MUGBERIA GANGADHAR MAHAVIDYALAYA
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DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

PROGRAMME OUTCOME (PO), COURSE OUTCOME (CO) AND PROGRAMME SPECIFIC OUTCOME (PSO) FOR END SEMESTER STUDENTS POSTGRADUATE COURSE: 2020-2021

Programme Name: M.SC (MATHEMATICS)

PROGRAMME OUTCOMES:

PO1: Disciplinary Knowledge: To acquire comprehensive and sufficient knowledge of understanding in Mathematics .

PO2: Critical Reasoning & Problem Analysis: To acquire the ability of deep study and then critically to think and analyse the subject of mathematics in its different areas.

PO3: Develop Interdisciplinary Knowledge: To enable students in developing an effective approach to Interdisciplinary study and enable them to build their own interdisciplinary pathway by choosing courses which makes sense to them.

PO4: Communication skill and attitudes: Excellent communication of mathematics in geometrical realization, documentation, makes effective presentation to develop other branches of sciences, to think existing open programme in mathematics using C –language, MATLAB, Lingo software. Also Study skill development Course on LaTeX

PO5: Self- directed Learning: Ability to work independently, study the subjects in its depth and apply thoughts for solving the problems in various field.

PO6: Experimental learning and Employability options: Students are able to identify problems, use constructive reasoning to make viable arguments, and applying mathematics in real-life problems Also they will able to find job in different sectors of mathematics and mathematics related subjects.

PO7: Develop Research Related Skill: Capability of thinking the various field of Mathematics advances in those fields and clear concept about them so that appropriate questions are formed on related fields.

PROGRAMME SPECIFIC OUTCOME:

PSO1: Thinking every topic in a critical manner.

PSO2: When there arise situation to provide information about any problem students are able to identify it, locate, evaluate and use the information effectively.

PSO3: Realize, evaluate, and formulate different quantitative models arising in social science, business and other fields.

PSO4: Apply mathematical and logical argument to develop and formulate every problem in a unique way.

PSO5: Acquire clear concept and knowledge to understand every problem and use mathematical and statistical method by the students through the course.

PSO6: Aware about the responsibility to become a citizen of the society and promise to scatter the scope of acquire knowledge.

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Course Outcomes (CO) for End Semester Students: 2018-2019

CO21: (MTM-401-Functional Analysis)

CO21:1: Idea about Normed Space, fundamental properties of Normed Space, bounded linear transformation B(X,Y), Banach Space, Hahn- Banach Extension Theorem.

CO21:2: Idea about Conjugate Space, Reflexive Spaces, Uniform Roundedness Principle, Closed Graph theory, Open Mapping Theorem. Fundamental concept of Inner Product Space, orthonormal Basis, Varies properties of Inner Product Space and related theorem like Parallelogram law, Cauchy-Schwarz inequality, Projection Theorem.
Learn about weak and strong convergence.

CO22: (MTM-402.1- Fuzzy Mathematics with Application, MTM402.2-Soft Computing)

CO22:1: Define fuzzy sets, α-cuts, fuzzy complements. Discuss of operations on fuzzy sets, fuzzy numbers, Illustrate fuzzy relations, binary fuzzy sets, fuzzy number, fuzzy equivalence relations.State some application on fuzzy set.

CO22.2: Learnsoft computing, fuzzy logic, Genetic Algorithm, Neural networks, Application of fuzzy logic concepts in scientific problems, Solution of optimization problems using Genetic Algorithm. Neural Network approaches in scientific analysis, design, and diagnostic problems.

CO23: (MTM-403.1: Magneto Hydro-Dynamics, MTM-403.2: Stochastic Process and Regression)

CO23:1: Learn about Maxwell's Electro magnetic field equations when medium in motion. Lorentz's force. To know about the equations of motion of a conducting fluid. Basic equations. Simplification of the electro magnetic field equation. Magnetic Reynolds number. Alfven theorem. Magnetic body force. Ferraro's law of Isorotation . Laminar Flow of a viscous conducting liquid between parallel walls in transverse magnetic fields.

M.H.D. Flow. Understanding past a porous flat plate without induced magnetic field. MHD Couelte Flow under different boundary conditions, Magneto hydro dynamics waves.

CO23.2: Concept of Markov chains with finite and countable state space and classification of states.Understanding of random walk, Gambler's ruin problem. Markov processes in continuous time. Poisson's process partial correlation. Multiple correlation. Advanced theory of linear estimation.

CO24: (MTM-404B Special Paper-OR: Nonlinear Optimization)

CO24.1: -To know the non-linear programming problem the nature of optimization and scope of the theory (Farka's Theorem , Existence Theorem etc.).To know about Quadratic Programming, Geometric Programming and Stochastic programming and their problems and solution

CO24.2: Game Theory (bi-matrix game) Learn Legendre and Bessel's equation and find their power series solution.

CO25:MTM-405B(Special Paper-OR: Operational Research Modelling-II)

CO25.1:-Understand the optimal control of functional using calculus of variation technique , learn Pontryagn's principle, Bang Bang Control.

CO25.2: Learn the Concept of reliability and use parallel and series system to get a reliability of machines, age, stress and mission time. Learn Entropy function , Encoding, Decoding, Noiseless Channel, marginal and conditional entropies also.

CO26: (MTM-495Special Paper-OR: Lab. on MATLAB and LINGO)

Able to solve problems on Advanced Optimization and Operations Research by using MATLAB and LINGO software in computer (Simplex Method, Revised Simplex Method, Stochastic Programming, Geometric Programming, Bi-matrix Games, Queuing Theory, Wolfe's Modified Method, IPP by Gomory's Cutting Plane Method, Inventory, Monte Carlo Simulation Technique, Dynamic Programming, Reliability).

CO27:(MTM-406: Dissertation Project Work)

Performance of dissertation Project on Tutorial/Review Work on Research Papers.

DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

DETAILED SYLLABUS OF ALL SEMESTER PG COURSES

Semester-I

MTM-101 **Real Analysis** **50**

Complete Metric spaces, compactness, connectedness (with emphasis on $\mathbb{R}^n$), Heine-Borel Theorem, Separable and non-separable metric spaces.

Functions of bounded variation, R-S Integral.

Measurable sets. Concept of Lebesgue function. Inner and outer measure. It's simple properties. Set of measure zero. Cantor set, Borel set and their measurability, Non-measurable sets.

Measurable function: Definition and it's simple properties, Borel measurable functions, sequence of measurable functions, Statement of Lusin's theorem, Egoroff's theorem. Simple functions and it's properties.

Lebesgue integral on a measurable set: Definition. Basic simple properties. Lebesgue integral of a bounded function over a set of finite measure. Simple properties. Integral of non-negative measurable functions, General Lebesgue integral. Bounded convergence theorem for a sequence of Lebesgue integrable function, Fatou's lemma. Classical Lebesgue dominated convergence theorem. Monotone convergence theorem, Relation between Lebesgue integral and Riemann integral

References:

1. W. Rudin, Principles of Mathematical Analysis, 3rd ed., McGraw-Hill.
2. W. Rudin, Real and Complex Analysis, International Student Edition, McGraw-Hill.
3. T. Apostol, Mathematical Analysis, 2nd ed., Narosa Publishers.
4. S. Kumaresan, Topology of Metric Spaces, 2nd ed., Narosa Publishers.
5. Inder K. Rana, An Introduction to Measure and Integration (2nd ed.), Narosa Publishing House, New Delhi.
6. P.R. Halmos, Measure Theory, Graduate Text in Mathematics, Springer-Verlag.
7. H.L. Royden, Real Analysis, 3rd ed., Macmillan.

Learning Outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Verify whether a function is a function of bounded variation and find the R-S integral of a bounded function.
2. Know the measurability of a set, integrability of any function and the Monotone convergence theorem.
3. Understand the fundamentals of measure theory and be acquainted with the proofs of the fundamental theorems underlying the theory of integration.
4. They will develop a perspective on the broader impact of measure theory and have the ability to pursue further studies in this and related area.
5. Explain the concept of length, area, volume using Lebesgue's theory.
6. Apply the general principles of measure theory and integration in such concrete subjects as the theory of probability or financial mathematics.

MTM-102 Complex Analysis 50

The definition of an analytic function. Cauchy- Riemann differential equation. Construction of analytic function. Jardan arc. Contour. Rectifiable arcs. Cauchy's theorem. Cauchy's integral formula. Morer's theorem. Liouville's theorem. Taylor's and Laurent's series. Maximummodulus principle.

Residues and Poles: Isolated Singular Points, Residues, Cauchy's Residue Theorem ,Residue at Infinity, The Three Types of Isolated Singular Points, Residues at Poles, Zeros of Analytic Functions, Zeros and Poles, Behavior of Functions Near Isolated Singular

Application of Residues: Evaluation of Improper Integrals, Improper Integrals from Fourier Analysis, Jordan's Lemma, Indented Paths, An Indentation Around a Branch Point, Integration Along a Branch Cut, Definite Integrals Involving Sines and Cosines, Argument Principle, Rouch´e's Theorem, Inverse Laplace Transforms

Mapping by Elementary Functions: Linear Transformations, Mappings by 1/z, Linear Fractional Transformations, An Implicit Form, Mappings of the Upper Half Plane, The Transformation $w = \sin z$, Mappings by z^2 and Branches of $z^{1/2}$, Square Roots of Polynomials, Riemann Surfaces

Conformal Mapping: Preservation of Angles, Scale Factors, Local Inverses, Harmonic Conjugates, Transformations of Harmonic Functions, Transformations of Boundary Conditions, The Schwarz–Christoffel Transformation: Mapping the Real Axis Onto a Polygon, Schwarz– Christoffel Transformation, Triangles and Rectangles, Degenerate Polygons.

