Lesson Plan for Course: B.Sc (H) Sem-III **Code:** MTMACOR05T **Credit: 6**

- Course Name: Theory of Real Functions
- Course coordinator: Dr. Biswajit Sarkar
- Course Outcomes:
  - CO-1. To understand limits of functions including through their definition, continuous functions and uniform continuity theorem.
  - CO-2. Aware about differentiability of a function.
  - CO-3. To familiar with several mean value theorems and their applications.
  - CO-4. Able to express Taylor's and Maclaurin's series expression of several functions.
  - CO-5. Able to apply Taylor's theorem to convex functions and inequalities.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: 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.	PD	14	Theoretical-12 Tutorial-02
Oct	**Unit -2** : 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.	PD	14	Theoretical-11 Tutorial-03
	1st Internal Assessment			
Nov	**Unit-3**: 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.	PD	10	Theoretical-08 Tutorial-02
Dec	**Unit-3**: Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $ln(1+x)$, $1/ax+b$ and $(1+x)^n$. Application of Taylor's theorem to inequalities.	PD	12	Theoretical-11 Tutorial-01
	2nd Internal Assessment			
Jan	Revision	PD	04	Theoretical-04 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 54 Hrs**	**Theoretical-46 Tutorial-08**

Books:

- Walter Rudin, Principles of Mathematical analysis, Third Edition, McGrawhill Education
- S. K. MAPA, Introduction to Real Analysis, Sarat Book Distributor,India, 2019.
- Satish Shirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.

For CBCS courses

Lesson Plan for Course: B.Sc (H) Sem-III **Code:** MTMACOR06T **Credit: 6**

- Course Name: Group Theory-I
- Course coordinator: Dr. Sudip Mondal
- Course Outcomes:
  - CO-1. To understand various types of groups, order of an element of a group, subgroups and their product.
  - CO-2. To familiar with cyclic group and their classification, permutation on group and cosets.
  - CO-3. To prove Lagrange's theorem and its application to prove Fermat's Little theorem.
  - CO-4. To understand external direct product of a finite number of groups and other familiar groups.
  - CO-5. To learn group homomorphisms and their properties.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1:** Symmetries of a square, Dihedral groups, definition and examples of groups.	BS	06	Theoretical-04 Tutorial-02
Oct	**Unit-1:** Definition and examples of groups and quaternion groups (through matrices), elementary properties of groups. **Unit-2:** Subgroups and examples of subgroups. Centralizer, normalizer, center of a group. Product of two subgroups.	BS	16	Theoretical-14 Tutorial-02
	1st Internal Assessment			
Nov	**Unit-3:** Properties of cyclic groups, classification of subgroups of cyclic groups.	BS	04	Theoretical-02 Tutorial-02
Dec	**Unit-3:** Cycle notation for permutations, properties of permutations, even and odd permutations. Alternating group, properties of cosets. Lagrange's theorem and consequences including Fermat's Little theorem.	BS	15	Theoretical-14 Tutorial-01
	Unit-4: External direct product of a finite number of groups. Normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. **Unit-5:** Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.	PD	14	Theoretical-12 Tutorial-02
	2nd Internal Assessment			
Jan	Revision	BS PD	02 02	Theoretical-04 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 59 Hrs**	**Theoretical-50 Tutorial-09**

Books:

- David S. Dummit and Richard M. Foote, Abstract Algebra (http://library.lol/main/36E6532B72807B9EF6B27E52E8C62CCC) , Third Edition , Wiley pvt.Ltd.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, 1997.
- S. K. Mapa, Higher Algebra, Sarat Book Distributor,India 2019.

