution techniques.

CO5: optimize the allocation of resources to Demand points in the best possible way using various techniques and minimize the cost or time of completion of number of jobs by number of persons.

CO6: model competitive real-world phenomena using concepts from game theory and analyze pure and mixed strategy games.

Paper: Major-9 (CC9)

Title: *Probability & Statistics*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, the students will be able to

CO1: calculate the expectation and moments of one- and two-dimensional random variables.

CO2: use of some important one dimensional discrete and continuous distributions and their basic properties.

CO3: learn the concept correlation and regression

CO4: explain the concept of convergence and check for the of convergence of a given sequences of random variables. CO5: find the expressions for the characteristic function of a random variable and verify its properties.

CO6: apply the various laws of large numbers to sequences of random variables.

CO7: understand the basic components of sampling and have the knowledge on exact sampling distributions which are essential for estimating and testing hypothetical statements.

CO8: find a best estimator with reference the different criteria in case of real-life applications. Understand critically the problems that are faced in testing of a hypothesis.

CO9: apply the different testing tools like t-test, chi-square test etc. to analyze the real-life problems.

Paper: Major-10 (CC10)

Title: *Numerical Methods & Computer Programming in C*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, the students will be able to

CO1: Understand the concepts of approximation and round-off errors, including the significance of decimal places and significant figures.

CO2: understand the theoretical and practical aspects of the use of numerical analysis.

CO3: derive numerical methods for various mathematical operations and tasks, such as interpolation techniques, integration, the solution of linear and nonlinear equations, and the solution of ordinary differential equations.

CO4: understand of common numerical analysis and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

CO5: establish the limitations, advantages, and disadvantages of numerical analysis.

CO6: proficient in implementing numerical methods for a variety of multidisciplinary applications.

CO7: understand the basics of computer programming in C, including different computer languages, Boolean algebra, and the binary number system.

CO8: write C programs using fundamental programming structures such as variables, operators, conditional statements (IF, IF-ELSE, LADDER, SWITCH), loops (DO, WHILE-DO, FOR), and arrays (one and two dimensions).

CO9: apply programming techniques to solve statistical problems and other simple programming tasks.

CO10: have a solid foundation in numerical methods, computer programming in C, and their applications in solving mathematical problems.

Paper: Major-11 (CC11)

Title: *Metric Spaces & Complex Analysis*

Course Outcomes (CO): The whole course will have the following outcomes:

CO1: The course is aimed at exposing the students to foundations of analysis, which will be useful in understanding various physical phenomena and give the students the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the students in understanding pure mathematics and in research.

CO3: Students will be able to know the basic concepts of metric space and developments of metric space which will prepare the students to take up the further application in the relevant fields.

CO4: After successful completion, the students will acquire clear knowledge and problems solving ideas on interior points, limit points, open sets and closed sets in metric space and their application.

CO5: Students will be able to know the basic concepts of complex analysis and developments of complex analysis which will prepare the students to take up the further application in the relevant fields. They can prove and explain concepts of power series and integration of complex functions and clearly understand problem-solving using complex analysis techniques.

Paper: Major-12 (CC12)

Title: *Abstract Algebra-II & Linear Algebra-II*

Course Outcomes (CO): The whole course will have the following outcomes:

At the end of the course the students will be able to

CO1: get concepts of direct product of finite number of group and group action etc.

CO2: deal with ideal and isomorphism of rings and polynomial ring etc. use diverse property of field extension in various areas.

CO3: compute the Galois group for several classical situations.

CO4: acquire facility with linear transformation and to apply it in real world.

CO5: understand geometric view of Eigen value, Eigen vector & Eigen space and their relation with diagonalizability.

CO6: understand the notion of an inner product space in general setting and to use Gram-Schmidt process to generate an orthonormal set of vectors etc.

Paper: Major-13 (CC13)

Title: *Computer Aided Numeral Practical in C (P)*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: write the algorithms and sketch the flowcharts of the given numerical problems.

CO2: develop a C program for a given algorithm.

CO3: understand a functional hierarchical code organization.

CO4: control the sequence of the program and give logical outputs.

CO5: work with textual information, characters and strings.

CO6: learn problem-solving skills, creativity, algorithmic, sequential and computational thinking skills.

CO7: manage I/O operations.

CO8: repeat the sequence of instructions and points for a memory location.

