

NEP: UGCF 2022
B.Sc. (Hons.) Mathematics
***Syllabi and Books* for**
Discipline-Specific Core & Elective Courses
Semester-IV

Syllabi (Source File):
[21092023_Maths.pdf](#)

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(The books are hosted on [GitHub](#) and [Drive](#))

Depending on the features of the cited PDF file, either the PDF viewer or the Browser may be invoked.

DSC-X
SEQUENCES AND SERIES OF FUNCTIONS

Unit-I Sequences of Functions

- ◆ Pointwise and uniform convergence of sequence of functions ◆ The uniform norm
- ◆ Cauchy criterion for uniform convergence ◆ Continuity of the limit function of a sequence of functions ◆ Interchange of the limit and derivative, and the interchange of the limit and integral of a sequence of functions ◆ Bounded convergence theorem

Unit-II Series of Functions

- ◆ Pointwise and uniform convergence of series of functions
- ◆ Theorems on the continuity, differentiability and integrability of the sum function of a series of functions ◆ Cauchy criterion and the Weierstrass M -test for uniform convergence

Unit-III Power Series

- ◆ Definition of a power series ◆ Radius of convergence ◆ Absolute convergence (Cauchy–Hadamard theorem) ◆ Differentiation and integration of power series ◆ Abel’s theorem
- ◆ Weierstrass’s approximation theorem ◆ The exponential, logarithmic and trigonometric functions: Definitions and their basic properties

Essential Readings

1. Bartle, Robert G. & Sherbert, Donald R. (2011) - Introduction to Real Analysis (4th Edition) - Wiley India Edition (Indian Reprint)
[View/Download \(9.18 MB\)](#)
2. Ross, Kenneth A. (2013) - Elementary Analysis: The Theory of Calculus (2nd Edition) - Undergraduate Texts in Mathematics, Springer (Indian Reprint)
[View/Download \(3.28 MB\)](#)

Suggestive Readings

- Bilodeau, Gerald G., Thie, Paul R. & Kenough, G. E. (2010) - An Introduction to Analysis (2nd Edition) - Jones and Bartlett India Pvt. Ltd. Student Edition (Reprinted 2015)
[View/Download \(150.07 MB\)](#)
- Denlinger, Charles G. (2011) - Elements of Real Analysis - Jones and Bartlett India Pvt. Ltd. Student Edition (Reprinted 2015)
[View/Download \(180.95 MB\)](#)

DSC-XI MULTIVARIATE CALCULUS

Unit-I Calculus of Functions of Several Variables

- ◆ Basic concepts ◆ Limits and continuity ◆ Partial derivatives ◆ Tangent planes
- ◆ Total differential ◆ Differentiability ◆ Chain rules ◆ Directional derivatives and the gradient
- ◆ Extrema of functions of two variables ◆ Method of Lagrange multipliers with one constraint

Unit-II Double and Triple Integrals

- ◆ Double integration over rectangular and nonrectangular regions ◆ Double integrals in polar coordinates ◆ Triple integrals over a parallelepiped and solid regions ◆ Volume by triple integrals
- ◆ Triple integration in cylindrical and spherical coordinates ◆ Change of variables in double and triple integrals

Unit-III Green's, Stokes' and Gauss Divergence Theorem

- ◆ Vector field ◆ Divergence and curl ◆ Line integrals and applications to mass and work
- ◆ Fundamental theorem for line integrals ◆ Conservative vector fields ◆ Green's theorem
- ◆ Area as a line integral ◆ Surface integrals ◆ Stokes' theorem ◆ Gauss divergence theorem

Essential Reading

1. Strauss, Monty J., Bradley, Gerald L. & Smith, Karl J. (2007) - Calculus (3rd Edition) - Dorling Kindersley (India) Pvt. Ltd., Pearson Education (Indian Reprint)
[2006, 4th Edition] [View/Download \(345.37 MB\)](#)

Suggestive Reading

- Marsden, J. E., Tromba, A. & Weinstein, A. (2004) - Basic Multivariable Calculus - Springer (SIE) (Indian Reprint)
[1993] [View/Download \(175.26 MB\)](#)

DSC-XII NUMERICAL ANALYSIS

Unit-I Methods for Solving Algebraic and Transcendental Equations

◆ Rate and order of convergence ◆ Bisection method, Method of false position, Fixed point iteration method, Newton's method, and Secant method, their order of convergence and convergence analysis

Unit-II Techniques to Solve Linear Systems and Interpolation

◆ LU decomposition and its applications ◆ Iterative methods: Gauss–Jacobi, Gauss–Seidel methods
◆ Lagrange and Newton interpolation ◆ Piecewise linear interpolation