References:

1. Complex Variable and Applications, J. W. Brown and R. V. Churchill, 8th Edition, GcGraw Hill.
2. Foundations of Complex Analysis , S. Ponnusamy , Narosa, 1995.

Learning Outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. What is multi-valued function and difference from the definition of single-real valued function?
2. How the residue theorem can be applied to calculate some of the improper as well as definite integrals.
3. Mapping by different elementary functions
4. What is conformal mapping and how it can be applied to some of the fluid dynamics problem.
5. What is analytic continuation?

MTM-103 Ordinary Differential Equations and Special Functions 50

Differential equation: Homogeneous linear differential equations, Fundamental system of integrals, Singularity of a linear differential equation, Solution in the neighbourhood of a singularity, Regular integral, Equation of Fuchsian type, Series solution by Frobenius method.

Hypergeometric equation. Hypergeometric functions, Series solution near zero, one and infinity, Integral formula for the hypergeometric function, Differentiation of hypergeometric function, The confluent hypergeometric function, Integral representation of confluent hypergeometric function.

Legendre equation: Legendre functions, Generating function, Legendre functions of first kind and second kind, Laplace integral, Orthogonal properties of Legendre polynomials, Rodrigue's formula, Schlaefli's integral.

Bessel equation: Bessel function, Series solution of Bessel equation, Generating function,

Integrals representations of Bessel’s functions, Hankel functions, Recurrence relations, Asymptotic expansion of Bessel functions.
Green’s Function: Green’s Function and its properties, Green’s function for ordinary differential equations, Application to Boundary Value Problems.
Eigen Value Problem: Ordinary differential equations of the Strum-Liouville type, Properties of Strum Liouville type, Application to Boundary Value Problems, Eigen values and Eigen functions, Orthogonality theorem, Expansion theorem.
System of Linear Differential Equations: Systems of First order equations and the Matrix form, Representation of nth order equations as a system, Existence and uniqueness of solutions of system of equations, Wronskian of vector functions.

References:

1. G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974.
2. M.S.P. Eastham: Theory of Ordinary Differential Equations, Van Nostrand, London, 1970.
3. S.L. Ross: Differential Equations (3rd edition), John Wiley & Sons, New York, 1984.

Learning Outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Three important topics of ODEs such as the Sturm-Liouville problem, Green‟s function and systems of linear differential equations.
2. On solving the SL problem, a broad idea can be carried on eigen value and eigen function which helps a lot to solve real-life problems.
3. Green’s function approach for solving complex initial and boundary value problems involving differential equations.
4. Modelling real-life problems as a system of linear differential equations and its solution method.
5. Learners achieve the overall concept for solving system of differential equations which have a great impact to extract the solutions for real-life problems.
6. The three important special functions such as Hypergeometric differential equation, Legendre differential equation, Bessel’s function and their properties.
7. Learners mainly achieve the solution procedure of special type differential equations which have many applications in engineering design problems and these are more related with real-life complex problems also

MTM-104 Advanced Programming in C and MATLAB 50

Programming in C: Review of basic concepts of C programming**,** Arrays, structure and union, Enum, pointers, pointers and functions, pointers and arrays, array of pointers, pointers and structures, strings and string handling functions, Dynamic memory allocation: using of malloc(), reallc(), calloc() and free(), file handling functions: use of fopen, fclose, fputc, fgets, fputs, fscanf, fprintf, fseek, putc, getc, putw, getw, append, low level programming and C preprocessor: Directive, #define, Macro Substitution, conditional compilation, #if, #ifdef, #ifndef, #else, #endif.

Programming in MATLAB: The Matlab workspace, data types, variables, assignment statements, arrays, sets, matrices, string, time, date, cell arrays and structures, introduction to M – file scripts, input and output functions, conditional control statements, loop control statements, break, continue and return statements.

References:

1. Kernighan BW, Ritchie DM. The C programming language. 2006.
2. Balagurusamy E. programming in ANSI C. Tata McGraw-Hill Education; 2012.
3. Byron Gottfried and Jitender Chhabra, Programming with C (Schaum's Outlines Series),2017
4. Gilat A. MATLAB: an Introduction with Applications. New York: Wiley; 2008.
5. Palm III WJ. Introduction to MATLAB for Engineers. New York: McGraw-Hill; 2011.
6. Chapman SJ. MATLAB programming with applications for engineers. CengageLearning; 2012.

Learning outcomes of the course:

Upon successful completion of this course, students will learn the following:

1. The features of numeric computation, advanced graphics and visualization using MATLAB.
2. Arrays and matrices to solve the various types of problems such as algebraic, differential,statistical, plotting etc using MATLAB.
3. Pointers in function, structure, union, dynamic memory management to construct linked listusing C Language.
4. Pointers in function, structure, union, dynamic memory management to construct linked listusing C Language.

MTM-105 Classical Mechanics and Non-linear Dynamics 50

Motion of a system of particles. Constraints. Generalized coordinates. Holonomic and non- holonomic system. Principle of virtual work. D'Alembart's Principle. Lagrange's equations. Plane pendulum and spherical pendulum. Cyclic co-ordinates. Coriolis force. Motion relative to rotating earth.

Principle of stationary action. Hamilton's principle. Deduction of Lagrange from Hamilton's principle. Brachitochrone problem. Lagrange's equations from Hamilton's principle.. Invariance transformations. Conservation laws. Infinitesimal transformations. Space-time transformations.

Hamiltonian. Hamilton's equations. Poisson bracket. Canonical transformations. Liouville's theorem.
Small oscillation about equilibrium. Lagrange's method. Normal co-ordinates. Oscillations under constraint. Stationary character of a normal mode. Small oscillation about the state of steady motion.Normal coordinates
Orientation and displacement of a rigid body. Eulerian angles. Principal axis transformation. Euler equations of motion. Motion of a free body about a fixed point.
Special theory of relativity in Classical Mechanics:-Postulates of special relativity. Lorentz transformation. Consequences of Lorentz transformation. Force and energy equations in relativistic mechanics.
Nonlinear Dynamics: Linear systems. Phase portraits: qualitative behavior. Linearization at a fixed point. Fixed points. Stability aspects. Lyapunov functions (stability theorem). Typical examples. Limit cycles. Poincare-Bendixson theory. Bifurcations. Different types of bifurcations.

References:

1. H. Goldstein, *Classical Mechanics*, Addison-Wesley, Cambridge, 1950.
2. A. S. Gupta, *Calculus of Variations with Applications*, Prentice-Hall of India, NewDelhi, 2005.
3. B. D. Gupta and S. Prakash, *Classical Mechanics*, Kedar Nath Ram Nath, Meerut, 1985.
4. T.W.B. Kibble, *Classical Mechinics*, Orient Longman, London, 1985.
5. N. C. Rana and P. S. Joag, *Classical Mechanics*, Tata McGraw-Hill Publishing CompanyLimited, New Delhi, 2004.

Learning outcomes of the course:

Upon successful completion of this course, the students can do the following:

1. The student will able to apply the Lagrangian formalism to analyze problems in Mechanics; dissect and describe the dynamics of systems of particles, rigid bodies, and systems in non inertial reference frames.
2. The student will deconstruct complex problems into their building blocks. Translate physical problems into appropriate mathematical language and apply appropriate mathematical tools to analyze and solve the resulting equations.
3. Students will demonstrate the ability to apply basic methods of classical mechanics towards solutions of various problems, including the problems of complicated oscillatory systems, the motion of rigid bodies, etc.

MTM-106 Graph Theory 25

Basic graph theoretical concepts: paths and cycles, connectivity, trees, spanning subgraphs, bipartite graphs, Hamiltonian and Euler cycles. Distance and centre, Cut sets and cut vertices. Colouring and matching. Four colour theorem (statement only). Planar graphs, Dual graph. Directed graphs and weighted graphs. Matrix representation of graphs, Algorithms for shortest path and spanning trees, Intersection graph, Applications of graphs in operations research.

References:

1. West, D. B. (2001). *Introduction to graph theory*, Upper Saddle River: Prentice hall.
2. Deo, N. (2017). *Graph theory with applications to engineering and computer science*.Courier Dover Publications.
3. Chartrand, G. (2006). *Introduction to graph theory*. Tata McGraw-Hill Education.
4. Gross, J. L., & Yellen, J. (2005). *Graph theory and its applications*. CRC press.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Understand and apply the fundamental concepts in graph theory.
2. Modelling of real-life problems using the concepts of graph theory.
3. Concept of the graph, tree, Euler graph, planar graph, cut set and Combinatorics.
   Solving capability for solving practical problems in science, business and industry

MTM-197 Lab.1:(Computational Methods: Using MATLAB) 25

Problem: 20 marks; Lab. Note Book and Viva-Voce: 5.