CO9: provide hands-on experience to apply computing skills in all other fields of study like Engineering, Geography, Bio Sciences, Physics, Chemistry, Medical Sciences etc.

CO10: become technology-oriented with the knowledge and ability to develop creative solutions, and better understand the effects of future developments of computer systems and technology on people and society as a whole.

Paper: Major-14 (CC14)

Title: *General Topology*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: Understand terms, definitions and theorems related to topology.

CO2: Demonstrate knowledge and understanding of concepts such as open and closed sets, interior, closure and boundary.

CO3: Create new topological spaces by using subspace, product and quotient topologies.

CO4: Use continuous functions and homeomorphisms to understand structure of topological spaces.

CO5: Apply theoretical concepts in topology to understand real world applications.

Paper: Major-15 (CC15)

Title: *Integral Transforms & Integral Equations*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: understand the ideas and importance of the Integral transforms that are used to map one domain into another in which the problem is simpler to analyze.

CO2: understand the analysis of linear time-invariant systems usually becomes easier if the time domain representation is changed to the frequency domain representation using the Laplace and Fourier transformations.

CO3: understand the difference between Laplace transform and Fourier transform.

CO4: develop two extremely powerful methods to solving differential equations: the Fourier and the Laplace transforms. Besides its practical use, the Fourier transform is also of fundamental importance in quantum mechanics.

CO5: turn a complicated problem into a simpler algebraic equation one in view of an integral transform.

CO6: categorize and solve different integral equations using various techniques.

CO7: determine the unknown function from an integro-differential equation.

CO8: understand the methods to reduce Initial value problems associated with linear differential equations to various integral equations.

CO9: understand the Fredholm and Volterra Integral Equations.

CO10: classify the initial and boundary value problems and their evaluation techniques.

Paper: Major-16 (CC16)

Title: *Elementary Differential Geometry*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: describes a multilinear relationship between sets of algebraic objects related to a vector space.

CO2: do computations with tensors, both in coordinates and in a coordinate-free form.

CO3: understand the basic knowledge of tensor calculus which has many applications in physics, engineering and computer science.

CO4: formulate a concise mathematical framework for solving physical problems in the areas of continuous media such as mechanics, electromagnetism, elasticity theory and theory of general relativity.

CO5: explain the central topics of curvature, connection and Riemannian metric.

CO6: develop understanding of basics of differential geometry.

CO7: compute the curvature of spheres and hyperbolic spaces.

CO8: find the shortest path between two points on the surface, which is called a geodesic.

CO9: explain the relationship between distances and geodesic curves.

CO10: express by intrinsic geometry that is closely connected to the concept of covariant differentiation.

Paper: Major-17 (DSC 1)

Title: *Advanced Mechanics*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: determine resultant of various force systems.

CO2: determine centroid, moment of inertia and solve problems related to them.

CO3: determine positions of equilibrium and conditions of equilibrium using principles of virtual works.

CO4: determine the tension of a string or thrust of a rod joining in a framework by principles of virtual works.

CO5: solve the mathematical moving models under the action forces in two dimensional spaces.

CO6: describe the physical properties of a fluid and calculate hydrostatic characteristics for a given floating structure.

CO7: calculate the pressure distribution for incompressible fluids and compute the hydrostatic pressure and force on plane and curved surfaces.

CO8: provide a mathematical framework to analyze the behavior of materials at macroscopic length, time and energy scales.

CO9: express the deformation and related stresses.

CO10: get an idea about the homogeneous, isotropic, continuous materials modelled as a continuous mass rather than as discrete particles.

Paper: Major-18 (DSC 2)

Title: *Operations Research & Calculus of Variations*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems and graphs.

CO2: solve various mathematical and physical problems using variational techniques.

CO3: formulate and solve the differential equations and extremum problems.

CO4: solve a problem using calculus of variations, which concerns finding functions that optimize the values of quantities that depend on those functions.

CO5: formulate the processing of n jobs through m machines.

CO6: understand project network, flow network, inventory control models and queuing theory.

Course Outcomes (CO) of Minor Course (NEP 2020)

Paper: Minor-1

Title: *Algebra and Analytical Geometry in 2D & 3D.*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: learn concepts of complex numbers, De' Moivre's theorem and its application, theory of equations.

CO2: Group theory is one of the building blocks of modern algebra. The objective of this course is to introduce the students with basic concepts of group and their properties.

CO3: determine the Eigen values and the corresponding Eigen vectors of a matrix.

