**Course title: Mathematics for Science Education** Full marks: 100

Course No. : Sc. Ed. 424 Pass marks: 35T

Nature of course: Theory (T) Periods per week: 6(T)

Level: B. Ed (Four Year) Total periods: 150

Year: Second Time per period: 45 minutes

# **Course Description**

This is an integrated theoretical course of various branches of mathematics. It deals with the mathematical foundation for the students who want to major in science education. This course starts with the number system, statistics, trigonometry, matrix, determinants and vector space and develops through analytical geometry, functions and graph, limit and continuity of functions, differentiation, integration and differential equationsto lay firm foundation of higher mathematics.

# **The General Objectives**

The general objectives of this course are as follows:

* To make the students understand the concept of complex number and apply this concept to derive roots of complex numbers.
* To apply the skills of statistics and probability in day to day problems.
* To develop the skill for proving trigonometric identities and solving trigonometric equations.
* To make the students understand the concept of matrices, determinants and vector space apply this concept to solve system of linear equations.
* To familiarize the students with the different co-ordinate systems in analytical geometries of two and three dimensions.
* To make the students able in describing analytically the structure of space, special relation with lines, planes and sphere in space.
* To enhance the knowledge of vectors and their products, curvilinear coordinates, and to find differentiation of vectors.
* To familiarize the students with different types of functions.
* To inculcate the skills of drawing graphs of function.
* To make the students understand the concept of limit, continuity, derivability.
* To develop skill of solving the problems of higher order derivatives, partial differentiation, maxima and minima, tangent and normal, and curvature.
* To make the students understand the concept of integration and to inculcate the skills of solving the problems of integration.
* To solve the differential equations of first order and first degree and second order second degree with constant coefficients.