Working with matrix: Generating matrix, Concatenation, Deleting rows and columns. Symmetric matrix, matrix multiplication, Test the matrix for singularity, magic matrix. Matrix analysis using function: norm, normest, rank, det, trace, null, orth ,rref, subspace, inv, expm, logm, sqrtm,funm.
Array: Addition, Subtraction, Element-by-element multiplication, Element-by-element division, Element-by-element left division, Element-by-element power. Multidimensional Arrays, Cell Arrays, Characters and Text in array,
Graph Plotting: Plotting Process, Creating a Graph, Graph Components, Figure Tools, Arranging Graphs Within a Figure, Choosing a Type of Graph to Plot, Editing Plots, Plotting Two Variables with Plotting Tools, Changing the Appearance of Lines and Markers, Adding More Data to the Graph, Changing the Type of Graph, Modifying the Graph Data Source, Annotating Graphs for Presentation, Exporting the Graph.
Using Basic Plotting Functions: Creating a Plot, Plotting Multiple Data Sets in One Graph, Specifying Line Styles and Colors, Plotting Lines and Markers, Graphing Imaginary and Complex Data, Adding Plots to an Existing Graph, Figure Windows, Displaying Multiple Plots in One Figure, Controlling the Axes , Adding Axis Labels and Titles, Saving Figures.
Programming: Conditional Control – if, else, switch, Loop Control – for, while, continue, break, Error Control – try, catch, Program Termination – return.
Scripts and Functions: Scripts, Functions, Types of Functions, Global Variables, Passing String Arguments to Functions, The eval Function, Function Handles, Function Functions, Vectorization, Preallocation.
Linear Algebra: Systems of Linear Equations, Inverses and Determinants, Factorizations, Powers and Exponentials, Eigenvalues, Singular Values.
Polynomials: Polynomial functions in the MATLAB® environment, Representing Polynomials, Evaluating Polynomials, Roots, Derivatives, Convolution, Partial Fraction Expansions, Polynomial Curve Fitting, Characteristic Polynomials.

References:

1. Gilat A. MATLAB: an Introduction with Applications. New York: Wiley; 2008.
2. Palm III WJ. Introduction to MATLAB for Engineers. New York: McGraw-Hill; 2011.
3. Chapman SJ. MATLAB programming with applications for engineers. Cengage Learning; 2012.
4. Lopez C. MATLAB programming for numerical analysis. Apress; 2014.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. The interactive examples and hands-on problem-solving techniques.
2. The utility of basic MATLAB and its demonstration.
3. Vector and matrix manipulations, plotting of functions and data, solution ODE and its graph,and the creation of user interfaces, etc.
4. Applications in various disciplines such as engineering science and economics.

Semester –II

MTM-201 Fluid Mechanics 50

Compressible/Incompressible flow, Newtonian/Non-Newtonian fluids, Rotational/irrotational flows, Steady/Unsteady Flow, Uniform/Non uniform Flow, One, Two or three Dimensional Flow, Laminar or Turbulent Flow), Preliminaries for the derivation of governing equation (Coordinate systems: Lagrangian description and Eulerian description) Models of the flow(Finite Control Volume and Infinitesimal Fluid Element), Substantial Derivative, Source of Forces)

Derivation of Governing Equations: Derivation of Continuity Equation, Derivation of Momentum Equation, Special case (Incompressible Newtonian Fluid), Physical interpretation of each term, Derivation of Energy Equation, Boundary Conditions.

Boundary Layer Theory: Prandtl's Concept of Boundary Layer, Boundary Layer Flow along a Flat Plate, Governing Equations, Boundary Conditions , Exact Solution of the Boundary-Layer Equations for Plane Flows (Similarity Solution, Vorticity, Stress).

Exact/Analytical Solution of Navier-Stokes Equation**:** Reynolds number, Non-dimensionalization, Importance of Reynolds number to Navier-Stokes Equation, Exact Solution of Navier-Stokes Equation (Couette-Poisseuille flow, Flow of a Viscous Fluid with Free Surface on an Inclined Plate)

Incompressible Viscous Flows via Finite Difference Methods: Variable arrangement (Cell center / Colocated arrangement or Staggered Gird), One-Dimensional Computations by Finite Difference Methods, Space discretisation (Simple and general methods based on Taylor's series for first, second, and fourth order accuracy, and hence Accuracy of the Discretisation Process), Time discretization (Explicit Algorithm, Implicit Algorithm, and Semi-implicit Algorithm), Solution of Couette flow using FTCS and Crank-Nicolson methods.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. The general concept of what is fluid and its properties, and different kinds of flows.
2. Preliminaries (substantial derivative, different types of forces, etc) for the derivation ofgoverning equation for fluid flow.
3. Derivation of Governing Equations (Continuity, Navier-Stokes and Energy) in a mathematicalflavour.
4. Implementation of Initial and Boundary Conditions for the governing equations.
5. Exact Solution of the Navier-Stokes Equation in some of the special cases, like, Couette-Poisseuille flow.
6. Calculate momentum and thermal boundary layer thickness, the friction of force on the plate, flow rate, point of separation and reattachment, governing equations for boundary layer flows
7. Scaling the equations of motion and to see the role of nonlinear terms in the Navier-Stokes equation, derivation of Reynolds average Navier-Stokes (RANS) equation.

MTM-202 Numerical Analysis 50

Cubic spline interpolation. Lagrange's bivariate interpolation. Approximation of function. Chebyshev polynomial Minimax property. Curve fitting by least square method. Use of orthogonal polynomials. Economization of power series Numerical integration: Newton-Cotes formulae-open type. Gaussian quadrature Gauss- Legendre, Gauss-Chebyshev Integration by Monte Carlo method.

Roots of polynomial equation: Bairstow method. Solution of a system of non-linear equations by fixed point method and Newton-Raphson methods. Convergence and rate of convergence. Solution of a system of linear equations: Matrix inverse.LU decomposition method Solution of tri-diagonal system of equations Ill-conditioned linear systems Relaxation method.

Eigenvalue problem. Power method. Jacobi's method.Solution of ordinary differential equation: Runge-Kutta method to solve a system of equations and second order IVP. Predictor-corrector method: Milne's method. Stability Solution of second order boundary value problem by finite difference and finite element methods. Partial differential equation: Finite difference scheme. Parabolic equation: Crank-Nicolson method. Iteration method to solve Elliptic and hyperbolic equations.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Interpolation using spline interpolation.
2. Approximation of a function using the least square method, orthogonal polynomials.
3. Integration using Gaussian quadrature.
4. Solution of ordinary differential equations using RK-methods, predictor-corrector method,finite difference method, the finite element method.
5. Solution of a system of linear and non-linear equations and matrix inversion with pivoting.
6. Computation of the eigen values and eigenvectors of a matrix.
7. Solution of the partial differential equations (finite difference method) and analysis of stability of the methods to solve ODEs and PDEs.
8. Student will understand the theory behind these methods. The programming skill will increase after this course and hence they can write computer programs of any mathematical and logical problems.

MTM-203 Unit-1: Abstract Algebra 25

Groups: Morphism of groups. Quotient groups. Fundamental theorem on homomorphism of groups. Isomorphism theorems. Automorphism. Solvable groups and theorems on them.
Direct product. Conjugacy. Conjugate classes. Class equation. Theorems on finite groups. Cauchy's theorem. Sylow's theorem. Application of Sylow's theorem, Simple groups, Permutation groups, Cayley theorem, Group actions.
Rings and Field: Integral domain. Fields. Skew fields. Quotient rings. Morphism of rings. Ideals (Prime and maximal). Isomorphism theorem. Euclidean domain. Principal ideal domain. Unique factorization domain. Polynomial rings.
Field extensions, Finite, algebraic and finitely generated field extensions, Classical ruler and compass constructions, Splitting fields and normal extensions, algebraic closures. Finite fields, Cyclotomic fields, Separable and inseparable extensions.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Analyze and demonstrate examples of solvable groups and their propertiesof them.
2. Understand the importance of field extension.
3. Analyze and demonstrate examples of the classical ruler and compass constructions, normal extensions and separable extensions.
4. Understand the Galois group of a field extension.

Unit-2: Linear Algebra 25

Review of Linear transformations and matrix representation of Linear transformation, Linear operators, Isomorphism, Isomorphism theorems, Invertibility and change of coordinate matrix, The dual space, Minimal polynomial, Diagonlization.
Canonical Forms: Triangular canonical form, Nilpotent transformations, Jordan canonical form, The rational canonical form.
Inner product spaces, Hermitian, Unitary and Normal transformations, Spectral theorem. Bilinear forms, Symmetric and Skew-symmetric bilinear forms, Sylvester's law of inertia.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. The concept of a linear transformation, inner product space, bilinear forms, quadratic forms, canonical forms, minimal polynomial and Jordan canonical forms.
2. Diagonalisation process of a linear operator.
3. A details understanding of inner-product space, dual space and quotient space.
4. A complete idea about bilinear form.

MTM-204B HISTORY OF MATHEMATICS 50

Ancient Mathematical Sources, Mathematics in Ancient Mesopotamia, The Numeral System and Arithmetic Operations, Geometric and Algebraic Problems, Mathematical Astronomy, Mathematics in Ancient Egypt, Geometry, Assessment of Egyptian Mathematics, Greek Mathematics, The Development of Pure Mathematics, The Pre-Euclidean Period, The Elements, The Three Classical Problems, Geometry in the 3rd Century BCE, Archimedes, Apollonius, Applied Geometry, Later Trends in Geometry and Arithmetic, Greek Trigonometry and Mensuration, Number Theory, Survival and Influence of Greek Mathematics. Mathematics in the Islamic World (8th–15th Century), Origins, Mathematics in the 9th Century, Mathematics in the 10th Century, Omar Khayyam, Islamic Mathematics to the 15th Century The Foundations of Mathematics : Ancient Greece to the Enlightenment, Arithmetic or Geometry, Being Versus Becoming, Universals, The Axiomatic Method, Number Systems, The Reexamination of Infinity, Calculus Reopens Foundational The Philosophy of Mathematics: Mathematical Platonism, Traditional Platonism, Nontraditional Versions, Mathematical Anti-Platonism, Realistic Anti-Platonism, Nominalism, Logicism, Intuitionism, and Formalism, Mathematical Platonism: For and Against, The Fregean Argument for Platonism, The Epistemological Argument, Against Platonism.

