Detailed Mathematics Syllabuses

B.Tech and M.Tech Courses

Applicable since session 2018-2019

12th Board of Studies

(held on 24-08-2018)

Department of Applied Mathematics
School of Vocational Studies and Applied Sciences
GAUTAM BUDDHA UNIVERSITY
Greater Noida, UP-201312

2018-2019

Contents

MA 101 (Engineering Mathematics-I)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I

SINGLE VARIABLE CALCULUS- Rolle s Theorem, Mean value theorems, Taylor and Maclaurin's theorem with remainders, Indeterminate forms, Maxima and Minima. Evaluation of definite integrals, Improper integrals: Beta and Gamma functions and their properties, Application of definite integrals to evaluate surface area and volume of revolution.

Unit II

SEQUENCE AND SERIES- Convergence of sequences and series, Tests for convergence, The Integral Test, Comparison Test, Absolute convergence; The Ratio and Root Tests, Alternating Series and Conditional convergence, Power series, Taylor series, Convergence of Taylor Series.

Unit III

MULTIVARIABLE CALCULUS- Limits, Continuity and differentiability in higher dimensions, Partial differentiation, Chain rules, Jacobian, Directional Derivatives and Gradient Vectors, Tangent plane and Normal line, Extreme values and Saddle points, Lagrange's multiplier method. Taylor's series for a function of several variables. Curvature and Torsion, Unit binomial vector.

Unit IV

MULTIPLE INTEGRAL- Double Integral, triple integral, Fubini's Theorem, Change of order for double integral, Change of variables (*double integral: polar form, triple integral: Cylindrical and Spherical form*). Application of area and volume, center of mass

Unit V

FUNDAMENTAL THEOREMS OF VECTOR CALCULUS- Vector line integrals, Scalar surface integrals, and vector surface integral, Green's Theorem, Vector fields, Divergence and curl of vector fields. Stokes' Theorem and Gauss divergence theorems. (Without proofs)

Textbook Thomas' Calculus , 11th Edition, Pearson Education Asia, 2009.

Reference Books

[1] R. K. Jain and S.R.K Iyengar, *Advanced Engineering Mathematics*, Narosa Publications.

[2] E. Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 2005.

[3] J. Stewart, *Calculus*, Cengage Learning, Sixth Edition.

MA 102 (Engineering Mathematics-II)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I
Introduction to matrices, Elementary row and column operations and reduced echelon forms, Normal Form, Inverse and Rank of a matrix, Consistency of linear system of equations and their solutions.

Unit II
Finite dimensional vector spaces over reals, Subspace, Linear Dependence and Independence of vectors, Basis, Dimension. Linear transformations, range and kernel of a linear map, rank and nullity, Inverse of linear transformation, rank nullity theorem, composition of linear maps, Matrix associated with linear maps. Characteristic equation and characteristic polynomial, eigenvalues and eigenvectors, Cayley-Hamilton theorem, diagonalisation.

Unit III
Symmetric and skew symmetric matrices, orthogonal matrices, Inner product spaces, Gram-Schmidt orthogonalization.

Unit IV
Functions of complex variables, Limit, Continuity and Differentiability of Complex functions. C-R equation, Analytic function, Harmonic functions, Elementary (exponential, trigonometric and logarithm). Conformal mapping. Line Integral in complex form, Cauchy's integral theorem, Morera's Theorem, Cauchy's integral formula: Cauchy's Integral formula for derivatives of analytic functions, Liouville's theorem, Maximum-modulus theorem (without proof), Fundamental Theorem of algebra.

Unit V
Taylors and Laurent's Series, Singularities, Zeroes and Poles, Residue, Residue theorem, Evaluation of real integrals.

Textbook E. Kreyszig, *Advanced Engineering Mathematics*. John Wiley and Sons, 2005.

Reference Books

[1] R. K. Jain and S.R.K Iyengar, *Advanced Engineering Mathematics*, Narosa Publications.

[2] J. W. Brown, R. V. Churchill, *Complex Variables and Application*s, McGraw-Hill Higher Education; 8 edition, 2008.

MA 103 (Mathematics-I)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I
Sets and their representations, operations on sets, Cartesian product of sets, relations, functions, algebraic and transcendental function, Principle of Mathematical induction, Solution of quadratic equations. Permutation and Combination, Binomial Theorem.