For CBCS courses

Lesson Plan for Course: B.Sc (H) Sem-III **Code:** MTMACOR07T **Credit: 6**

- Course Name: Numerical Methods
- Course coordinator: Dr. Pintu Debnath
- Course Outcomes:
  - CO-1. To learn algorithms of various numerical methods including their convergences and error.
  - CO-2. To find root of a algebraic an transcendental equation and matrix inverse by various numerical methods.
  - CO-3. To learn various types of interpolation methods and finite differences, and their application on numerical differentiation.
  - CO-4. To integrate numerically by several rules, and power method for determining eigen values.
  - CO-5. To solve Ordinary Differential Equations by Euler's method and Runge-Kutta methods.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: Algorithms, Convergence, Errors: Relative, Absolute. Round off, Truncation. **Unit-2**: *Transcendental and Polynomial equations*: Bisection method, Newton's method, Secant method, Regula falsi method. Newton-Raphson method, Fixed point iteration, Rate of convergence of these methods.	SM	09	Theoretical-07 Tutorial-02
Oct	**Unit-3**: *System of linear algebraic equations*: Gaussian Elimination and Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method and their convergence analysis, LU Decomposition.	SM	09	Theoretical-07 Tutorial-02
	1st Internal Assessment			
Nov	**Unit-4**: *Interpolation*: Lagrange and Newton's methods, Error bounds, Finite difference operators. Gregory forward and backward difference interpolations. **Unit-4**: *Numerical differentiation*: Methods based on interpolations, methods based on finite differences.	SM	08	Theoretical-06 Tutorial-02
Dec	**Unit-5**: *Numerical Integration*: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule. Boole's rule, Midpoint rule, Composite Trapezoidal rule, Composite Simpson's 1/3rd rule, Gauss quadrature formula. **Unit-5**: *The algebraic eigenvalue problem*: Power method. **Unit–6:** *Ordinary Differential Equations*: The method of successive approximations. Euler's method, the modified Euler method. Runge-Kutta methods of orders two and four.	SM	16	Theoretical-14 Tutorial-02
	2nd Internal Assessment			
Jan	Revision	SM BS	_ _	Theoretical-00 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 42 Hrs**	**Theoretical-34** **Tutorial-08**

For CBCS courses

Books:

- Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
- Mollah S. A. Numerical Analysis and Computational Procedures. Publisher ArunabhaSen Books and Allied (P) Ltd. 2018.
- Gupta R. K. Numerical Methods: Fundamentals and Applications. Cambridge University Press; 2019 May 9.

Lesson Plan for Course: B.Sc (H) Sem-III **Code:** MTMACOR07P **Credit: 6**

- Course name: Numerical Methods Lab
- Course coordinator: Dr. Pintu Debnath
- Course Outcomes:
  - CO-1. To learn algorithms of various programing problems.
  - CO-2. Able to write C-programming of various methods to solve transcendental and algebraic equations.
  - CO-3. Able to write C-programming of various methods to solve system of linear equations and ODEs.
  - CO-4. Able to write C-programming for numerical integration and differentiation.
  - CO-5. Able to write C-programming of various methods to fitting a polynomial functions, Power method to find eigen values.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: Basic Programming **Unit-2**: Basic Programming	SM	02	Practical-02
Oct	**Unit-3**: *Solution of transcendental and algebraic equations*: a) Bisection method. b) Newton Raphson method. c) Secant method. d) Regula Falsi method. **Unit-4**: *Solution of system of linear equations*: b) Gaussian elimination method. c) Gauss-Jacobi method. d) Gauss-Seidel method. a) LU decomposition method.	SM BS PD	04 02 02	Practical-08
Nov	**Unit-5:** *Interpolation*: a) Lagrange Interpolation. b) Newton Interpolation. **Unit-6**: *Numerical Integration*: a) Trapezoidal Rule. b) Simpson's one third rule. c) Weddle's Rule. d) Gauss Quadrature.	SM BS PD	04 02 02	Practical-08
Dec	**Unit-7:** Method of finding Eigenvalue by *Power method* **Unit-8:** Fitting a Polynomial Function. **Unit-9:** *Solution of ordinary differential equations*: a) Euler method. b) Modified Euler method. c) Runge-Kutta method.	SM BS PD	06 04 02	Practical-12
Jan	Revision	SM+BS		Practical
	End Semester Examination			
	Assessment: Assignment		**Total: 30 Hrs**	**Practical -30**

Books:

- Yashavant Kanetkar, Let Us C , BPB Publications, 2016.
- Kamthane AN. Programming in C, 2/e. Pearson Education India; 2011.
- SatbirMehla, Vishakha Gupta, M.L. Jain, AmitSehgal, New College Programming in C and Numerical Methods for B.A./B.Sc., Jeevansons Publications, India, Ninth Revised Edition, 2015