Unit-III Numerical Differentiation and Integration

◆ First and higher order approximation for the first derivative
◆ Approximation for the second derivative ◆ Numerical integration by closed Newton–Cotes formulae: Trapezoidal rule, Simpson's rule and its error analysis ◆ Euler's method to solve ODEs
◆ Modified Euler method ◆ Runge–Kutta Method (fourth-order)

Practical

Practical/Lab work to be performed in a Computer Lab using any of the Computer Algebra System Software such as Mathematica/MATLAB/Maple/Maxima/Scilab/SageMath etc., for the following problems based on:

- 1) Bisection Method.
- 2) Newton–Raphson Method.
- 3) Secant Method.
- 4) LU Decomposition Method.
- 5) Gauss–Jacobi Method.
- 6) Gauss–Seidel Method.
- 7) Lagrange Interpolation.
- 8) Newton Interpolation.
- 9) Trapezoidal Rule.
- 10) Simpson's Rule.
- 11) Euler's Method.
- 12) Runge–Kutta Method (fourth-order).

Essential Reading

1. Bradie, Brian (2006) - A Friendly Introduction to Numerical Analysis - Pearson Education India, Dorling Kindersley (India) Pvt. Ltd. (Third impression 2011)
[View/Download \(31.33 MB\)](#)

Suggestive Readings

- Gerald, Curtis F. & Wheatley, Patrick O. (2007) - Applied Numerical Analysis (7th Edition) - Pearson Education, India
[\[2004\] View/Download \(21.7 MB\)](#)
- Jain, M. K., Iyengar, S. R. K. & Jain, R. K. (2012) - Numerical Methods for Scientific and Engineering Computation (6th Edition) - New Age International Publisher, India
[\[2016\] View/Download \(152.96 MB\)](#)

DSE-II(i)

BIOMATHEMATICS

Unit-I Mathematical Modelling for Biological Processes

- ◆ Formulation a model through data ◆ A continuous population growth model
- ◆ Long-term behavior and equilibrium states ◆ The Verhulst model for discrete population growth
- ◆ Administration of drugs ◆ Differential equation of chemical process and predator-prey model
(Function response: Types I, II and III)

Unit-II Epidemic Model: Formulation and Analysis

- ◆ Introduction to infectious disease ◆ The SIS, SIR and SEIR models of the spread of an epidemic
- ◆ Analyzing equilibrium states ◆ Phase plane analysis ◆ Stability of equilibrium points
- ◆ Classifying the equilibrium state ◆ Local stability, Limit cycles, Poincaré–Bendixson theorem

Unit-III Bifurcation, Chaos and Modelling Molecular Evolution

- ◆ Bifurcation ◆ Bifurcation of a limit cycle ◆ Discrete bifurcation and period-doubling ◆ Chaos
- ◆ Stability of limit cycles ◆ Introduction of the Poincaré plane
- ◆ Modelling molecular evolution: Matrix models of base substitutions for DNA sequences,
Jukes–Cantor and Kimura models, Phylogenetic distances

Essential Readings

1. Robeva, Raina S., et al. (2008) - An Invitation to Biomathematics - Academic Press
[View/Download](#) (5.37 MB)
2. Jones, D. S., Plank, M. J. & Sleeman, B. D. (2009) - Differential Equations and Mathematical Biology (2nd Edition) - CRC Press, Taylor & Francis Group
[View/Download](#) (5.52 MB)
3. Allman, Elizabeth S. & Rhodes, John A. (2004) - Mathematical Models in Biology: An Introduction - Cambridge University Press
[View/Download](#) (1.31 MB)

Suggestive Readings

- Allen, Linda J. S. (2007) - An Introduction to Mathematical Biology - Pearson Education [2006] [View/Download](#) (13.08 MB)
- Murray, J. D. (2002) - Mathematical Biology: An Introduction (3rd Edition) - Springer
[View/Download](#) (4.31 MB)
- Shonkwiler, Ronald W. & Herod, James (2009) - Mathematical Biology: An Introduction with Maple and MATLAB (2nd Edition) - Springer
[View/Download](#) (10.83 MB)

DSE-II(ii) MATHEMATICAL MODELLING

Unit-I Mathematical Epidemiological and Dieting Models

- ◆ Modelling concepts and examples ◆ Scaling of variables, and approximations of functions
- ◆ SIR and SEIR models for disease spread: Methodology, Standard and solvable SIR models, Basic reproduction number ◆ Dieting model with analysis and approximate solutions

Unit-II Modelling with Nonlinear Systems and Phenomena

- ◆ Stability and the phase plane ◆ Almost linear systems ◆ Ecological models: Predators and competitors, Critical points, Oscillating populations, Survival of single species, Peaceful coexistence of two species, Interaction of logistic populations, Wildlife conservation preserve
- ◆ Nonlinear mechanical systems: Hard and soft spring oscillations, Damped nonlinear vibrations

Unit-III Simulation and Optimization Modelling

- ◆ Monte Carlo simulating deterministic and probabilistic behavior ◆ Generating random numbers
- ◆ Linear programming model: Geometric and algebraic solutions, Simplex method and its tableau format, Sensitivity analysis

Practical

Practical/Lab work to be performed in a Computer Lab:

Modeling of the following problems using R/Python/SageMath/Mathematica/MATLAB/Maple/Maxima/Scilab etc.