# **Specific Objectives and Contents**

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| * To define complex numbers * To prove properties of absolute value of complex numbers * To find square root of a complex number * To derive properties of cube roots of unity * To find product and quotient of a complex numbers in trigonometric form. * To derive roots of a complex number using De-Moivre's theorem. * To explain Euler formula and write down the value of sin and cos in series form. | **Unit I: Numbers System (10)**   * Review of Counting system * Complex number and Argand diagram * Modules and argument of a complex number * Algebraic properties of complex numbers * conjugate and absolute value of complex number * Properties of absolute values of complex numbers * Square root of complex numbers * Cube roots of unity * Properties of cube roots of unity * Trigonometric form of complex numbers * Product and quotient of complex numbers in trigonometric form * De-Moivre's theorem (Integral powers only) * Roots of complex numbers * Euler formula, Power of complex number |
| * To define and calculate the correlation coefficient of two variables. * To explain and establish the equation of regression lines * To solve the problems concerning permutation and combination. * To solve the problems related to binomial and normal distribution. | **Unit II: Statistics and Probability (12)**   * Correlation: Scatter diagram, Pearson’s and Spearmian rank correlation * Regression: Equation of y on x and x on y * Probability: Permutation,   Combination, Conditional probability, Mathematical expectation, Binomial distribution, and Normal distribution |
| * To establish the formula of sin(AB), cos(A, tan(A, cot(A, sin2A, cos2A, tan2A, sin3A, cos3A, tan3A * To establish transformation formula * To prove trigonometric identities using formula * To solve trigonometric equations (0) | **Unit III: Trigonometry (10)**   * Review:   Trigonometric ratios, relationship among trigonometric ratios, trigonometric ratios of -, 90-, etc.,  Trigonometric functions of compound angles, multiple angles and sub-multiple angles   * Transformation formula * Trigonometric equation |
| * To define various type of matrices * To discuss operation of matrices * To find the determinant of square matrices & state and apply the properties of determinants * To find inverse of square matrix * To solve by matrix method * To solve system of linear equations of two or three variables by Cramer’s rule * To define vector space and explain linearly dependent and independent. * To introduce basis and dimension of vectors * To define and explain linear operators * To explain coordinate transformations * To discuss eigenvalues and eigenvectors and solve the eigenvalue problems | **Unit IV:Matrix, Determinants and Vector Space (12)**   * Matrix and Determinants:   Introduction, Types of matrix, Operation of matrices  Introduction of Determinants, Sarrus rule, Minors, Cofactors, Properties of determinants, Inverse matrix, Application of matrices to solve system of linear equations, Cramer’s rule   * Vector Space:   Introduction, linear dependent and independent, basis, dimension linear operator,coordinate transformations, Eigenvalue and Eigen vector |
| * To review distance formula, section formula and area of triangle * To discuss fundamental principles of coordinate geometry and find the equation of locus * To find the equation of straight line in standard form, point slope form and two point form * To establish the relationship among centigrade scale ,Kelvin scale, f-scale using equation related level of mercury at different temperature * To reduce general equation of first degree into standard form * To find the distance between a point and a line * To find the single equation of two lines * To separate the single equation of two lines * To find equation of circle * To discuss the meaning of conic section with term eccentricity, focus, directrix, axis and latus rectum * To derive the equation of ellipse, parabola and hyperbola in standard form * To identify the equation of motion of projectile as that of parabola * To draw the graph between displacement and velocity of particle in S.H.M. hence identify with the graph. * To establish the relationship between Cartesian coordinates and polar coordinates of a point and derive polar equation of conic section. * To explain the meaning of coordinates of a point in space * To find the distance between two poins * To derive section formula in space * To explain the meaning of direction cosines l,m,n of a line and establish their relationship * To find the angle between two lines * To justify ax+by+cz+d=o represents a plane * To establish equation of plane in intercept form and normal form * To find equation of a line in different form * To find the equation of sphere | **Unit V:Analytical Geometry**   * **Two Dimensions (28)** * Review:   Introduction, Coordinates of a point in plane, Distance formula, Section formula, Mid-point formula, Area of triangle, Locus: Introduction, Fundamental principle of co-ordinate geometry, Equation of locus   * Straight line:   Introduction, Slope, Intercepts, Equation of straight line in intercept form, slope-intercept form, perpendicular form, point slope form and two point form,  General equation of first degree, Distance between a point and a line, Angle between two lines, Pair of straight lines, Single equation of pair of lines   * Circle:   Introduction, Equation of circle   * Conic section:   Introduction, ellipse, parabola and hyperbola with equation in standard form, Reduction of Cartesian co-ordinates to polar co-ordinates, Polar equation of conic section   * **Three Dimensions** * **Straight line and plane** * Co-ordinates of a point in space, Distance between two points, Section formula, Direction cosines of a line, Direction cosines of a line joining two given points, Angle between two lines * Introduction of a plane, General equation plane, Equation of plane in normal form and in intercept form * Equation of straight line passing through a point with given direction cosines, Equation of a line passing through two points * **Sphere**   Introduction, Equation of sphere with centre and radius, Equation of sphere in diametric form |
| * To discuss application of unit vector in science * To explain the physical meaning of scalar product, vector product and to use them for solving geometrical and trigonometric problems * To find work done by force using w=**f.d** * To explain scalar product of force and displacement * To explain torque and couple and calculate them using formula * To find column force between to charge Q1 and Q2 located at points **r**1  and **r2** * To explain Biot and Savart law , to find magnetic field at point r2 due to current carrying element at point r1 hence find the magnetic field at r2 due to long straight conductor carrying current * To establish acceleration in circular by vector method * To find the force experienced by charge qmoving with velocity **v**  in the region where magnetic is **B** * To explain the meaning of ., and use them to solve problems * To discuss ordinary derivatives of vectors, space curves, continuity and differentiability * To establish the formula of differentiation of vectors * To discuss partial derivative of vectors and use them * To explain the physical meaning of curl, gradient and divergence and establish the formula related to them * To find angular momentum using **L =r×p** * To identify curvilinear coordinates, cylindrical and spherical coordinates * To define and explain orthogonal curvilinear coordinates, right circular cylindrical coordinates and spherical polar coordinates * To express gradient, divergence, curl and Laplacian in the coordinate system mentioned above | **Unit VI: Vectors (20)**   * Review:   Vectors and scalars, Triangle law of vectors, Parallelogram law of vectors, Polygon law of vectors, Unit vectors, Rectangular unit vectors. Components of vectors   * Product of two vectors:   Scalar product, Vector product, Triple products   * Vector differentiation:   Ordinary derivatives of vectors, Space curves, Continuity and differentiability, Differentiation formula, partial derivative of vectors, Gradient, Curl, Divergence of vector   * Curvilinear coordinates: * Introduction, orthogonal curvilinear coordinates, gradient, divergence and curl in orthogonal curvilinear coordinates, The Laplacian in orthogonal curvilinear coordinates,Right circular cylindrical coordinates and spherical polar coordinates, gradient, divergence, curl and Laplacian in cylindrical and spherical polar coordinates |
| * To identify characteristics and nature of functions. * To be able to draw the graph of functions * To interpret the displacement y=asinᾧt of particle in S.H.M. * To state the actual meaning of limit and continuity * To solve the problems related to limit and continuity | **Unit VII: Functions and Graph, Limit and continuity (10).**   * Function (Review),   Algebraic function (linear function, constant function, identity function, quadratic function, cubic function, polynomial function), and their graph  Transcendental function  (trigonometric function, exponential function, logarithmic function), and their graph   * Analytic function, & their graph * Introduction to limits, explanation with some examples, fundamental theorem on limits, problem on limits * Continuity, problems on continuity |
| * To explain the physical meaning of derivative in figure with example * To find differential coefficient of algebraic and transcendental functions using first principles * To use fundamental theorems on differentiation * To find differential coefficient of functions * To find higher order derivatives of functions * To explain necessary condition for maxima and minima and solve the problems related to them * To find partial derivatives and successive partial derivatives of function of two and three variables * To find the equation of tangent and normal of given curve at given point * To determine length of tangent and normal of given curve * To find curvature and radius of curvature of the given curve at given point | **Unit VIII : Differentiation and its applications(24)**   * Introduction of differential coefficient, * Derivative of algebraic functions, * Trigonometric function, analytic function etc. * Fundamental theorems on differentiation * Higher order derivatives * Partial differentiation * Maxima and minima * Tangent and normal * Curvature |
| * To identify with fundamental integrals * To use method of substitution, integration by parts * To evaluate the standard integrals and use them * To find integration by rational fraction * To explain geometrical interpretation of definite integral * To identify and use fundamental theorem of integral calculus * To evaluate the value of definite integrals * To use general properties of definite integrals * To find the value of infinite integrals | **Unit IX: Integration (12)**   * Introduction, * Basic formula, * Method of integration, * Definite integral, * General properties of definite integrals, * Infinite integrals   (, , , etc.) |
| * To solve the differential equation of first degree with first order * To establish equation of motion of particle using calculus * To establish law of radioactivity using differential equation * To solve the differential equation of second order and first degree * To establish the time period of classical harmonic oscillator using differential equation of second order * To solve the wave equation in one dimension * To solve Laplace equation in two dimensions | **Unit X: Differential Equations (12)**  (Definition and classification, formation of ordinary differential equation)   * Equation of first order and first degree   (Separation of variables, homogeneous exact equation, linear equations, Bernoulli’s equation)   * Equations of second order and first degree with constant coefficients   ( , , where p1 and p2 are constants   * Application: Classical harmonic oscillator * Partial differential equations: Introduction, wave equation in one dimension, Laplace equation in two dimensions |