Lesson Plan for Course: B.Sc (H)Sem-III **Code:** MTMSSEC01M **Credit: 6**

- Course Name: C-Programming Language
- Course coordinator: Dr. Biswajit Sarkar
- Course Outcomes:
  - CO-1. Learn basic of high-level programming languages.
  - CO-2. To know about some arithmetic operators and logical operators to construct flowchart.
  - CO-3. Able to use for loop, while loop and do-while loop in C-programming.
  - CO-4. Able to use arrays and multi-dimensional arrays in C-programming.
  - CO-5. Capable to write programming by using functions.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1: Basics of Computer Programming**: Definition, Requirement of programming language, Machine language, high-level programming languages, machine code of a program: compilation process, Problem solving approaches: algorithm and flowchart.	SM	03	Theoretical-01 Tutorial-02
Oct	**Unit-2: Fundamentals of Programming:** Built in Data Types: int, float, double, char; Constants and Variables; first program: printf(), scanf(), compilation etc., keywords, Arithmetic operators: precedence and associativity, Assignment Statements: post & pre increment/decrement, logical operators: and, or, not. **Unit-3: Statements:** Relational operators, if-else statement, Iterative Statements: for loop, while loop and do-while loop; controlling loop execution: break and continue, nested loop.	SM	06	Theoretical-04 Tutorial-02
Nov	**Unit-4: Arrays:** Definition & requirement, declaration & initialization, indexing, one dimensional array: finding maximum, minimum, simple sorting and searching. **Unit-5: Multi-dimensional arrays:** Matrix Manipulations (Addition, Multiplication, Transpose). Arrays and Pointers, Memory allocation and deallocation: *malloc()* and *free()* functions.	SM	03	Theoretical-02 Tutorial-01
Dce	**Unit-6: Functions:** Why?, How to declare, define and invoke a function, Variables' scope, local& global variables and function parameters, Pointers, arrays as function parameters, *return* statement, Header files and their role. Illustrate different examples like swapping values, compute n!, nCr, find max/min from a list of elements, sort a set of numbers, matrix addition/ multiplication	SM	05	Theoretical-03 Tutorial-02
	End Semester Examination (By Department)			
	Assessment: Assignment		**Total: 17 Hrs**	**Theoretical-10 Tutorial-07**

For CBCS courses

Books:

- Yashavant Kanetkar, Let Us C , BPB Publications, 2016.
- Kamthane AN. Programming in C, 2/e. Pearson Education India; 2011.
- Satbir Mehla, Vishakha Gupta, M.L. Jain, AmitSehgal, New College Programming in C and Numerical Methods For B.A./B.Sc., Jeevansons Publications, India, Ninth Revised Edition, 2015

Lesson Plan for Course: B.Sc (H) Sem-V **Code:** MTMACOR11T **Credit: 6**

- Course Name: Partial Differential Equations, Applications of Ordinary, Differential Equations
- Course coordinator: Dr. Biswajit Sarkar
- Course Outcomes:
  - CO-1. To conceptualize basic concepts of PDE, and able to solve different types of first order PDE.
  - CO-2. To classify second order linear PDE and transform into their canonical forms.
  - CO-3. To find out the solution of different types of initial and boundary value problems.
  - CO-4. To find solution of Cauchy problems of first order PDE.
  - CO-5. To apply some application of ODE on particle dynamics.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: *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.	PD	09	Theoretical-07 Tutorial-02
Oct	**Unit-1**: Method of Separation of Variables for solving first order partial differential equations. **Unit-2**: 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.	PD	12	Theoretical-10 Tutorial-02
	1st Internal Assessment			
Nov	**Unit-3**: The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string. Initial Boundary Value Problems.	PD	09	Theoretical-07 Tutorial-02
Dec	**Unit-3**: Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end. Equations with non-homogeneous boundary conditions. Non-Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating String Problem. Solving the Heat Conduction problem.`	PD	14	Theoretical-12 Tutorial-02
	Unit 4: Central force. Constrained motion, varying mass. Tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.	SM	13	Theoretical-10 Tutorial-03
	2nd Internal Assessment			
Jan	Revision	PD SM	04 02	Theoretical-06 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 63 Hrs**	**Theoretical-52 Tutorial-11**

For CBCS courses

Books:

- TynMyint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th Edition, Springer, Indian reprint, 2006.
- S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., ElsevierAcademic Press, 2004.
- Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill,2013.
- Miller, F. H., Partial Differential Equations, John Wiley and Sons,2013.
- Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press,2007.

Lesson Plan for Course: B.Sc (H) Sem-V **Code:** MTMACOR12T **Credit: 6**

- Course Name: Group Theory II
- Course coordinator: Dr. Biswajit Sarkar
- Course Outcomes:
  - CO-1. To conceptualize some advance theoretical results like automorphism, inner automorphism, etc. on group and cyclic group.
  - CO-2. To know about characteristic subgroup, Commutator subgroup and its properties.
  - CO-3. To understand the direct product of groups and use it to prove fundamenatal theorem of abelian groups.
  - CO-4. To apply concepts and results of group actions to prove generalized Cayley's theorem.
  - CO-5. To realize the beauty of Sylow's theorem and its applications to find simplicity of alternating group.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: 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.	PD	09	Theoretical-07 Tutorial-02
Oct	**Unit-3**: Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions. Generalized Cayley's theorem. Index theorem.	PD	13	Theoretical-10 Tutorial-03
	1st Internal Assessment			
Nov	**Unit-2**: 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.	PD	10	Theoretical-7 Tutorial-03
Dec	**Unit-4**: Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, pgroups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.	PD	23	Theoretical-22 Tutorial-01
	2nd Internal Assessment			
Jan	Revision	PD	04	Theoretical-04 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 59 Hrs**	**Theoretical-50 Tutorial-09**