- 1) a) Simulation of SIR model and its variants using some initial parameter values, and finding basic reproduction number for analysis.
 b) Analysis of the dieting process, which includes both body-mass loss and gain.
- 2) Nonlinear Systems and Phenomena
 - a) Plot phase plane portraits and solutions of first-order equations
 - b) Obtain interesting and complicated phase portraits for almost linear systems.
 - c) Discuss large wildlife conservation preserve model and obtain: (i) The period of oscillation of the rabbit and fox populations, (ii) The maximum and minimum numbers of rabbits and foxes.
 - d) Discuss the Rayleigh and van der Pol models.
- 3) (i) Random number generation and then use it for the following:
 - a) Simulate area under a given curve.
 - b) Simulate volume under a given surface.(ii) [2] Chapter 7 (Projects 7.4 and 7.5).

Essential Readings

1. Mickens, Ronald E. (2022) - Mathematical Modelling With Differential Equations - CRC Press, Taylor & Francis Group
[View/Download \(7.52 MB\)](#)
2. Edwards, C. Henry, Penney, David E. & Calvis, David T. (2023) - Differential Equations and Boundary Value Problems: Computing and Modeling (6th Edition) - Pearson
[2015, 5th Edition] [View/Download \(9.02 MB\)](#)
3. Giordano, Frank R., Fox, William P. & Horton, Steven B. (2014) - A First Course in Mathematical Modeling (5th Edition) - Brooks/Cole, Cengage Learning India Pvt. Ltd.
[2013] [View/Download \(11.79 MB\)](#)

Suggestive Readings

- Barnes, Belinda & Fulford, Glenn R. (2015) - Mathematical Modelling with Case Studies. Using Maple, MATLAB (3rd Edition) - CRC Press, Taylor & Francis Group
[View/Download](#) (4.33 MB)
- Ross, Shepley L. (2014) - Differential Equations (3rd Edition) - Wiley India Pvt. Ltd.
[1984] [View/Download](#) (43.28 MB)
- Simmons, George F. (2017) - Differential Equations with Applications and Historical Notes (3rd Edition) - CRC Press, Taylor & Francis Group
[View/Download](#) (3.77 MB)

DSE-II(iii) MECHANICS

Unit-I Statics

- ◆ Fundamental laws of Newtonian mechanics ◆ Law of parallelogram of forces
- ◆ Equilibrium of a particle ◆ Lamy's theorem ◆ Equilibrium of a system of particles
- ◆ External and internal forces ◆ Couples ◆ Reduction of a plane force system ◆ Work
- ◆ Principle of virtual work ◆ Potential energy and conservative field ◆ Mass centers
- ◆ Centers of gravity ◆ Friction

Unit-II Dynamics

- ◆ Kinematics of a particle ◆ Motion of a particle ◆ Motion of a system
- ◆ Principle of linear momentum ◆ Motion of mass center ◆ Principle of angular momentum
- ◆ Motion relative to mass center ◆ Principle of energy ◆ D'Alembert's principle
- ◆ Moving frames of reference, Frames of reference with uniform translational velocity, Frames of reference with constant angular velocity ◆ Applications in plane dynamics: Motion of a projectile, Harmonic oscillators, General motion under central forces, Planetary orbits

Unit-III Hydrostatics

- ◆ Shearing stress ◆ Pressure ◆ Perfect fluid ◆ Pressure at a point in a fluid
- ◆ Transmissibility of liquid pressure ◆ Compression ◆ Specific gravity
- ◆ Pressure of heavy fluids: Pressure at all points in a horizontal plane, Surface of equal density
- ◆ Thrust on plane surfaces

Essential Readings

1. Synge, J. L. & Griffith, B. A. (2017) - Principles of Mechanics (3rd Edition) - McGraw-Hill Education (Indian Reprint)
[1942, 1st Edition] [View/Download](#) (517.07 MB)
2. Ramsey, A. S. (2017) - Hydrostatics - Cambridge University Press (Indian Reprint)
[1936] [View/Download](#) (80.27 MB)

Suggestive Readings

- Roberts, A. P. (2003) - Statics and Dynamics with Background Mathematics - Cambridge University Press
[View/Download](#) (1.81 MB)
- Ramsey, A. S. (1985) - Statics (2nd Edition) - Cambridge University Press
[1945, Edition N/A] [View/Download](#) (362.63 MB)