

Annexure-II(A)
Draft of (20%) Reduced Syllabus due to Covid-19
B.Sc. (Honours) Mathematics
BODOLAND UNIVERSITY

1st Semester

C-1: Calculus

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$, concavity and inflection points, asymptotes, L Hospital's rule, applications in business, economics and life sciences.

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx dx$, $\int \cos nx dx$, $\int \tan nx dx$, $\int \sec nx dx$, $\int (\log x)^n dx$, $\int \sin^n x \sin^m x dx$, parametric equations, arc length, arc length of parametric curves, area of surface of revolution. Techniques of sketching conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

List of Practicals (using any software)

- (i) Plotting of graphs of function e^{ax+b} , $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $|ax+b|$ and to illustrate the effect of a and b on the graph.
- (ii) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
- (iii) Tracing of conics in cartesian coordinates/ polar coordinates.
- (iv) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.
- (v) Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. L td. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), SpringerVerlag, New York, Inc., 1989.

C-2: Algebra

Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications.

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers.

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $Ax=b$, solution sets of linear systems, applications of linear systems, linear independence.

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.

Books Recommended

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

GE-1: Object Oriented Programming in C++

OOP Paradigm: Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++, Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers. Enumeration, Arrays and Pointer.

Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables with Functions.

Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers private, public and protected. Implementing Class Functions within Class declaration or outside the Class declaration. instantiation of objects, Scope resolution operator, Working with Friend Functions, Using Static Class members.

Practical to be performed in lab.

Books Recommended

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, *Mastering C++*, TMH, 1997.
2. S. B. Lippman and J. Lajoie, *C++ Primer*, 3rd Ed., Addison Wesley, 2000.

3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall.

3rd Semester

C-5: Theory of Real Functions

Limits of functions ($\epsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Continuous functions, sequential criterion for continuity and discontinuity. 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.

Differentiability of a function at a point and in an interval, Caratheodory's 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, Taylor's theorem to inequalities.

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

Books Recommended

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.
2. K. A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.

C-6: Group Theory I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Subgroups and examples of subgroups.

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem.

Normal subgroups, factor groups.

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

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

C-7: PDE and Systems of ODE

Partial Differential Equations Basic concepts and Definitions, Mathematical Problems. First Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.

Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions, Method of separation of variables.

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.

List of Practicals (using any software)

- (i) Solution of Cauchy problem for first order PDE.
- (ii) Finding the characteristics for the first order PDE.
- (iii) Plot the integral surfaces of a given first order PDE with initial data.
- (iv) Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions
 - (a) $u(x,0)=\phi(x)$, $u_t(x,0) = \psi(x)$, $x \in R, t > 0$
 - (b) $u(x,0)=\phi(x)$, $u_t(x,0) = \psi(x)$, $u(0,t)=0$, $x \in (0, \infty), t > 0$
 - (c) $u(x,0)=\phi(x)$, $u_t(x,0) = \psi(x)$, $u_t(0,t)=0$, $x \in (0, \infty), t > 0$
 - (d) $u(x,0)=\phi(x)$, $u_t(x,0) = \psi(x)$, $u(0,t)=0$, $u(1,t)=0, 0 < x < l, t > 0$

Books Recommended

1. TynMyint-U and LokenathDebnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.

3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.

SEC-1: Analytical Geometry

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Spheres.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

GE -3: Differential Calculus

Limit and Continuity (ϵ and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves.

Rolle's theorem, Mean Value Theorems, Taylor's Theorem with Lagrange's & Cauchy's forms of remainder. Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(l + x)$, $(l + x)^m$.

Books Recommended

1. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

5th Semester

C-11: Multivariate Calculus

Use of Scientific calculator is allowed.

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability.Chain rule for one and two independent parameters, directional derivatives, the gradient, Definition of vector field, divergence and curl.

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals.

Change of variables in double integrals and triple integrals. Line integrals, Fundamental theorem for line integrals, conservative vector fields, independence of path.

Green s theorem, surface integrals, integrals over parametrically defined surfaces. Stoke s theorem, The Divergence theorem (**theorems only**).

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) Pvt. L td. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.
4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson L earning, USA, 2001.

C-12: Group Theory II

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups.

Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley s theorem.

Groups acting on themselves by conjugation, class equation and consequences, Cauchy s theorem.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3rd Ed., John Wiley and Sons (Asia) Pvt. L td., Singapore, 2004.
5. J.R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000.

6. D. A. R. Wallace, *Groups, Rings and Fields*, Springer Verlag London L td., 1998.

DSE-1: Number Theory

Linear Diophantine equation, prime counting function, statement of prime number theorem, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat s Little theorem, Wilson s theorem.

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler s phi-function, Euler s theorem, some properties of Euler s phi-function.

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler s criterion, the Legendre symbol and its properties, quadratic reciprocity, the equation $x^2 + y^2 = z^2$, Fermat s Last theorem.

Books Recommended

1. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw_Hill, Indian reprint, 2007.
2. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

DSE-2: Probability and Statistics

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf).

Chebyshev s inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.

4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007