Books:

- 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., 1999.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, Tata McGrawHill,1997.
- I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
- S.K.Mapa, Higher Algebra, Sarat Book Distributor,India, 2019.

Lesson Plan for Course: B.Sc (H) Sem-V **Code:** MTMADSE01T **Credit: 6**

- Course Name: Linear Programming
- Course coordinator: Dr. Dr. Sudip Mondal
- Course Outcomes:
  - CO-1. To analyze and solve linear programming models of real life situations.
  - CO-2. To provide several methods for solving LPP including the concept of convex set and extreme points.
  - CO-3. To understand the theory of the transportation problem, assignment problems etc.
  - CO-4. To know about the relationships between the primal and dual problems.
  - CO-5. To learn about the applications to two-person zero-sum game problems.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: Introduction to linear programming problem. convex sets, Theory of simplex method, graphical solution, Optimality and unboundedness. The simplex algorithm, simplex method in tableau format. Introduction to artificial variables, two-phase method. Big-M method and their comparison.	BS	10	Theoretical-08 Tutorial-02
Oct	**Unit-2:** Duality, formulation of the dual problem, primal-dual relationships. Economic interpretation of the dual. Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution. Algorithm for solving transportation problem.	BS	14	Theoretical-12 Tutorial-02
	1st Internal Assessment			
Nov	**Unit-2:** Algorithm for solving assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.	BS	08	Theoretical-06 Tutorial-02
Dec	**Unit 3:** Game theory: Formulation of two person zero sum games. Solving two person zero sum games, Games with mixed strategies, graphical solution procedure, linear programming solution of games.	BS	17	Theoretical-16 Tutorial-01
	2nd Internal Assessment			
Jan	Revision	BS	04	Theoretical-04 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 53 Hrs**	**Theoretical-46 Tutorial-07**

Books:

- P.M.Karak, Linear programming and Theory of Games, ABS Publishing House, Kolkata-700007
- F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
- Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
- G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

For CBCS courses

Lesson Plan for Course: B.Sc (H)Sem-V **Code:** MTMADSE03T **Credit: 6**

- Course Name: Probability & Statistics
- Course coordinator: Dr. Dr. Pintu Debnath
- Course Outcomes:
  - CO-1. To understand the basic concepts of classical probability.
  - CO-2. To learn probability distribution and density function, and their properties with example.
  - CO-3. To understand Chebyshev's inequality and central limit theorem and their applications.
  - CO-4. To conceptualize random samples, sampling distributions and estimation of parameters.
  - CO-5. Able to solve the real life data-based problems by testing of hypothesis.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
Sep	**Unit-1**: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function.	SM	08	Theoretical-06 Tutorial-02
Oct	**Unit-1**: *Discrete distributions*: Uniform, binomial, Poisson, geometric, negative binomial. *Continuous distributions*: uniform, normal, exponential. **Unit-2**: 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), linear regression for two variables.	SM	16	Theoretical-14 Tutorial-02
	1st Internal Assessment			
Nov	**Unit-3:** Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.	SM	10	Theoretical-08 Tutorial-02
Dec	**Unit-3:** Central Limit theorem for independent and identically distributed random variables with finite variance. Markov Chains, Chapman-Kolmogorov equations, classification of states.	SM	12	Theoretical-10 Tutorial-02
	Unit-4: Random Samples, Sampling Distributions, Estimation of parameters, Testing of hypothesis.	BS	06	Theoretical-04 Tutorial-02
	2nd Internal Assessment			
Jan	Revision	SM	04	Theoretical-04 Tutorial-00
	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 56 Hrs**	**Theoretical-46** **Tutorial-10**

Books:

- Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, PearsonEducation, Asia, 2007.
- Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
- A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers, 1983.
- A. Banerjee, S.K. De, S. Sen, Mathematical Probability, U.N.Dhur& Sons Pvt. Ltd., Kolkata-700073.
- S.K. De, S. Sen, Mathematical Statistics, U.N.Dhur& Sons Pvt. Ltd., Kolkata-700073.

For CBCS courses