Unit II
Straight Lines, slope of a line and angle between two lines, various forms of equations of a line: parallel to axes, point-slope form, slope-intercept form, two point forms, intercepts form and normal form, general equation of a line, distance of a point from a line. Introductory idea of Ellipse, Circle, parabola and Hyperbola.

Unit III
Trigonometric functions, positive and negative angles, Measuring angle in radians & in degree and conversion from one measure to another. Definition of trigonometric with the help of unit circle. Trigonometric identities. Complex numbers, algebraic properties of complex numbers, Argand plane and polar representation of complex numbers, Fundamental theorem of algebra.

Unit IV
Vectors and scalars, magnitude and direction of a vector, direction cosines (and ratios) of vectors, Types of vectors, position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Scalar product of vectors, projection of a vector on a line, vector product of vectors.

Unit V
Matrices and determinants: definition of a matrix, various types of matrices, addition, subtraction, multiplication of matrices, inverse of matrix, determinant of matrices, expansion of determinant, properties of determinants, solution of linear system of equations, Cramer rule.

Textbook *Mathematics Part I and Part II - Textbook for Class XI and XII*, NCERT.

Reference Books

[1] H. S. Hall and S.R. Knight, *Higher Algebra*. Arihant, 2010.

[2] J. Stewart, *Calculus*, Cengage Learning, Sixth Edition.

MA 104 (Mathematics-II)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I
Limit, continuity and differentiability of functions, Derivatives of elementary functions, rules of differentiation, Derivatives of polynomial and trigonometric functions, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit function, logarithmic differentiation. Derivative of functions expressed in parametric forms, successive differentiation

Unit II
Successive differentiation, Leibnitz Theorem, Partial differentiation, Euler Theorem, Taylors series (Single Variable), Maxima and Minima (Single Variables),

Unit III
Integration as inverse process of differentiation, Integration of elementary functions, integration by substitution, by partial fractions and by parts, Fundamental theorem of calculus, Basic properties of definite integrals and evaluation of definite integrals, definite integral as limit of sum, Application to areas and curves

Unit IV
Definition of ordinary differential equations, order and degree, general and particular solutions of a differential equation, Formation of differential equation, solution of differential equations of first order and first degree: solution by method of separation of variables, homogeneous differential equations, linear differential equations, exact differential equations, Solution of second order differential equations with constant coefficients.

Unit V
Introduction to mathematical modeling, modeling of Simple elementary biological system, population growth model, exponential models, logarithmic models

Textbook *Mathematics Part I and Part II - Textbook for Class XI and XII*, NCERT.

Reference Books

[1] G. B. Thomas and R. L. Finney, *Calculus and Analytical Geometry*, Pearson Education.

[2] J. N. Kapoor, *Mathematical Modeling*, New Age International.

[3] J. Stewart, *Calculus*, Cengage Learning, Sixth Edition.

MA 107 (Foundation course in Mathematics)

Credits (L-T-P) : 2 (2- 0- 0)

Unit I

Representation of real numbers as points on the line and the set of real numbers as complete ordered field, Bounded and unbounded sets, neighborhoods and limit points, Complex Number, D Moivre's Theorem, Natural Logarithm of complex number, Powers of Complex number Summation of series and complex roots of unity, Binomial Theorem (without infinite series), Algebra of matrices, symmetric and skew symmetric matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. unitary, involutory and nilpotent matrices, Adjoint and inverse of a matrix and related properties. Determinants of Matrices: Definition, properties and applications of determinants for 3rd order and higher orders, Rank of Matrices, system of linear equations, Cramer's rule, eigenvalues and eigenvectors.

Unit II

Limits of functions, Continuity, Differentiation, Successive Differentiation, Expansion of Functions Rolle's theorem, Mean Value theorem, Cauchy mean value theorem, Integration Definite and Indefinite (ordinary, method of substitution, special trigonometric function, partial fraction) Application of integration to find area, Differential equations –homogeneous and Linear ODE and applications to acceleration and velocity model, growth and decay model.