Learning outcomes of the course: Upon successful completion of this course, the students will learn the following:

1. A general idea of the evolution of some of the major concepts of modern mathematics.

2. Understand basic, fundamental arguments that were developed centuries ago and are still of central importance today.

MTM-205 **General Theory of Continuum Mechanics** **50**

Stress: Body force. Surface forces. Cauchy's stress principle. Stress vector. State of stress at a point. Stress tensor. The stress vector –stress tensor relationship. Force and moment equilibrium.Stress tensor symmetry stress quadric of Cauchy. Stress transformation laws. Principal stress.Stress invariant. Stress ellipsoid.

Strain: Deformation Gradients. Displacement Gradient Deformation tensor. Finite strain tensors. Small deformation theory-infinitesimal strain tensor. Relative displacement. Linear rotation tensor. Interpretation of the linear strain tensors. Strength ratio. Finite strain interpretation. Principal strains. Strain invariant. Cubical dilatation . Compatibility equation for linear strain. Strain energy function. Hook's law. Saint –Venant's principal. Airy's strain function. Isotropic media. Elastic constrains. Moduli of elasticity of isotropic bodies and their relation. Displacement equation of motion. Waves in isotropic elastic media.

Perfect fluid: Kinematics of fluid. Lagrangian method.. Eulerian method. Acceleration. Equation of continuity. The boundary surface.. Stream lines and path lines. Irrotational motion and its physical interpretation. Velocity potential. Euler's equation of motion of an in viscid fluid. Cauchy's integral. Bernoulli's equation. Integration of Euler's equation. Impulsive motion of fluid. Energy equation. Motion in two dimensions. The stream functions Complex potential.

Source, sink and doublet and their images. Milne-Thompson circle theorem and its application. Vorticity. Flow and circulation. Kelvin's circulation theorem. Kelvin's minimum energy theorem.

References:

1. Continuum Mechanics: T.J.Chung, Prentice – Hall.
2. Continuum Mechanics: Schaum's Outline of Theory and Problem of Continuum Mechanics: Gedrge R. Mase, McGraw Hill.
3. Mathematical Theory of Continuum Mechanics: R.N.Chatterjee, Narosa PublishingHouse.

Continuum Mechanics: A.J.M. Spencer, Longman

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. The concept of strain deformation of an object as a continuum which assumes that the substance of the object completely fills the space it occupies.
2. The knowledge about stress vector which is applied on material points in an object.
3. The relationship between strain tensor and stress tensors in an elastic substance.
4. Fundamental physical laws such as the conservation of mass, the conservation of momentum, and the conservation of energy to be applied to such models to derive differential equations describing the behavior of such objects, and some information about the particular material studied to be added through constitutive relations.

MTM-206 **General Topology** **25**

Topological Spaces: open sets, closed sets, neighborhoods, basis, sub-basis, limit points, closures, interiors, continuous functions, homeomorphisms. Examples of topological spaces: subspace topology, product topology, metric topology, order topology, Quotient Topology.
Connectedness and Compactness: Connected spaces, connected subspaces of the real line, Components and local connectedness, Compact spaces, Local–compactness, Tychnoff's Theorem on compact spaces.
Separation Axioms: 1st and 2nd countable spaces, Hausdorff spaces, Regularity, Complete Regularity, Normality.
Urysohn Lemma, Urysohn Metrization Theorem, Tietze Extension theorem (statement only).

References:

1. J. R. Munkres, Topology, 2nd Ed., Pearson Education (India).
2. M. A. Armstrong, Basic Topology, Springer (India).
3. K. D. Joshi, Introduction to General Topology, New Age International, New Delhi.
4. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, NewYork.
5. J. L. Kelley, General Topology, Van Nostrand, Princeton.

Learning outcomes of the course:

Upon successful completion of this course, students will learn the following:

1. How the topology on a space is determined by the collection of open sets, by the collection of closed sets, or by a basis of neighbourhoods at each point.
2. Subspace topology, order topology, product topology, metric topology and quotient topology.
3. What it means for a function to be continuous?
4. Urysohn Lemma and the Tietze extension theorem and can characterize metrizable spaces.

MTM-301 Partial Differential Equations and Generalized Functions 50

Differential Equations: First order PDE in two independent variables and the Cauchy problem. Semi-linear and quasilinear equations in two-independent variables. Second order linear PDE. Adjoint and self-adjoint equations. Reduction to canonical forms. Classifications. Fundamental equations: Laplace, Wave and Diffusion equations.

Hyperbolic equations: Equation of vibration of a string. Existence. uniqueness and continuous dependence of the solution on the initial conditions. Method of sepearation of variables. D'Alembert's solution for the vibration of an infinite string. Domain of dependence. Higher- dimensional wave equations.

Elliptic equations: Fundamental solution of Laplace's equations in two variables. Harmonic function. Characterization of harmonic function by their mean value property. Uniqueness. Continuous dependence and existence of solutions. Method of separation of variables for the solutions of Laplace's equations. Dirichlet's and Naumann's problems. Green's functions for the Laplace's equations in two dimensions. Solution of Dirichlet's and Naumann's problem forsome typical problems like a disc and a sphere. Poisson's general solution.

Parabolic equations: Heat equation - Heat conduction problem for an infinite rod - Heat conduction in a finite rod - existence and uniqueness of the solution.

Generalized Functions: Dirac delta function and delta sequences. Test functions. Linear functionals. Regular and singular distributions. Sokhoski-Plemelj formulas. Operations on distributions. Derivatives. Transformation properties of delta function. Fourier transform of generalized functions.

References:

1. Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations,Cambridge University Press.
2. F. John, Partial Differential Equations, 3rd ed., Narosa Publ. Co., New Delhi.
3. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19,AMS, Providence.
4. E. Zauderer, Partial Differential Equations of Applied Mathematics, 2nd ed., John Wileyand Sons, New York.
5. S. Rao, Introduction to Partial Differential Equations, 3rd Edition, PHI Learning PrivateLimited, New Delhi.

J. J. Duistermaat and J. A. C. Kolk, Distributions Theory and Applications, Birkhauser

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Use the knowledge of first and second order partial differential equations (PDEs),the generalstructure of solutions, and analytic methods for solutions.
2. Classification of PDEs, analytical methods, and physically interpretation of the solutions.
3. Solution of standard PDEs (Wave, Heat & Laplace equations) using separation of variables and Analyse the stability and convergence properties of this method.
4. Finding the solution of Dirichlet's and Neumann's problems for some typical problems like a Disc and a sphere.
5. Use the knowledge of first and second order partial differential equations (PDEs), the generalstructure of solutions, and analytic methods for solutions.
6. Classification of PDEs, analytical methods, and physically interpretation of the solutions.

MTM-302 Transforms and Integral Equations 50

Fourier Transform: Fourier Transform, Properties of Fourier transform, Inversion formula, Convolution, arseval's relation, Multiple Fourier transform, Bessel's inequality, Application of transform to Heat, Wave and Laplace equations (Partial differential equations).

Laplace Transform: Laplace Transform, Properties of Laplace transform, Inversion formula of Laplace transform (Bromwich formula), Convolution theorem, Application to ordinary and partial differential equations.

Wavelet Transform: Time-frequency analysis, Multi-resolution analysis, Spline wavelets, Sealing function, Short-time Fourier transforms, Wavelet series, Orthogonal wavelets, Applications to signal and image processing.

Integral Equation: Formulation of integral equations, Integral equations of Fredholm and Volterra type, Solution by successive substitutions and successive approximations, Resolvent Kernel Method, Integral equations with degenerate kernels, Abel's integral equation, Integral Equations of convolution type and their solutions by Laplace transform, Fredholm's theorems, Integral equations with symmetric kernel, Eigen value and Eigen function of integral equation and their simple properties, Fredholm alternative.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Understanding of integral transformation, such as Laplace, Fourier and Wavelet transforms.
2. Solution of ODE and PDE, particularly IVP or BVP, using integral transformation.
3. Determination of the exact location of the solution using Wavelet transforms.
4. Formation and solution method of integral equations.
5. Solution method of dynamical problems and applied based practical problems using integralequations.

MTM-303 Unit-1: Dynamical Oceanology and Meteorology 25

Dynamical Oceanology: Properties of Sea Water relevant to Physical Oceanography: Measurement of density, temperature and salinity, Relative density, sigma-t and specific volume, Density and specific volume as functions of temperature, salinity and pressure;The Basic Physical Laws used in Oceanography and Classifications of Forces and Motions in the Sea: Basic laws, Classifications of forces and motions;The Equation of Continuity of Volume: The concept of continuity of volume, The derivation of the equation of continuity of volume.he Equation of Motion in Oceanography: The form of the equation of motion, Obtaining solutions to the equations, including boundary conditions, The derivation of the terms in the equation of motion, The pressure term,Transforming from axes fixed in space to axes fixed in the rotating earth, Gravitation and gravity, The Coriolis terms, Other accelerations.

