RAJA NARENDRA LAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Proposed Syllabus of 4 years
Bachelor of Science (Honours) in Mathematics

[w.e.f 2024-25]

[under NEP-2020]

SEMESTER-IV

Raja N.L Khan Women's College (Autonomous)
Gope Palace, Midnapore- 721 102, West Bengal

➢ Semester – IV

Course Type	Course Code	Course Details		L-T-P	Credit	Marks Distribution			
						IA	CA	ESE	Total
MAJOR-04	**MTMH MJ-401**	**Group-A**	**Ordinary Differential Equations**	3-1-0	4	10	5	60	75
		Group-B	**Mechanics-I/.Particle Dynamics**						
	MTMH MJ-402	**Group-A**	**Group Theory-II**	3-1-0	4	10	5	60	75
		Group-B	**Linear Algebra-II**						
	MTMH MJ-403		**Real Analysis-II**	3-1-0	4	10	5	60	75
MINOR-04	**MTM MI-301**	**Group-A**	**Classical Algebra**	3-1-0	4	10	5	60	75
		Group-B	**Vector Analysis-I**						

SEC-Skill Enhancement Course, L-T-P=Lecture-Tutorial-Practical, IA-Internal Assessment; CA-Class Attendance; ESE-End Semester Examination

MAJOR-04

Course Code: MTMH MJ-401
Course Title: Ordinary Differential Equations & Particle Dynamics
Credit: 04
No of Lectures: 60 hours
Full Marks: 75

Group-A: Ordinary Differential Equations **Marks:36**

Unit-I:

Differential equations and mathematical models, General, particular, explicit, implicit and singular solutions of a differential equation, Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Unit-II:

Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

Unit-III:

Equilibrium points, Interpretation of the phase plane of autonomous system of differential equation for two vaiable.

Unit-IV:

Power series solution of a 2^{nd} order differential equation about an ordinary point, solution about a regular singular point.

Group-B: Particle Dynamics **Marks:24**

Motion in Plane (Radial and cross radial, tangential and normal components), Central force and stability of central orbit, Constrained motion, Varying mass, Planetary motion

Text Books:

Reference Books:

- S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
- Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.
- G.F. Simmons, Differential Equations, Tata Mc Graw Hill.
- Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed.,Taylor and Francis group, London and New York, 2009.

- C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
- Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
- Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press.

Learning Outcomes of the course

After completion of the course, the student will learn the following

(a) Learn the exact differential equation and solve it by integrating factors, method of separation of variable etc.

(b) Know the principle of super position for homogeneous equation, Wronskian: its properties and applications,

(c) Learn solution methodology of linear homogeneous and nonhomogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients and method of variation of parameters

(d) Know the power series solution of ordinary differential equation.

(e) Determine the equilibrium points of system of linear equations and its stability.

(f) Know the application of differential equation in particle dynamics like central force, planetary motion etc.

Course Code: MTMHMJ-402
Course Title: Group Theory-II & Linear Algebra-II
Credit: 04
No of Lectures: 60 hours
Full Marks: 75

Group-A: Group Theory-II **Marks:24**

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties

Group-B: Linear Algebra-II **Marks:36**

Unit-I:

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear dependence and independence, Deletion theorem, basis and dimension of subspaces, replacement theorem and extension theorem, complement of subspaces, quotient spaces, row and column spaces of a matrix. Concept of infinite dimension of vector space.

Unit-II:

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations, Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Text Books:

Reference Books:

- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Edition., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
- Kennath Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice- Hall of India Pvt. Ltd., 1971.
- D.A.R Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.
- S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
- S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2007.
- Gilbert Strange, Linear Algebra and Its Applications, Thomson, 2007

Learning Outcomes of the course

After completion of the course, the student will learn the following

(a) Able to solve the problems of direct product of finite number of groups, factor groups.

(b) Learn the finite abelian groups and related theorems and problems

(c) Learn group homomorphism and its properties, fundamental isomorphism theorems and able to solve related problems of homomorphism and isomorphism.

(d) Know the vector spaces, subspaces, quotient spaces and dimension and able to solve problems of dimension, linear dependence and independence

(e) Understand the linear transformation, algebra of linear transformation and isomorphism theorem

(f) Compute linear transformations, kernel and range, and inverse linear transformations, and find matrices of general linear transformations.

Course Code: MTMHMJ-403
Course Title: Real Analysis-II
Credit: 04
No of Lectures: 60 hours
Full Marks: 75

Unit-I:

Limits of functions (ε - δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Unit-II:

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln (1 + x), 1/(ax + b) and $(x+1)^n$. Application of Taylor's theorem to inequalities.

Unit-III:

Functions of several variables, limit and continuity of functions of two or more variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Taylor's theorem for two variables, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems

Text Books:

Reference Books:

- R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
- Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
- K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
- A Mattuck, Introduction to Analysis, Prentice Hall, 1999.
- S.R. Ghorpade and B.V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006.
- T. Apostol, Mathematical Analysis, Narosa Publishing House
- Courant and John, Introduction to Calculus and Analysis, Vol II, Springer

- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
- Terence Tao, Analysis II, Hindustan Book Agency, 2006.
- S. Goldberg, Calculus and mathematical analysis.
- Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones& Bartlett, 2010
- E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005
- James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001
- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

Learning Outcomes of the course

After completion of the course, the student will learn the following

(a) Understand the concept of real-valued functions, limit, continuity, uniform continuity and differentiability in detail and related theorems

(b) Student can find expansions of real functions in series forms.

(c) Develop concepts on limit and continuity of functions of two or more variables, their partial derivatives, total derivative and differentiability, Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes

(d) Find Extrema of functions of two variables & understand the use of the method of Lagrange multipliers & solve constrained optimization problem

MINOR-04

Course Code: MTM MI-401
Course Title: Classical Algebra & Vector Analysis-I
Credit: 04
No of Lectures: 60 hours
Full Marks: 75

Group-A: Classical Algebra Marks: 30

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Exponential, logarithmic, trigonometric and hyperbolic functions of complex variable.

Theory of equations: Relation between roots and coefficients, transformation of equation, Descartes rule of signs, Application of Sturm's theorem, cubic equation (solution by Cardan's method) and biquadratic equation (solution by Ferrari's method)

Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality

Group-B: Vector Analysis-I Marks: 30

Triple product, Vector equation of straight line and plane, Solution of vector equation, applications to geometry and mechanics: concurrent forces, couple, work done, Lamis's theorem, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable, space curve and its properties.

Reference Books:

- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
- David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
- K.B. Dutta, Matrix and linear algebra.
- K. Hoffman, R. Kunze, Linear algebra.
- W.S. Burnstine and A.W. Panton, Theory of equations.
- Ghosh& Chakraborty, Vector , U.N Dhar and Sons Pvt Ltd
- S.K.Mapa, Higher Algebra, Sarat Book Publishing House
- M.R. Speigel, Schaum's outline of Vector Analysis
- Marsden, J., and Tromba, Vector Calculus, McGraw Hill.

Learning Outcomes of the course

(a) Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots

(b) Familiarize with relations, equivalence relations, partitions and basic properties of numbers.

(c) Apply De Moivre's theorem to solve numerical Problems and determine the roots of polynomial equation

(d) Know about the vector triple product, differentiation and integration of a vector function.

(e) Find the vector equation of plane, straight line and application in mechanics