Unit III

Functions of several variables, Limit and continuity of functions of two or more real variables, Partial Differentiation, Derivative as a slope, higher order derivatives, Leibnitz rule, chain rule, Euler theorem on homogeneous functions and its application.

Reference Books

[1] Apostol, Tom. M. (2002): *Calculus, Vol. I.,* John Wiley & Sons.

[2] Ross, S.L. (1984): *Differential Equations*, John Wiley and Sons (Student Edition).

[3] Stewart, J. (2009): *Essential Calculus: Early Transcendentals*, Cengage Publications, 7th Edition

[4] Erwin Kreyszig (2009): *Advanced Engineering Mathematics*, John Wiley and Sons.

MA 201 (Engineering Mathematics-III)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I

Introduction: linear, nonlinear, order, degree, and types of solutions of ODE, exact differential equations, integrating factors, linear equation, Bernoulli equations, Picard's existence and uniqueness theorem for $dy/dx = f(x, y)$ (without proof). ODE of first order not of first degree, Solvable for x, Solvable for y, Solvable for p, Clairaut's form.

Unit II

Linear differential equations of nth order with constant coefficients, homogeneous and non-homogeneous linear differential equations, simultaneous linear differential equations, Euler -Cauchy linear differential equations, method of variation of parameters, Power series method for ODE (Frobenious Method). (*Optional Topics: Legendre function and Bessel function and their properties.*)

Unit III

Laplace Transform: Existence theorem, Properties of Laplace transform, Inverse Laplace transform, Unit step function, Dirac delta function, Laplace transform of periodic functions, Convolution theorem, Application to solve linear and simultaneous differential equations.

Unit IV

Periodic functions, Trigonometric series, Fourier series of period 2π, Euler's formulae, Functions having arbitrary period, Change of interval, Even and odd functions, Half range sine and cosine Fourier series.

Unit V

PDEs and its Applications: Linear partial differential equations with constant coefficients (Operator method only). Classifications of 2^{nd} order PDE. Method of separation of variables for solving partial differential equations, Its applications to solve Heat conduction equation, Wave equation, steady state heat equation (Laplace equation) through Fourier series.

Textbook R. K. Jain and S.R.K Iyengar, *Advanced Engineering Mathematics*, Narosa Publications.

Reference Books

[1] G. F. Simmons, *Differential Equations*. Tata Mc Graw-Hill Publishing Company Ltd., 1981.

[2] E. Kreyszig, *Advanced Engineering Mathematics*. John Wiley and Sons, 2005.

[3] W. E. Boyce and R.C. DiPrima, *Elementary differential equations and Boundary Value Problems*. John Wiley and Sons, 8th Edition, 2010.

MA 202 (Numerical and Statistical Analysis)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I
Zeroes of transcendental and polynomials, Bisection method, Regular-falsi method and Newton-Raphson method, Secant Method, Rate of convergence of above methods, Error Analysis.

Unit II
Interpolation, Finite differences, difference tables, Newton's forward and backward interpolation, Divided differences, Lagrange's and Newton's divided difference formula for unequal intervals. Numerical differentiation, Numerical integration, Newton-Cote quadrature formula, Trapezoidal, Simpson's one third and three-eight rules.

Unit III
Solution of system of linear equations, Gauss-Seidal method, Gauss-Jordan Method, Crout method, Jacobi Iteration method. Numerical Solutions of Ordinary Differential Equations and Partial Differential Equations: Picard's Method, Euler's Method, Modified Euler's Method, Runge-Kutta method. Numerical solutions of parabolic and elliptic partial differential equations, Introduction to finite element method.

Unit IV
Probability, Conditional Probability, Bayes' Theorem, Random variable, Probability distributions,Mean and Variance of the distribution, Probability density function, Binomial distributions, Poisson distributions and Normal distributions.

Unit V
Mathematical Expectations, Moments, Moment generating functions, Skewness, Kurtosis, Curve fitting, Method of least squares, Fitting of straight lines, Polynomials, Exponential curves, Correlation, Regression analysis: Linear, Nonlinear and multiple. Random sampling,Sample mean, Sample variance, Estimation of parameters, Maximum likelihood method, Confidence intervals, Testing of Hypotheses:in the case of normal distributions, Goodness of Fit, Chi-square test, t-test, Analysis of variance.

