DARJEELING HILLS UNIVERSITY

Syllabus and Examination Scheme for **FIRST** semester

M. Sc.

in

MATHEMATICS

Under

CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from Academic Session 2021-2022)

Department of Mathematics, Darjeeling Hills University, Jogighat, P.O. – Mangpu, District-Darjeeling, PIN-734313, West Bengal, India

29.12.2021

Course Coordinator
Department of Mathematics
Darjeeling Hills University

TRUNCATED

Structure of Syllabus for M.Sc. in Mathematics

Semester-I

Course Code	Course Name	Marks (Term End)	Marks (Internal)	Duration of Exam (Hrs.)	Total Lectures (Hrs.)	Credi
MATH-CCT-101	Groups and Rings	50	10	2	50	2.4
MATH-CCT-102	Naive Set Theory and Elements of Topology	50	10	2	50	2.4
MATH-CCT-103	Analysis of Several Variables	50	10	2	50	2.4
MATH-CCT-104	Real Analysis	50	10	2	50	2.4
MATH-CCT-105	Complex Analysis	50	10	2	50	2.4
MATH-CCT-106	Ordinary Differential Equations and Special Functions	50	10	2	50	2.4
MATH-CET-107	Project-I	-	40	-		1.6
	Total	400		-		16

In first semester, every student will undertake the following tasks: report writing, presentation and open viva-voce before the faculty members

Tasks	Contents	Marks
Project-I	Report: Any topic to be chosen from course and curriculum	10
	Presentation on the report	10
	An open viva-voce	20

Question Pattern

Question Pattern for all Papers	Group-A (10 Marks)	5 Moderate problems each of 2 marks
	Group-B (10 Marks)	2 Harder problems out of 3 each of 5 marks
	Group-C (30 Marks)	3 Questions out of 5 each of 10 marks

Detailed Syllabus

Semester-I

MATH-CCT-101: Groups and Rings

Total Lectures: 50 Hrs. **Marks: 50+10=60** **Credit: 2.4**

Homomorphism of Groups, Group Action, Conjugacy Relation, Class Equation, Cauchy's Theorem, Sylow's Theorems and applications.

Ring Homomorphism. Ideals and Quotient Ring. Prime and irreducible elements. Maximal and Prime Ideals. Quotient Field of an Integral Domain. Irreducible and Prime Elements in a Ring. Factorisation Domain, Unique Factorisation Domain, Principal Ideal Domain, Euclidean Domain, Ring of Polynomials.

Recommended Books:

1. *D. S. Dummit, R. M. Foote, Abstract Algebra (3e), John Wiley and Sons.*
2. *S. Lang, Algebra, 3rd Edition, Springer (Indian reprint 2004).*
3. *M. K. Sen, S. Ghosh, P. Mukhopadhyay, S. K. Maity, Topics in Abstract Algebra, Universities Press.*
4. *J. R. Gallian, Contemporary Abstract Algebra, Narosa Publishing House.*
5. *J. B. Fraleigh, A First Course in Abstract Algebra, Narosa Publishing House.*
6. *M. Artin, Algebra, Prentice Hall.*
7. *I.N. Herstein, Topics in Abstract Algebra, Wiley Eastern Limited.*
8. *D. S. Malik, J. N. Mordeson, M. K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill, International Edition, 1997.*
9. *Thomas Hungerford, Algebra, Springer GTM.*
10. *J.J. Rotman, The Theory of Groups: An Introduction, Allyn and Bacon, Inc., Boston.*

MATH-CCT-102: Naive Set Theory and Elements of Topology

Total Lectures: 50 Hrs **Marks: 50+10=60** **Credit: 2.4**

Ordinal and Cardinal numbers.
Topological spaces, open and closed sets, basis and sub-basis, closure, interior and boundary ofa set. Subspace topology. Continuous maps: properties and constructions; Pasting Lemma. Open and closed maps, Homeomorphisms. Product topology, Quotient topology. Countability and separation axioms: Urysohn's lemma, Tietze extension theorem and applications. Urysohn embedding lemma and metrization theorem for second countable spaces. Connected, path-connected and locally connected spaces. Lindelof and Compact spaces.