Dynamical Meteorology: Dynamical Meteorology: Composition of Atmosphere, Atmospheric Structure, Basic Thermodynamics of the atmosphere, Poisson's Equation, Potential temperature, Equation of state of dry air, hydrostatic equation, variation of Pressure with altitude, hypsometric equation, dry adiabatic lapse rate, Equation of moist air,Virtual temperature, mixing ratio, specific humidity, absolute humidity and relative humidity, fundamental atmospheric forces, derivation of momentum equation of an air parcel in vector and Cartesian form, Geostrophic wind and Gradient wind.

References:

1. Introductory Dynamical Oceanology, 2nd Ed, Pond, Stephen; Pickard, George L., Butterworth-Heinemann Ltd Linacre House, Jordan Hill, Oxford 0X2 8DP

Learning outcomes of the course: Upon successful completion of this course, students will learn the following:

1. Different thermodynamics laws are applied in the atmosphere to get a state of dry and moist air in the atmosphere.
2. The understanding of the basic physical processes occurring in the atmosphere in a mathematical perspective.
3. Measurement formula of the height in the atmosphere.
4. Measurement of humidity variables.
5. Stability analysis of the atmosphere.

MTM-305B Special Paper-OR: Advanced Optimization and Operations Research 50

Revised simplex method (with and without artificial variable). Modified dual simplex. Large Scale Linear Programming: Decomposition Principle of Dantzig and Wolf.

Parametric and post-optimal analysis: Change in the objective function. Change in the requirement vector, Addition of a variable, Addition of a constraint, Parametric analysis of costand requirement vector.
Search Methods: Fibonacci and golden section method.Gradient Method: Method of conjugate directions for quadratic function, Streepest descent and Davodon-Fletcher-Powell method. Methods of feasible direction and cutting hyperplane method.

Integer Programming: Gomory's cutting plane algorithm, Gomory's mixed integer problem algorithm, A branch and bound algorithm.Goal Programming: Introduction, Difference between LP and GP approach, Concept of Goal Programming, Graphical solution-method of Goal Programming, Modified simplex method of Goal Programming.Optimization for Several Variables: Algebraic approach, Algebraic geometrical approach, costdifferent approach, Inequality approach.

References:

1. S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.
2. Taha, Hamdy A. *Operations research: An introduction*. Pearson Education India, 2004.
3. Belegundu, Ashok D., and Tirupathi R. Chandrupatla. *Optimization concepts andapplications in engineering*. Cambridge University Press, 2011.

Sharma, S. D. Operations Research, Kedar Nath Ram Nath & Co., Meerut

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Identification and development of operational research models from the verbal description ofthe real system.
2. Understanding the mathematical tools that are needed to solve optimization problems.
3. Use of mathematical software to solve the proposed models.
4. Development of report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in management engineering.

MTM-306B Special Paper-OR: Operational Research Modelling-I 50

Dynamic Programming: Introduction, Nature of dynamic programming, Deterministic processes, Non-Sequential discrete optimization, Allocation problems, Assortment problems, Sequential discrete optimization, Long-term planning problem, Multi-stage decision process, Application of Dynamic Programming in production scheduling and routing problems.

Inventory control: Probabilistic inventory control (with and without lead time), Dynamic inventory models. Basic concept of supply – chain management and two echelon supply chain model.

Network: PERT and CPM: Introduction, Basic difference between PERT and CPM, Steps of PERT/CPM Techniques, PERT/CPM Network components and precedence relationships, Critical path analysis, Probability in PERT analysis, Project Time-Cost, Trade-off, Updating of the project, Resource allocation — resource smoothing and resource leveling.

Replacement and Maintenance Models: Introduction, Failure Mechanism of items, Replacement of items deteriorates with time, Replacement policy for equipments when value of money changes with constant rate during the period, Replacement of items that fail completely— individual replacement policy and group replacement policy, Other replacement problems — staffing problem, equipment renewal problem.

Simulation: Introduction, Steps of simulation process, Advantages and disadvantages of simulation, Stochastic simulation and random numbers— Monte Carlo simulation, Random number, Generation, Simulation of Inventory Problems, Simulation of Queuing problems, Role of computers in Simulation, Applications of Simulations.

References:

1. Taha, Hamdy A. Operations research: An introduction. Pearson Education India, 2004.

Learning outcomes of the course:

Upon successful completion of this course, the students will learn the following:

1. Inventory management techniques in deterministic and probabilistic environments.
2. Understanding of network optimization techniques.
3. Analysis of network using CPM and PERT.
4. Understanding of the project time-cost, trade-off, updating of the project and resourceallocation techniques.

MTM 401: Functional Analysis **Credits 04**

Course Content:

(a) Normed spaces , Continuity of linear maps , Bounded linear transformation. Set of all bounded linear transformation , Banach space Quotioent of normed linear spaces and its consequences. Hahn-Banach Extension theorem and Its applications , Banach Spaces. A NLS is Banachiff every absolutely convergent series is convergent. Conjugate spaces, Reflexive spaces.

(**b**) Uniform Boundedness Principle and its applications. Closed Graph Theorem , Open Mapping Theorem and their applications. Inner product spaces, Hilbert spaces, Orthonormal basis, Complete Orthonormal basis , Cauchy-Schwarz Inequality, Parallelogram law. Projection theorem , Inner product is a continuous operator. Relation between IPS and NLS. Bessel's inequality. Parseval's identity.

(**c**) Strong and Weak convergence of sequence of operators. Reflexivity of Hilbert Space. Riesz Representation theorem for bounded linear functional on a Hilbert space. Definition of self-adjoint operator, Normal, Unitary and Positive operators, Related simple theorems.

MTM 401: Unit-1: Fuzzy Mathematics with Applications : **Credit 02**

Course Content:

Basic concept and definition of fuzzy sets. Standard fuzzy sets operations and its properties.

Basic terminologies such as Support, α-Cut, Height, Normality, Convexity, etc. Fuzzy relations, Properties of α-Cut, Zadeh's extension principle, Interval arithmetic, Fuzzy numbers and their representation, Arithmetic of fuzzy numbers. Basic concept of fuzzy matrices. Basic concepts of fuzzy differential equations.

Linear Programming Problems with fuzzy resources:

(i) Vendegay's approach

(ii) Werner's approach

L.P.P. with fuzzy resources and objective: Zimmermann's approach. L.P.P. with fuzzy Parameters in the objective function. Definition of Fuzzy multi objective linear programming problems.

Unit-2: Soft Computing **Credit 02**

Course Content:

Introduction of soft computing, fuzzy logic, Genetic Algorithm, Neural networks, Application of fuzzy logic concepts in scientific problems, Solution of optimization problems using Genetic Algorithm. Neural Network approaches in scientific analysis, design, and diagnostic problems.

MTM-403 : Unit-1: Magneto Hydro-Dynamics **Credit 02**

Course Content:

Maxwell's electromagnetic field equations when medium in motion. Lorentz's force. The equations of motion of a conducting fluid. Basic equations. Simplification of the electromagnetic field equation. Magnetic Reynolds number. Alfven theorem. Magnetic body force. Ferraro's law of Isorotation. Laminar Flow of a viscous conducting liquid between parallel walls in transverse magnetic fields. M.H.D. Flow Past a porous flat plate without induced magnetic field. MHD Couelte Flow under different boundary conditions, Magneto hydro dynamics waves. Hall currents. MHD flow past a porous flat plate without induced magnetic field.

Unit-2: Stochastic Process and Regression **Credit 02**

Course Content:

Stochastic Process: Markov chains with finite and countable state space. Classification of states. Limiting behaviour of n state transition probabilities. Stationary distribution.Branching process. Random walk. Gambler's ruin problem. Markov processes in continuous time. Poisson's process Partial correlation. Multiple correlations. Advanced theory of linear estimation.

MTM-404B Special Paper-OR: Nonlinear Optimization **Credit-04**

Course content:

Optimization: The nature of optimization and scope of the theory, The optimality criterion of Linear programming, An application of Farka's theorem, Existence theorem for linear systems, Theorems of the alternatives, Slater's theorem of alternatives, Motzkin theorem of alternatives , Optimality in the absence of differentiability and constraint qualification, Karlin's constraint qualification, Kuhn-Tucker's saddle point necessary optimality theorem, Fritz-John saddle point optimality theorem, Optimality criterion with differentiability and Convexity, Kuhn-Tucker's sufficient optimality theorem, Fritz-John stationary point optimality theorem, Duality in non-linear programming, Weak duality theorem, Wolfe's duality theorem, Duality for quadratic programming. Quadratic Programming , Wolfe's modified simplex method, Beale's method, Convex programming. Stochastic Programming , Chance constraint programming technique. Geometric Programming , Geometric programming (both unconstrained and constrained) with positive and negative degree of difficulty. Games: Preliminary concept of continuous game, Bi-matrix games, Nash equilibrium, and solution of bi-matrix games through quadratic programming (relation with nonlinear programming). Multi-objective Non-linear Programming: Introductory concept and solution procedure.