CO4: verify Cayley-Hamilton theorem for a square matrix.

CO5: acquire knowledge on angle between pair of straight lines, bisectors etc. acquire concepts of poles and polar.

CO6: find polar equations of straight line, circle and conics.

CO7: understand the three-dimensional geometry of planes, straight lines, spheres, cones and cylinders.

Paper: Minor-2

Title: *Calculus, Differential Equations & Vector Calculus*

Course Outcomes (CO): The whole course will have the following outcomes:

Upon successful completion, students will be able to

CO1: differentiate successively of higher order derivatives using Leibnitz rule and can apply this to various real work problems.

CO2: acquire knowledge on partial derivatives and its broad application.

CO3: solve first order differential equations utilizing the standard techniques for exact, linear, homogeneous, or Bernoulli cases.

CO4: solve first order nonlinear differential equations using the standard techniques and get an idea of singular solution.

CO5: find the complete solution of a non-homogeneous differential equation as a linear combination of the complementary function and a particular solution.

CO6: have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.

CO7: obtain the product of three or more vectors.

CO8: analyze the concepts limit and continuity and differentiability of vector valued functions.

CO9: calculate divergence and curl of a vector valued function and problems regarding this.

Paper: Minor-3

Title: *Linear Programming Problem*

Course Outcomes (CO): The whole course will have the following outcomes. Upon successful completion, students will be able to

CO1: solve linear programming problems (LPP) using appropriate techniques and optimization solvers, interpret the results obtained.

CO2: determine optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products using various methods.

CO3: find the initial basic feasible and optimal solution of the LPP and Transportation problems.

CO4: construct linear integer programming models and discuss the solution techniques.

CO5: optimize the allocation of resources to Demand points in the best possible way using various techniques and minimize the cost or time of completion of number of jobs by number of persons.

Paper: Minor-4

Title: *Numerical Methods & Basic Computer Programming in C*

Course Outcomes (CO): The whole course will have the following outcomes. Upon successful completion, students will be able to

CO1: understand the concepts of approximation and round-off errors, including the significance of decimal places and significant figures.

CO2: understand the theoretical and practical aspects of the use of numerical analysis.

CO3: derive numerical methods for various mathematical operations and tasks, such as interpolation techniques, integration, the solution of linear and nonlinear equations, and the solution of ordinary differential equations.

CO4: understand of common numerical analysis and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

CO5: establish the limitations, advantages, and disadvantages of numerical analysis.

CO6: proficient in implementing numerical methods for a variety of multidisciplinary applications.

CO7: understand the basics of computer programming in C, including different computer languages, Boolean algebra, and the binary number system.

CO8: write C programs using fundamental programming structures such as variables, operators, conditional statements (IF, IF-ELSE, LADDER, SWITCH), loops (DO, WHILE-DO, FOR), and arrays (one and two dimensions).

CO9: apply programming techniques to solve statistical problems and other simple programming tasks.

CO10: have a solid foundation in numerical methods, computer programming in C, and their applications in solving mathematical problems.

Course Outcomes (CO) of
Skill Enhancement Course (SEC)
&
Multidisciplinary Course (MDC)
(NEP 2020)

Paper: SEC

Title: *Discrete Mathematics & Graph Theory*

Course Outcomes (CO): The whole course will have the following outcomes. Upon successful completion, students will be able to

CO1: apply algorithms based on prime numbers on practical problems.

CO2: understand the structure and types of proofs in mathematics.

CO3: define and relate basic notions in graph theory.

CO4: apply algorithms and theorems from graph theory on solving problems.

CO5: structure and solve real work problems by tools from discrete mathematics and graph theory working in teams.

Paper: MDC

Title: *Vedic Mathematics*

Course Outcomes (CO): The whole course will have the following outcomes. Upon successful completion, students will be able to

CO1: The objective of this course is to teach students the shortcut techniques which carries out numerical calculations in faster way.

CO2: This will help Students to develop their mental abilities and increases concentration.

CO3: Students will be able to utilize Vedic sutras to enhance their skills for competitive exams and able to solve examinations more efficiently.

CO4: It enables 10-15 times faster calculation as compared to the usual method and reduces silly mistakes.

CO5: It provides an easy and convenient solution to difficult mathematics problems and calculations.

CO6: It reduces burden (need to learn tables up to 9 only).

CO7: It's a magical tool to reduce scratch work finger counting.