Lesson Plan for Course: B.Sc(H) Sem-II **Code:** MTMACOR03T **Credit: 6**

- Course Name: Real Analysis
- Course coordinator: Dr. Sudip Mondal
- Course Outcomes:

CO-1. To understand some elementary concepts in set theory.
CO-2. To understand the concepts of countability and uncountability.
CO-3. To apply Archimedean property and its application to find limit points of a set.
CO-4. To recognize bounded, convergent, divergent, Cauchy and monotonic.
CO-5. To apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
January	**Unit-1:** Review of Algebraic and Order Properties of $\mathbb{R}$, ε-neighbourhood of a point in $\mathbb{R}$. Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets. Suprema and Infima. Completeness Property of $\mathbb{R}$ and its equivalent properties.	PD	21	Theoretical-17 Tutorial-04
February	**Unit-1:** The Archimedean Property, Density of Rational (and Irrational) numbers in $\mathbb{R}$, Intervals. Limit points of a set, Isolated points, Open set, closed set, derived set, Illustrations of Bolzano-Weierstrass theorem for sets, compact sets in $\mathbb{R}$, Heine-Borel Theorem.	PD	20	Theoretical-17 Tutorial-03
	1st Internal Assessment			
March	**Unit-2:** Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, liminf, lim sup. Limit Theorems. Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria. Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.	PD	21	Theoretical-17 Tutorial-04
April	**Unit-3:** Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test.	PD	21	Theoretical-18 Tutorial-03
	2nd Internal Assessment			
May	**Unit-3 :** Alternating series, Leibniz test. Absolute and Conditional convergence.	PD	07	Theoretical-06 Tutorial-01
June	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 90 Hrs**	**Theoretical-75 Tutorial-15**

Books:

- R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Tom M. Apostol, Mathematical Analysis, Narosa Publishing House
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
- Terence Tao, Analysis I, Hindustan Book Agency, 2006
- S.K. Mapa, Real Analysis, Asoke Prakasan, Kolkata-700007

Lesson Plan for Course: B.Sc(H) Sem-II **Code:** MTMACOR04T **Credit: 6**

- Course Name: Ordinary Differential Equations and Vector Calculus
- Course coordinator: Dr. Pintu Debnath
- Course Outcomes:

CO-1. To use Picard's theorem to test existence of unique solution of 1st order ODE.
CO-2. To learn some more technique to solve ODEs including Euler's equation, Bernoulli's equation.
CO-3. To able to solve ODEs through the method of undetermined coefficients and method of variation of parameters.
CO-4. To calculate power series solution of a differential equation.
CO-5. Able to test continuity, differentiability and integrability of vector functions.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
January	**Unit-1:** Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients.	BS	12	Theoretical - 10 Tutorial - 02
	Unit-3: Equilibrium points, Interpretation of the phase plane.	SM	09	Theoretical - 08 Tutorial - 01
February	**Unit-1:** Euler's equation, method of undetermined coefficients, method of variation of parameters.	BS	10	Theoretical - 08 Tutorial - 02
	Unit-3: Power series solution of a differential equation about an ordinary point, solution about a regular singular point.	SM	10	Theoretical - 09 Tutorial - 01
	1st Internal Assessment			
March	**Unit -2:** System of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.	BS	11	Theoretical - 09 Tutorial - 02
	Unit- 4: Triple product, introduction to vector functions, operations with vector-valued functions.	SM	10	Theoretical - 08 Tutorial - 02
April	**Unit -2:** Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients.	BS	11	Theoretical - 10 Tutorial - 01
	Unit- 4: Limits and continuity of vector functions. Differentiation of vector functions.	SM	10	Theoretical - 08 Tutorial - 02
	2nd Internal Assessment			
May	**Unit -2 :** Linear systems of two Equations in two unknown functions.	BS	03	Theoretical - 02 Tutorial - 01
	Unit- 4: integration of vector functions.	SM	04	Theoretical - 03 Tutorial - 01
June	End Semester Examination			

	Assessment: Internal Assessment & Assignment		**Total: 90 Hrs**	**Theoretical - 75** **Tutorial - 15**

Books:

- Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
- S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
- G.F.Simmons, Differential Equations, Tata McGraw Hill
- Maity, K.C. and Ghosh, R.K., An Introduction to Differential Equation, New Central Book Agency (P) Ltd. Kolkata (India).
- Maity, K.C. and Ghosh, R.K., Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
- M.R. Speigel, Schaum's outline of Vector Analysis

Lesson Plan for Course: B.Sc(H) Sem-IV **Code:** MTMACOR08T **Credit: 6**

- Course Name: Riemann Integration and Series of Functions
- Course coordinator: Biswajit Sarkar
- Course Outcomes:
  - CO-1. To find Riemann integrable functions and to apply the fundamental theorems of integration.
  - CO-2. To test integrability of improper integrals, convergence of beta and gamma functions.
  - CO-3. To learn some properties of sequence and series and their convergency test.
  - CO-4. To express function through Fourier series.
  - CO-5. To work with power series, radius of convergence, differentiation and integration including some theorems.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
January	**Unit 1:** Riemann integration: inequalities of upper and lower sums, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two Definitions. Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.	SM	21	Theoretical – 17 Tutorial - 04
February	**Unit 1:** Intermediate Value theorem for Integrals, Fundamental theorem of Integral Calculus. **Unit 2:** Improper integrals, Convergence of Beta and Gamma functions.	SM	19	Theoretical – 16 Tutorial - 03
	1st Internal Assessment			
March	**Unit 3:** Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions, Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.	SM	21	Theoretical – 18 Tutorial - 03
April	**Unit-4:** Fourier series: Definition of Fourier coefficients and series, Reimann Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. Examples of Fourier expansions and summation results for series. **Unit 5:** Power series, radius of convergence, Cauchy Hadamard Theorem.	SM	22	Theoretical – 18 Tutorial - 04
	2nd Internal Assessment			
May	**Unit 5:** Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.	SM	7	Theoretical – 06 Tutorial - 01
June	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 90 Hrs**	**Theoretical – 75** **Tutorial - 15**

For CBCS courses

Books:

- K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Santi Narayan, Integral calculus, S Chand, 2005.
- S. K. Mapa, Real Analysis, Asoke Prakasan, Kolkata- 700007.
- T. Apostol, Calculus I, II, Wiley, 2007.