MTM-405B Special Paper-OR: Operational Research Modelling-II Credit-02

Course Content :

Optimal Control: Performance indices, Methods of calculus of variations, Transversally

Conditions, Simple optimal problems of mechanics, Pontryagin's principle (with proof assuming smooth condition), Bang–bang Controls. Reliability: Concept, Reliability definition, System Reliability, System Failure rate, Reliability of the Systems connected in Series or / and parallel. MTBF, MTTF, optimization using reliability, reliability and quality control comparison, reduction of life cycle with reliability, maintainability, availability, Effect of age, stress, and mission time on reliability. Information Theory: Introduction, Communication Processes— memory less channel, the channel matrix, Probability relation in a channel, noiseless channel. A Measure of information- Properties of Entropy function, Measure of Other information quantities marginal and joint entropies, conditional entropies, expected mutual information, Axiom for an Entropy function, properties of Entropy function. Channel capacity, efficiency and redundancy. Encoding-Objectives of Encoding. Shannon-Fano Encoding Procedure, Necessary and sufficient Condition for Noiseless Encoding.

MTM-495B Special Paper-OR: Lab. (OR methods using MATLAB and LINGO) Credit -02

Course Content :

Problems on Advanced Optimization and Operations Researchare to be solved by using

MATLAB (one question carrying 9 marks) and LINGO (one question carrying 6 marks)

(Total: 15 Marks)

1. Problems on LPP by Simplex Method.

2. Problems on LPP by Revised Simplex Method.

3. Problems on Stochastic Programming.

4. Problems on Geometric Programming.

5. Problems on Bi-matrix Games.

6. Problems on Queuing Theory.

7. Problems on QPP by Wolfe's Modified Method.

8. Problems on IPP by Gomory's Cutting Plane Method.

9. Problems on Inventory.

10. Problems on Monte Carlo Simulation Technique.

11. Problems on Dynamic Programming.

12. Problems on Reliability.

MTM-406 :Dissertation Project Work **Credit-04**

Course Content

Dissertation Project will be performed on Tutorial/ Review Work on Research Papers. For Project Work one class will be held in every week. Marks are divided as the following: Project Work-25, Presentation-15, and Viva-voce-10. Project Work of each student will be evaluated by the concerned internal teacher/supervisor and one External Examiner. The external examiner must be present in the day of evaluation.

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MAPPING OF CO, PO, PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO21.1	✔	✔				✔	✔		✔			✔	
CO21.2	✔	✔			✔			✔		✔		✔	
CO22.1	✔	✔		✔			✔		✔			✔	
CO22.2	✔	✔		✔			✔	✔	✔		✔		
CO23.1	✔	✔		✔				✔		✔	✔		
CO23.2	✔	✔		✔			✔		✔		✔		
CO24.1	✔	✔			✔			✔	✔				✔
CO24.2	✔	✔				✔	✔	✔				✔	
CO25.1	✔	✔			✔		✔		✔		✔		
CO25.2	✔	✔	✔			✔		✔		✔			
CO26	✔	✔		✔				✔		✔	✔		
CO27	✔	✔			✔		✔		✔		✔		

JUSTIFICATION MATRIX OF CO WITH PO & PSO (High: 3, Medium: 2, Low: 1)

	Mapping	Correlation	Justification
CO21.1	PO1	HIGH	Acquire knowledge on how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis.
	PO2	HIGH	Students make questioning and reasoning to enrich in theory of normed and Banach-spaces , including the Hahn-Banach theorem, the Uniform Boundedness principle.
	PO6	MODERATE	Students able to find their scope of job real life problem learning application of this course.
	PO7	HIGH	Students will be able to use research methods for this specified courses.
	PSO2	HIGH	Students will able to Identify critical problems related tothe theory of normed and Banachspaces, including the Hahn-Banach theorem,
	PSO5	HIGH	Student realize to evaluate the problemof the open mapping theorem, the closed graph theorem,
CO21.2	PO1	HIGH	Students will able to obtain vast fundamental knowledge of theory of Hilbert spaces to other areas, including Fourier series,the theory of self-adjoin operator
	PO2	HIGH	Student learn about the questioning on normal operators, unitary operators and positive Operator.
	PO5	HIGH	Student apply knowledge on bounded linear transformation in self directed way.
	PSO1	MODERATE	Students will think the topics of the Hilbert space theory, including Riesz representation theorem and weak convergence,
	PSO3	LOW	Student realize how tocritically reflect over chosen strategies and methods in problem solving.
	PSO5	HIGH	Student will able to understand the Uniform Boundedness principle by mathematical& statistical method
CO22.1	PO1	HIGH	Students will able to obtain vast fundamental knowledge of fuzzy sets, numbers, matrix, knowledge of various operations on above fuzzy sets.
	PO2	HIGH	Student learn about the questioning on the fuzzy ordinary differential equation, fuzzy linear programming problems, and fuzzy multi-objective linear programming problems.
	PO4	HIGH	Students apply the knowledge of fundamental uncertain programming solving skill which occur almost all decision making problem
	PO7	HIGH	Student able to think in advance topics related this subject and improve research skill

	PSO2	HIGH	Students able to he problems and analyze to find information correctly in this course
	PSO5	HIGH	Students acquired more detailed knowledge about the problem of this course by mathematical& statistical method
CO22.2	PO1	HIGH	Students learn the concept.the basic concepts Soft computing like how it resemble biological processes more closely than traditional techniques.
	PO2	HIGH	Acquire knowledge of questioning and reasoning onthe fuzzy logic and system control.
	PO3	HIGH	Students will able to build their interdisciplinary pathway by choosing genetic algorithm and hands on solving optimization problems.
	PSO1	MODERATE	Students will able to think critical problems related to this course.
	PSO2	HIGH	To help the learners for solving complex mathematical modeling of various real-life practical problems.
	PSO4	HIGH	Student will able to identify and formulate the basic neural network models and illustrate with numerical examples.
CO23.1	PO1	HIGH	Students acquired sound and sufficient knowledge the basic concepts and the equations of flow of viscous fluids and the electromagnetic induction mechanism..
	PO2	HIGH	To understand how to make appropriate questions and reasoning in ability to translate a magnetic hydrodynamic problem in an appropriate mathematical form and to interpret the solutions of the equations established in physical terms.
	PO4	MODERATE	Student learn to communicate with other using concept of different aspect of this course
	PSO1	HIGH	Students will able to think critical problems related to this course
	PSO3	LOW	Student realize how to evaluate the problem by figures and models of this course
	PSO4	HIGH	Student will able to identify and formulate the problems of Skills in analysis and synthesis; the application of knowledge and problem solving,critical thinking and independent learning.
CO23.2	PO1	HIGH	Obtain knowledge on basic concepts from the theory of Markov chains
	PO2	HIGH	Acqrire knowledge about critical reasoning and questioning in Poisson processes and birth and death processes. The student also knows about Wiener Process and branching process
	PO4	MODERATE	Student learn to communicate with other using concept of different aspect of this course
	PO7	HIGH	Student able to think in advance topics related this subject and improve research skill
	PSO2	HIGH	Student learn to identify the problems and analyze to find information correctly in this course
	PSO4	LOW	Student will able to identify and derive the expression for three or more dimensional curve fitting, including multiple and partial correlations for relevant practical systems of metric space in a unique way
CO24.1	PO1	HIGH	Obtain concepts on Non-linear Optimization such as Geometric Programming, Quadratic Programming, Nash Equilibrium, Bimatrix Game, Stochastic Programming, Multi-Objective Programming
	PO2	HIGH	Students make questioning and reasoning to enrich in specific subject
	PO5	HIGH	Students apply the knowledgefor solving complex mathematical modeling of various real-life practical problemsin self directed way.

	PSO1	MODERATE	Students will able to think critical problems related to this course
	PSO2	HIGH	Student learn to identify the problems and analyze to find information correctly in this course.
	PSO6	HIGH	Student will able to create awareness and scope of applying this course
CO24.2	PO1	HIGH	Acquire knowledge on tackling of random parameters in optimization problems through stochastic programming
	PO2	HIGH	Students make questioning and reasoning to enrich in Bi matrix Game, Stochastic Programming
	PO6	MODERATE	Students able to find their scope of job real life problem learning application of this course
	PO7	HIGH	Students will be able to use research methods for this specified courses
	PSO1	HIGH	Students will able to think critical problems related to. Multi-objective Non-linear Programming.
	PSO5	HIGH	Student realize to evaluate the problem of this course by mathematical& statistical method
CO25.1	PO1	HIGH	Obtain clear concept to Prepare and motivate future specialists to continue in their study by having an insightful overview of operations research.
	PO2	HIGH	Students make questioning and reasoning to enrich in Understand the technique to solve the problem using Optimal Control theory.
	PO5	MODERATE	Students gather the knowledge of Pontryagin's principle and Bang–bang Controls to solve mechanical and other real life problems in self directed way.
	PO7	LOW	Student able to think in advance topics related this subject and improve research skil
	PSO2	HIGH	Student learn to identify the problems and analyze to find information correctly in this course.
	PSO4	HIGH	Student will able to identify and formulate the problems of Optimal Control in a unique way.
CO25.2	PO1	HIGH	Students obtain a vivid knowledge thorough understanding of reliability of a component and a system of components.
	PO2	HIGH	Acquire knowledge of questioning and reasoning on Entropy and its measurement and properties
	PO3	MODERATE	Students will able to build their interdisciplinary pathway by choosing Reliability and Information Theory.
	PO6	HIGH	Students will able to identify problems, solve using constructive reasoning on this course.
	PSO1	HIGH	Students will able to think critical problems Shannon-Fano Encoding procedure and necessary and sufficient condition for noiseless encoding
	PSO3	MODERATE	Student realize how to evaluate the problems of this course by figures and models
CO26	PO1	HIGH	Learn vividly about Collecting data from different sources for the real-life optimization problems
	PO2	HIGH	To understand how to make appropriate questions and reasoning of the programming.
	PO4	MODERATE	Student learn to communicate with other using concept of different aspect of this course

	PSO1	HIGH	Students will able to think critical problems related to this course
	PSO3	HIGH	Student realize how to evaluate the problem by figures and models of this course
	PSO4	MODERATE	Student will able to identify and formulate the problems and learners will handle the real-life application of optimization Problems in a unique way
CO27	PO1	HIGH	Obtain clear concept to demonstrate appropriate referencing and develop skills in other aspects of academic writing.
	PO2	HIGH	Identify key research questions within the field of Demography on which students will carry out independent research.
	PO5	HIGH	Apply the demographic/statistical research training acquired in the taught element of the Programme by designing an appropriate research strategy and research methodology to carry out research in self directed way.
	PO7	MODERATE	Student able to think in advance topics related this subject and improve research skil
	PSO2	HIGH	Student learn to identify the problems and analyze to find information correctly in this course.
	PSO4	HIGH	Student will able to demonstrate knowledge and understanding of report writing in a unique way.