Textbook E. Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 2005.

Reference Books

[1] R. S. Gupta, *Elements of Numerical Analysis*, Macmillan, 2009

[2] C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis* 7th Edit., Addison-Wesley, Boston, 2003.

[3] R. A. Johnson, *Miller & Freund's Probability and Statistics for Engineerings* Prearson, 2001

[4] S. M. Ross, *Introduction to Probability and Statistics for Engineers & Scientists* Elsevier, Academic press, 2004.

MA 203 (Quantative Techniques in Biotechnology)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I
Frequency Distribution, Graphic representation of a frequency distribution, Measures of Central tendency, Moments, moment generating functions, Central Moments, Non- Central Moments, Measures of Dispersion, Measures of Skewness, Measures of Kurtosis

Unit II
Curve fitting, Method of Least squares, Fitting of Straight lines, Polynomials, Exponential Curves, Linear Correlation, Correlation Coefficient, Properties of Correlation Coefficient, Rank Correlation Coefficient, Regression Analysis: Linear & Non linear. Time series and forecasting.

Unit III
Introduction, Experiments, Outcomes, Events, Definition of Probability, Conditional Probability, Independent Events, Total Probability, Bayes' Theorem.

Unit IV
Random Variable, Discrete Random Variable, Probability Function, Continuous Random Variable, Probability Density Function, Discrete Distributions, Continuous Distributions, Mathematical Expectation, properties of Expectation, Two Dimensional Random Variables, Joint Probability Density Functions, Marginal Probability Distribution, Conditional Probability Distribution.

Unit V
Binomial Distribution, Poisson Distribution, Normal Distribution Sampling theory, Tests of significations, Chi-square test, t-test, Analysis of variance (one way), Statistical quality control methods, Control charts, R, p, np, and c charts.

Textbook J. N. Kapoor, Mathematical Statistics, S. Chand Publication, 2004.

Reference Books

[1] V. K Rohatgi, *An Introduction to Probability Theory and Mathematical Statistics*, John Wiely & Sons 1976.

[2] Marylees Miller, John E. Freund, Irwin Miller, *Mathematical Statistics: With Applications,* Prentice Hall 2003.

[3] Gupta, S.C. and Kapoor, V.K. (2007): *Fundamentals of Mathematical Statistics*, 11th Edn.,(Reprint), Sultan Chand and Sons.

[4] S. M. Ross, *Introduction to Probability and Statistics for Engineers & Scientists* Elsevier, Academic press, 2004.

MA 204 (Numerical Methods)

Credits (L-T-P) : 3 (2- 0- 2)

Note: This course may be offered for 3 Credits L-T-P (2-0-2). In this case Unit-IV and V will be removed and Implementation of methods discussed in remaining will also be done using C++/Python/MATLAB.

Unit I
Zeroes of transcendental and polynomials, Bisection method, Regular-falsi method and Newton-Raphson method, Secant Method, Rate of convergence of above methods, Error Analysis.

Unit II
Interpolation, Finite differences, difference tables, Newton's forward and backward interpolation, Divided differences, Lagrange's and Newton's divided difference formula for unequal intervals. Numerical differentiation, Numerical integration, Newton-Cote quadrature formula, Trapezoidal, Simpson's one third and three-eight rules.

Unit III
Solution of system of linear equations, Gauss-Seidal method, Gauss-Jordan Method, Crout method, Jacobi Iteration method. Numerical Solutions of Ordinary Differential Equations and Partial Differential Equations: Picard's Method, Euler's Method, Modified Euler's Method, Runge-Kutta method. Numerical solutions of parabolic and elliptic partial differential equations, Introduction to finite element method.

Textbook E. Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 2005.

Reference Books

[1] R. S. Gupta, *Elements of Numerical Analysis*, Macmillan, 2009

[2] C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis* 7th Edit., Addison-Wesley, Boston, 2003.

MA 402 (Modeling and Simulation)

Credits (L-T-P) : 4 (3- 1- 0)

Unit I
Introduction to Simulation and Modeling, Simulation process, Advantages and disadvantages of simulation techniques, Limitations of simulation techniques, Comparison of simulation and analytical methods, fixed time-step vs even to even model, Analog vs digital Simulation.