Lesson Plan for Course: B.Sc(H) Sem-IV **Code:** MTMACOR09T **Credit: 6**

- Course Name: Multivariate Calculus
- Course coordinator: Dr. Sudip Mondal
- Course Outcomes:
  - CO-1. To understand limit, continuity and differentiability of functions of two or more variables and partial differentiation.
  - CO-2. To verify the total differentiability of a function and existence of directional derivatives, and to apply method of Lagrange multipliers to solve optimization problem.
  - CO-3. To calculate double and triple integration over rectangular region and non-rectangular region.
  - CO-4. Able to work with vector field, divergence, curl and application of line integration.
  - CO-5. Able to apply Green's theorem, Stoke's theorem and Divergence theorem in computing surface integral.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
January	**Unit-1**: Functions of several variables, limit and continuity of functions of two or more variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters	BS	21	Theoretical-17 Tutorial-04
February	**Unit-1**: Directional derivatives, the gradient, maximal and normal property of gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.	BS	19	Theoretical-17 Tutorial-02
	1st Internal Assessment			
March	**Unit-2**: 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, cylindrical and spherical coordinates. Change of variables in double integrals and triple integrals.	BS	21	Theoretical-18 Tutorial-03
April	**Unit-3**: Definition of vector field, divergence and curl. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.	BS	22	Theoretical-17 Tutorial-05
	2nd Internal Assessment			
May	**Unit-4**: Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.	BS	7	Theoretical-06 Tutorial-01
June	End Semester Examination			
	Assessment: Internal Assessment & Assignment		**Total: 90 Hrs**	**Theoretical-75** **Tutorial-15**

For CBCS courses

Books:

- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
- Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 2nd Ed.,2002
- Courant and John, Introduction to Calculus and Analysis, Vol II, Springer New York, 2012
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill, 3rd Ed.,2013
- Maity, K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
- Maity, K.C. and Ghosh, R.K. An Introduction to Differential calculus, New Central Book Agency (P) Ltd. Kolkata (India).
- Maity, K.C. and Ghosh, R.K. An Introduction to Integral calculus, New Central Book Agency (P) Ltd. Kolkata (India).
- Terence Tao, Analysis II, Hindustan Book Agency, 3rd Ed., 2015
- M.R. Speigel, Schaum's outline of Vector Analysis. Tata McGraw-Hill, 2009.

Lesson Plan for Course: B.Sc(H) Sem-IV **Code:** MTMACOR010T **Credit: 6**

- Course Name: Ring Theory and Linear Algebra I
- Course coordinator: Biswajit Sarkar
- Course Outcomes:
  - CO-1. To know the fundamental concepts in ring theory such as the concepts of ideals, ideal generated by a subset of a ring, factor rings, operations on ideals.
  - CO-2. To learn about ring homomorphism and field of quotients.
  - CO-3. To understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
  - CO-4. To get concepts on linear transformations and its representation by a matrix.
  - CO-5. To learn about isomorphism.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
January	**Unit 1:** Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.	PD	20	Theoretical-17 Tutorial-3
February	**Unit 2:** Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients.	PD	20	Theoretical-17 Tutorial-3
	1st Internal Assessment			
March	**Unit 3:** Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.	PD	21	Theoretical-17 Tutorial-4
April	**Unit 4:** Introduction to linear transformations, Subspaces, dimension of subspaces, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.	PD	22	Theoretical-18 Tutorial-4
	2nd Internal Assessment			
May	**Unit 4:** Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.	PD	07	Theoretical-6 Tutorial-01
June	End Semester Examination			
	Assessment: Internal assessment and Assignment		**Total: 90 Hrs**	**Theoretical-75** **Tutorial-15**

Books:

- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999
- Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra,1997.

Lesson Plan for Course: B.Sc(H) Sem-IV **Code:** MTMSSEC02M **Credit: 2**

- Course Name: Logic and Sets
- Course coordinator: Dr. Pintu Debnath
- Course Outcomes:

CO-1. To learn the syntax of first-order logic and semantics of first-order languages.
CO-2. Able to understand the propositional logic and basic theorems like compactness theorem, meta theorem and post-tautology theorem.
CO-3. To learn about sets and subsets.
CO-4. To learn several operations on sets.
CO-5. To learn relation, partitions, equivalence relations, partial ordering relations, n-ary relations on sets including congruence modulo relation.

Course planner

Month	Course Topic	Teacher	Class-hour	Remarks*
January	**Unit 1:** Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.	SM	08	Theoretical – 7 Tutorial - 01
February	**Unit 1:** Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.	SM	06	Theoretical – 5 Tutorial - 01
March	**Unit 2:** Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.	SM	06	Theoretical – 5 Tutorial - 01
April	**Unit 3:** Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set. Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.	SM	08	Theoretical – 06 Tutorial - 02
May	**Unit 3:** Partial ordering relations, n-ary relations.	SM	02	Theoretical – 02 Tutorial - 00
June	End Semester Examination (By Department)			
	Assessment: Internal Assessment & Assignment		**Total: 30 Hrs**	**Theoretical – 25** **Tutorial - 5**

Books:

- R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
- P.R. Halmos, Naive Set Theory, Springer, 1974.