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ARTICULATION MATRIX OF CO WITH PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO21.1	3	3				2	3		3			3	
CO21.2	3	3			3			2		3		3	
CO22.1	3	3		3			3		3			3	
CO22.2	3	3		3			3	3	3		3		
CO23.1	3	3		2				3		1	3		
CO23.2	3	3		2			3		3		1		
CO24.1	3	3			3			2	3				3
CO24.2	3	3				2	3	3				3	
CO25.1	3	3			2		1		3		3		
CO25.2	3	3	2			3		3		2			
CO26	3	3		2				3		3	2		
CO27	3	3			3		2		3		3		
Target	3	3	2	2.4	2.7	2.3	2.6	2.7	3	2.3	2.5	3	3

DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

Department of Mathematics (UG & PG)

Attainment of Course & Programme Outcomes

(http://www.vidyasagar.ac.in/admission/PGProgrammes.aspx#)

In the Outcome Based Education (OBE), assessment is done through one or more than one processes, carried out by the department, that identify, collect, and prepare data to evaluate the achievement of course outcomes (CO's).

The process for finding the attainment of Course outcomes uses various tools/methods. These methods are classified into two types: **Direct methods and indirect methods.**

Direct methods display the student's knowledge and skills from their performance in the class/assignment test, internal assessment tests, assignments, semester examinations, seminars, laboratory assignments/practicals, mini projects etc. These methods provide a sampling of what students know and/or can do and provide strong evidence of student learning.

Indirect methods such as course exit survey and examiner feedback to reflect on student's learning. They are used to assess opinions or thoughts about the graduate's knowledge or skills.

Following tables show the various methods used in assessment process that periodically documents and demonstrates the degree to which the Course Outcomes are attained. They include information on:

a) Listing and description of the assessment processes used to gather the data, and
b) The frequency with which these assessment processes are carried out.

Table 1 : Direct Assessment tool used for CO attainment

Sr. No.	**Direct Assessment Method**	**Assessment frequency**	**Description**
1.	Internal Assessment Test	Twice in a Semester	The Internal Assessment marks in a theory paper shall be based on two tests generally conducted at the end of 6th and 11th weeks of each semester. It is a metric used to continuously assess the attainment of course outcomes w.r.t course objectives. Average marks of two tests shall be the Internal Assessment Marks for the relevant

			course.
2.	Lab Assignments / experiments	Once in a week	Lab Assignment/Experiment is a qualitative performance assessment tool designed to assess students' practical knowledge and problem solving skills. Minimum ten experiments need to be conducted for every lab course.
3.	End Semester Examination	Once in a Semester	End Semester examination (theory or practical) are the metric to assess whether all the course outcomes are attained or not framed by the course incharge. End Semester Examination is more focused on attainment of all course outcomes and uses a descriptive questions.
4.	Practical Semester Examination		
5.	Home Assignments	Twice in a Semester	Assignment is a metric used to assess student's analytical and problem solving abilities. Every student is assigned with course related tasks & assessment will be done based on their performance. Grades are assigned depending on their innovation in solving/deriving the problems.
6.	Class / Assignment Test	Twice in a Semester	It is a metric used to continuously assess the student's understanding capabilities.
7.	Preliminary Examination	Once in a semester	Preliminary examination is the metric to assess whether all the course outcomes are attained or not by asking descriptive questions.
8.	Presentations	As per the requirement	Presentation is the metric used to assess student's communication and presentation skills along with depth of the subject knowledge. Seminars topics are given to the students that cover topics of current interest or provide in-depth coverage of selected topics from the core courses.

Table 2: Indirect Assessment tool used for CO attainment

Sr. No.	**Indirect Assessment Method**	**Assessment frequency**	**Method Description**
1	Course Exit Survey / Students Feedback Survey	End of Semester	Collect variety of information about course outcomes from the students after learning entire course.

The weightages given for various assessment tools used for the attainment of Course Outcomes are shown in table 3.

Table 3: List of Course Assessment tools

<table>
<tr><td rowspan="15">**Assessment Tools**</td><td rowspan="14">**Direct**</td><td rowspan="10">**Internal Tools**</td><td>**Tools**</td><td>**Frequency**</td><td>**Weightage**</td></tr>
<tr><td>Assignment Tests</td><td>Twice in a semester</td><td rowspan="9">**20%**</td></tr>
<tr><td>Internal Assessment</td><td>Twice in a semester</td></tr>
<tr><td>Home Assignments</td><td>Selected Topic</td></tr>
<tr><td>Practical</td><td>Weekly</td></tr>
<tr><td>MOCK Practicals</td><td rowspan="4">Once in a semester</td></tr>
<tr><td>MCQ</td></tr>
<tr><td>Seminar/Presentations</td></tr>
<tr><td>Mini Projects</td></tr>
<tr><td>Preliminary Examination</td><td>Once in a semester</td></tr>
<tr><td rowspan="4">**External Tools**</td><td>End Semester Examination</td><td>Once in a semester</td><td>**80%**</td></tr>
<tr><td>End Semester Practical</td><td>Once in a semester</td><td></td></tr>
<tr><td>End Semester Project</td><td>Only one paper(MTM 406) in IV Semester</td><td>**100%**</td></tr>
<tr><td>End Semester Field Visit</td><td>Only one paper(MTM 405) in IV Semester</td><td>**10%**</td></tr>
<tr><td>**Indirect**</td><td>**--**</td><td>Course Exit Survey/ Examiners’ feedback</td><td>Once in a Semester</td><td>**On Marks Allotted but As Per NAAC / IQAC Guideline**</td></tr>
</table>

DIRECT METHOD

Academic Session: **2020-2021** (**Semester IV**)

Attainment report for M. SC in Mathematics

Target Level	**Level Description Marks student scoring**	**50 → indicates % and above in the questions in Internal and External tests**
1	Below 40%	
2	**Below 40%-49%**	
3	50% & about	

Student Name	**Roll Number**	**SEM I SGPA**	**SEM II SGPA**	**SEM III SGPA**	**SEM IV SGPA**	**CGPA**	**Marks Obtained**	**Total Marks**
ANSAR ALI KHAN	0001	7.67	9.50	9.67	9.00	8.96	999	1200
ASHARANI MANNA	0002	7.92	8.83	9.67	9.00	8.86	1004	1200
BIDHAN CHANDRA JANA	0003	8.42	9.42	9.67	9.59	9.28	1041	1200
CHANDAN GIRI	0004	8.67	9.33	9.67	9.50	9.29	1052	1200
CHAYAN PRADHAN	0005	6.92	8.67	9.67	9.67	8.73	980	1200
DEBMALYA MISHRA	0006	8.75	9.42	9.50	9.75	9.36	1059	1200
DURGA MANDAL	0007	8.75	9.58	9.67	9.67	9.42	1071	1200
GAYATRI JANA	0008	8.25	9.42	9.67	9.34	9.17	1023	1200
GOPAL DAS	0009	9.58	9.58	9.67	9.75	9.67	1104	1200
GOURANGA BERA	0010	9.00	9.33	9.50	9.00	9.21	1046	1200

MADHURI BERA	0011	8.75	9.42	9.67	9.50	9.33	1047	1200
MADHUSUDAN MIDYA	0012	8.33	9.25	9.67	9.50	9.19	1031	1200
MANISH ACHARYYA	0013	9.33	9.50	9.67	9.84	9.59	1085	1200
MOUMITA SAHOO	0014	9.42	9.50	9.67	9.75	9.59	1078	1200
NILANJAN PRAMANIK	0015	8.67	9.42	9.50	9.42	9.25	940	1200
PALLABITA MAITY	0016	8.17	9.17	9.67	9.42	9.10	1024	1200
RAMNARAYAN PATRA	0017	7.92	9.42	9.50	9.42	9.06	1021	1200
RANITA GIRI	0018	8.75	9.50	9.67	9.42	9.33	1052	1200
SANGITA PAUL	0019	8.50	9.67	9.67	9.50	9.33	1045	1200
SANJU SINGHA	0020	8.33	9.58	9.67	9.25	9.21	1037	1200
SATYAKI ADAK	0021	8.75	9.58	9.67	9.34	9.34	1039	1200
SEULI DEY	0022	8.92	9.25	9.67	9.34	9.29	1036	1200
SIMA BHUNIA	0023	8.42	89.58	9.67	9.25	9.23	1028	1200
SK SAJAHAN	0024	8.65	9.58	9.67	8.84	9.21	954	1200
SOUMIK HAIT	0025	8.83	9.42	9.67	9.59	9.38	1048	1200
SUDIPTA KHATUA	0026	8.92	9.42	9.67	9.59	9.40	1074	1200
SUMAN MANNA	0027	7.67	9.48	9.67	9.42	9.04	1022	1200
SUPRITI SI	0028	8.92	9.58	9.67	9.34	9.38	1054	1200
TAPAS SIT	0029	8.00	9.33	9.67	9.75	9.19	1028	1200
TUHINA GIRI	0030	9.33	9.58	9.67	9.75	9.58	1092	1200