# Note: The figures within the parentheses indicates the approximate periods for respective units.

# **Instructional Techniques**

Because of the theoretical nature of the course, teacher centered instructional techniques will be dominant in teaching learning process. The teacher will adopt the following techniques.

**4.1.General Instructional Techniques**

There are various techniques of teaching and learning so as to grasp the knowledge of mathematics. Although the methods of teaching and learning may differ, the techniques to be used are

* lecture,
* discussion,
* problem solving,
* inquiry,
* question answer,
* collaborative
* problem solving method.

**4.2 Specific Instructional Techniques**

The specific teaching and learning techniques chapter wise are listed below:

* Inquiry and question answer (for all units)
* Individual and group work presentation ( for units …..)

1. **Evaluation**

Students will be evaluated on the basis of written classroom test in between and at the end of the academic session, the classroom participation, presentation of the reports and other practical activities. The scores obtained will be used only for feedback purpose. The Office of the Controller of the Examination will conduct annual examination at the end of the academic session to evaluate student’s performance. The types, number and marks of the subjective and objective questions will be as follows.

|  |  |  |  |
| --- | --- | --- | --- |
| Types of questions | Total questions to be asked | Number of questions to be answered and marks allocated | Total marks |
| Multiple choice items | 20 questions | 20x1 mark | 20 |
| Short answer questions | 8 with 3 alternative questions | 8x7 marks | 56 |
| Long answer questions | 2 with 1 alternative question | 2x12 marks | 24 |

**Recommended Books and Reference Books**

Bajracharya, D. R., and et al. (2011).Basic Mathematics Vol.I and II.SukundaPustakBhawan (for all Units).

Das, B. C. and Mukherjee, B. N. (1994).Intermediate Trigonometry. Calcutta: U. N. Dhur& Sons Pvt. Ltd. (for Unit III).

Das, B. C. and Mukherjee, B. N. (1994).Differential Calculus. Calcutta: U. N. Dhur& Sons Pvt. Ltd. (for Units VII and VIII).

Das, B. C. and Mukherjee, B. N. (1994).Integral Calculus. Calcutta: U. N. Dhur& Sons Pvt. Ltd. (for Unit IX and X).

Fruend, J. E. ( ).Elementry Statistics (6th edition). Delhi: Prentice Hall of India Pvt. Ltd. (for Unit II).

Harper, C. (1995).*Introduction to Mathematical Physics*, Prentice Hall of India Pvt. Ltd. (for Units I, VI, and X).

Loney, S.L.( ? ) *. Elements of Coordinate Geometry*, MacMillan Book Co.:NY984 (for Unit V).

Mathew, J. and Walker, R. L. (1970). Mathematical Methods of Physics, (for unit IV).

Pant G.D. andShrestha, G.S.(1994). *Integral Calculus and Differential Equations*, Sunitaprakashan,Kathmandu (for Unit IX and X).

Singh. M.B and Bajracharya,B.C (1995). *Differential calculus*, SukundaPustakBhandar,Kathmandu,(for Units VII and VIII).

Sthapit, Y.R. and. Bajracharya, B.C .( ? ) *. A Text book of Three Dimensional geometry*, SukundaPustakBhandar, Kathmandu, (for Unit V).