Unit II
Simulation of continuous systems, Simulation of water reservoir system, Simulation of a servo system, simulation of an autopilot.

Unit III
Discrete system simulation, Queuing Models, Characteristics of Queuing Models, Behaviour of arrivals, Pattern of arrival at the system, The arrival time distribution, Queuing process, Queuing discipline, Service process, Distribution of service time, Performance measures of a queuing system, Classification of queuing models, Single server queuing models and its simulation. Inventory model, Deterministic inventory models with and without shortage cost model, Simulation of Inventory models.

Unit IV
Monte- Carlo simulation, Real time simulation, Hybrid simulation, Distributed Log models, Cobweb model, Generation of random numbers, Test for randomness, confidence interval, Statistical methods. CPM and PERT networks, Characteristics, Critical path computation.

Unit V
System dynamics, System dynamic diagrams, Exponential growth models, Exponential decay models, Modified exponential growth models, Verification and Validation of Simulation Models, Techniques for verification and validation of model, Time Series Approach.

Reference Books

[1] Law M, Kelton W, *Simulation Modeling and Analysis*. McGraw-Hill, New York, NY, 2000.

[2] Khoshnevis B, *Systems Simulation - Implementations in EZSIM*. McGraw-Hill, New York, NY, 1992.

[3] Geoftrey Gordon, *System Simulation*, PHI.

[4] Jerry Banks, John S. C Barry L. Nelson David M. Nicol, *Discrete Event System Simulation*, Pearson Education. TMH.

MA 415 (Biostatistics)

Credits (L-T-P) : 3 (3- 0- 0)

Unit I

Descriptive Statistics: Application of statistics in managerial decision-making, Collection of data, Tabulation and graphic presentation of data, Measures of Central tendency (Mean, Median and Mode), Measuring the variation in Data, Standard Deviation, Population Variance, Sample Variance, Significance of Standard Deviation; Percentiles, Quartiles, Skewness. Distribution of sample means, standard error and confidence interval.

Unit II

Correlation and Regression: Correlation: Meaning and uses, Methods of correlation, Regression: Meaning and uses, Regression equations, Time series: Concepts, Components of time series, Measurement of trend. Scatter plot, multiple regressions.

Unit III

Probability: Permutation and combination, Sample space and events, probability concepts, addition theorem, multiplication theorem, Conditional probability.

Unit IV

Probability Distributions: Discrete Random Variables, Continuous Random Variables, Expected Value, Variance, Introduction to one way and two-way analysis of variance; Data transformations. Binomial Distribution, Poisson distribution, Normal Distribution.

Reference Books

[1] Wayne W. Daniel, Biostatistics : *Basic Concepts and Methodology for the Health Sciences*, 9th edition, Wiley India Pvt Ltd, 2008

[2] Sheldon Ross, *A First Course in Probabilit*y, 9th Edition, , 2014.

[3] Edward Batschelet, *Introduction to Mathematics for Life Scientist*s, 3rd Edition, Springer-Verlag, 1992.

[4] S.P. Gordon and F.S. Gordon, *Contemporary Statistics:A Computer Approach*, McGraw-Hill Publishing Company, New York, 1994.

MA 416 (Engineering Optimization)

Credits (L-T-P) : 3 (3- 0- 0)

Unit I
Introduction of optimization, engineering applications of optimization, classification of optimization problem, single variable and Multivariable optimization with or without constraints.

Unit II
Basics of Linear Programming Problem, formulation, graphical solution, Simplex Method, Artificial Variable technique, Duality in linear programming.

Unit III
Transportation problem, Assignment problem, Sequencing Problem, Processing n Jobs through two, three, and machines.

Unit IV
Critical Path Determination by CPM and PERT.

Unit V
Dynamic Programming, Introduction to evolutionary Algorithms.

Textbook J.C. Pant, *Introduction to optimization: Operations Research*, Jain Brothers, New Delhi, 2002.

Reference Books

[1] A. Ravindran, D. Phillips, and J. Solberg, *Operations Research: Principles and Practice*, 2nd Ed., Wiley India, 2007.

[2] H. A. Taha, *Operations Research: An Introduction*, Pearson Prentice Hall, 2004.