Programme Name:M. Sc (MATHEMATICS)

DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

RATING AND RELATION OF POs AND PSOs WITH QUESTIONNARIE

Average Rating (Excellent- 4, Good-3, Average-2, Poor-1) Target level: 3

Questions	Average Rating (Out of 29 Students)
1. Did you acquire sound & sufficient knowledge of the courses taught?	**3.7**
2. Rate your skill development in terms of critical thinking & reasoning offered in the courses?	**3.5**
3. How much are the courses offered to you suggesting an interdisciplinary approach?	**3.5**
4. Rate the courses as per their communication skill and attitude	**3.8**
5. Did the courses help in developing self directed learning?	**3.4**
6. Rate the courses in terms of their updation with recent developments.	**3.3**
7. Rate the courses in terms of their experimental learning and employability option?	**2.7**
8. Rate the courses in terms of their environmental awareness and relevance to sustainable measures?	**3.7**
9.Rate the courses in terms of developing research oriented skill	**3.8**
10. How far the courses are relevant in terms of job opportunities and research/further studies?	**3.9**

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
Questionier	Q1, Q3, Q2	Q1,Q4,Q5	Q1, Q7, Q5	Q1, Q5, Q3	Q2, Q4, Q9	Q1, Q6, Q3	Q1, Q5, Q9	Q1,Q10,Q6	Q1,Q4,Q7	Q2,Q6,Q9	Q1,Q6,Q8	Q1, Q3, Q8	Q1, Q7, Q10
Average Rating	3.57	3.63	3.27	3.53	3.7	3.5	3.67	3.63	3.4	3.53	3.57	3.63	3.43

Mugberia Gangadhar Mahavidyalaya

DEPARTMENT OF MATHEMATICS

FINAL ATTAINMENT OF CO, PO & PSO

PROGRAMME NAME: M.Sc. IN MATHEMATICS

Direct Method: Average COs of all courses

	CO	CO	CO	CO	CO	CO	CO	CO	CO
	21.1, 21.2	22.1	22.2	23.1	23.2	24.1 24.2	25.1 25.2	26	27
Direct Attainment	3	3	3	3	3	3	3	3	3

In Direct Method, the target level is reached successfully.

Indirect Method: Average of PO & PSO with the questionnaire

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
	1	2	3	4	5	6	7	8	9	10	11	12	13
Indirect Attainment	3.57	3.63	3.27	3.53	3.7	3.5	3.67	3.63	3.4	3.53	3.57	3.63	3.43

In Indirect Method, the target level is reached successfully for POs & PSOs.

DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

The following list of students from 2020-2021Batch have taken admission into HEIs for higher studies:

Name of student enrolling into higher education PG Course (2018-2019)	Program Post Graduated from	Name of institution joined	Name of Programme admitted to
ASHARANI MANNA	Department of Mathematics	Subhas Chandra Basu B.Ed. Training College	B.Ed

CHANDAN GIRI	Department of Mathematics	Odalchua PTTI & B.Ed.	B.Ed
CHAYAN PRADHAN	Department of Mathematics	Odalchua PTTI & B.Ed.	B.Ed
DEBMALYA MISHRA	Department of Mathematics	Odalchua PTTI & B.Ed.	B.Ed
GAYATRI JANA	Department of Mathematics	B.Ed from contai PK college, Contai, Purba Medinipur	B.Ed
GOURANGA BERA	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed
MADHUSUDAN MIDYA	Department of Mathematics	Bankim Behari Teachers Training Institute	B.Ed
MANISH ACHARYYA	Department of Mathematics	Vidyasagar Basic College	B.Ed
MOUMITA SAHOO	Department of Mathematics	Vidyasagar Basic College	B.Ed
RAMNARAYAN PATRA	Department of Mathematics	Odalchua PTTI & B.Ed.	B.Ed
RANITA GIRI	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed
SEULI DEY	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed
SK SAJAHAN	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed
SUDIPTA KHATUA	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed
SUPRITI SI	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed
TAPAS SHEET	Department of Mathematics	Vidyasagar Basic College	B.Ed
TUHINA GIRI	Department of Mathematics	Deshapran College of Teachers Education.	B.Ed

DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

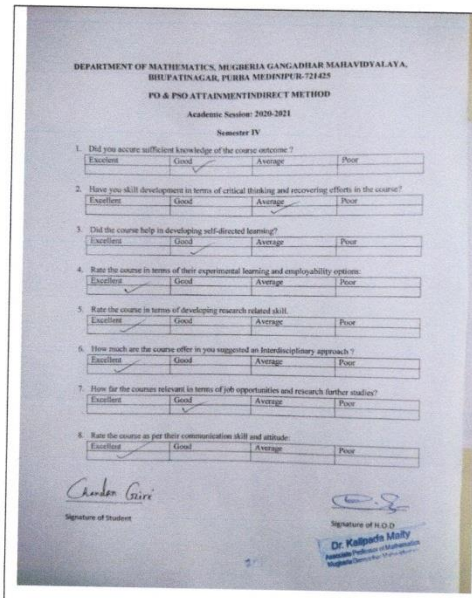
COs, POs & PSOs INDIRECT ATTAINMENTINDIRECT METHOD

Academic Session: 2021-2022

Semester IV

Programme Name: M. SC. (MATHEMATICS)

EXIT FORM SURVEY/ EXAMINER'S FEEDBACK IS CONDUCTED THROUGH QUESTIONNAIRE METHODS. OUT OF 10 QUESTIONS, FIRST 7 OF THEM RELATE DIRECTLY TO THE COs & POs &THE LAST 3 QUESTIONS RELATE TO THE PSOs. A SAMPLE FORM IS GIVEN BELOW:



DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

PO & PSO ATTAINMENTINDIRECT METHOD

Academic Session: 2020-2021

Semester IV

1. Did you accure sufficient knowledge of the course outcome ?

Excelent	Good	Average	Poor
	✓		

2. Have you skill development in terms of critical thinking and recovering efforts in the course?

Excellent	Good	Average	Poor
		✓	

3. Did the course help in developing self-directed learning?

Excellent	Good	Average	Poor
	✓		

4. Rate the course in terms of their experimental learning and employability options:

Excellent	Good	Average	Poor
✓			

5. Rate the course in terms of developing research related skill.

Excellent	Good	Average	Poor
✓			

6. How much are the course offer in you suggested an Interdisciplinary approach ?

Excellent	Good	Average	Poor
✓			

7. How far the courses relevant in terms of job opportunities and research further studies?

Excellent	Good	Average	Poor
	✓		

8. Rate the course as per their communication skill and attitude:

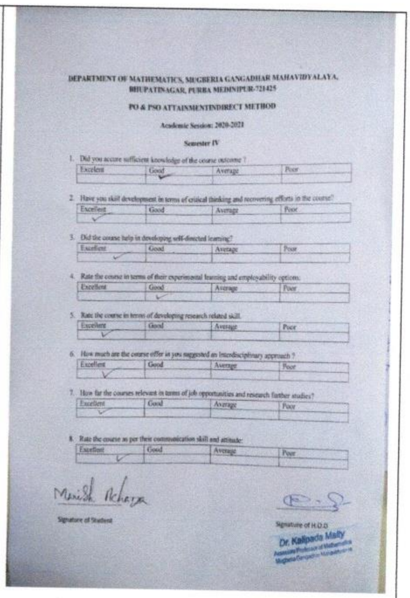
Excellent	Good	Average	Poor
✓			

Chandan Giri

Signature of Student

Signature of H.O.D

Dr. Kalipada Maity



DEPARTMENT OF MATHEMATICS, MUGBERIA GANGADHAR MAHAVIDYALAYA, BHUPATINAGAR, PURBA MEDINIPUR-721425

PO & PSO ATTAINMENTINDIRECT METHOD

Academic Session: 2020-2021

Semester IV

1. Did you accure sufficient knowledge of the course outcome ?
2. Have you skill development in terms of critical thinking and recovering efforts in the course?
3. Did the course help in developing self-directed learning?
4. Rate the course in terms of their experimental learning and employability options:
5. Rate the course in terms of developing research related skill.
6. How much are the course offer in you suggested an Interdisciplinary approach ?
7. How far the courses relevant in terms of job opportunities and research further studies?
8. Rate the course as per their communication skill and attitude:

Excelent	Good	Average	Poor

Manish Acharya

Signature of Student

Signature of H.O.D

Dr. Kalipada Maity

The above document of COs & POs of Mathematics Departments is original and correct to best of the knowledge.

The report is prepared by Dr. Kalipada Maity, HOD & Associate Professor, Mr. Bikash panda, SACT, and Mr. Santu Hati, Contractual Teacher, Dept. of Mathematics.

Mugberia Gangadhar Bhupatinagar ESTD.-1964 Purba Medinipur

12.05.23

Dr. Swapan Kumar Misra

Principal

Mugberia Gangadhar Mahavidyalaya

Principal
Mugberia Gangadhar Mahavidyalaya