Recommended Books:

1. *J. R. Munkres, Topology: a first course, Prentice-Hall (1975).*
2. *G. F. Simmons, Introduction to Topology and Modern Analysis, TataMcGraw-Hill (1963).*
3. *M. A. Armstrong, Basic Topology, Springer.*
4. *J. L. Kelley, General Topology, Springer-Verlag (1975).*
5. *J. Dugundji, Topology, UBS (1999).*
6. *S. Willard, General Topology, Dover (2004).*
7. *I. P. Natanson, Theory of functions of a real variable, Vol. II. (especially for Ordinal numbers)*

MATH-CCT-103: Analysis of Several Variables

Total Lectures: 50 Hrs. **Marks: 50+10=60** **Credit: 2.4**

Topology of R" , GLn(R) etc.. Differentiability of maps from R to Rn and the derivative as a linear map. Determinant as mapping; its continuity and differentiability. Existence and meaningfulness of eR and its continuity as well as differentiability (A is a real square matrix).

Higher derivatives, Chain Rule, mean value theorem for differentiable functions, Taylor expansions in several variables, Local maxima and minima, Lagrange multiplier, Sard's theorem. Multiple integrals, Change of variables and the Jacobian formula, illustration with plenty of examples. Inverse and implicit function theorems. Picard's Theorem.

Curves in R2 and R3. Line integrals, Surfaces in R3, Surface integrals, Integration of forms, Divergence, Gradient and Curl operations, Green's theorem, Gauss (Divergence) theorem and Stoke's theorem.

Recommended Books:

1. *M. Spivak, Calculus on Manifolds, Benjamin (1965).*
2. *W. Rudin, Principles of mathematical Analysis, Mc Graw-Hill.*
3. *T. M. Apostol, Mathematical Analysis, Addison-Wesley,(2007)*
4. *J. Munkres, Analysis on Manifolds, CRC Press, (2018)*
5. *T. M. Apostol, Calculus (Vol 2), John Wiley.*

MATH-CCT-104: Real Analysis

Total Lectures: 50 Hrs. **Marks: 50+10=60** **Credit: 2.4**

Extended real numbers, algebraic operations and convergence in extended real number system, Lebesgue outer measure on R, elementary properties of Lebegue measure space including σ-finiteness, translation invariance, positive homogeneity, existence of non-Lebesgue measurable sets, regularity of Lebesgue outer measure, Borel measurability on R, measurable functions, operations with measurable functions, sequence of measurable functions, Cantor ternary set and Cantor-Lebesgue function.

Recommended Books:

1. *S K. Berberian, Fundamentals of Real Analysis, Springer.*
2. *G. De Barra, Measure Theory and Integration, New Age International Publ.*
3. *H. L. Royden, Real Analysis, Prentice-Hall Of India Pvt. Limited, (1988).*
4. *W. Rudin, Principles of Mathematical Analysis, McGraw-Hill, (2013).*
5. *J. Yeh, Lectures on Real Analysis, World Sci.*
6. *R. G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, (1966).*

MATH-CCT-105: Complex Analysis

Total Lectures: 50 Hrs. **Marks: 50+10=60** **Credit: 2.4**

Analytic function and Power series, Complex integration, Cauchy-Goursat Theorem, Cauchy's integral formula, Morera's Theorem, Liouville's theorem, Zeros of analytic functions, Maximum modulus principle, Taylor's theorem, Laurent's series, bilinear transformation.

Recommended Books:

1. *J. B. Conway, Functions of one complex variable, 2nd Ed., Narosa Publishing House, NewDelhi, 1997.*
2. *R. Remmmert, Theory of complex functions, Springer-Verlag, New York, 1991.*
3. *L. V. Ahlfors, Complex Analysis- 3rdEdn, McGraw-Hill, 1979*
4. *R. V. Churchill and J. W. Brown, Complex Variables and applications, McGraw Hill, 1996.*
5. *I. Markushevich, Theory of Functions of a Complex Variable (Vol. I, II & III), Prentice-Hall, 1965 & 1967.*
6. *E. C. Titchmarsh, The Theory of Functions, Oxford University Press, 1939.*
7. *E. T. Copson, Introduction to the Theory of Function of a Complex Variable, OxfordUniversity press, 1970.*
8. *W. Rudin, Real and Complex Analysis, Tata Mc Graw-Hill Education, 1987.*
9. *H.A. Priestly, Introduction to Complex Analysis, Clarendon Press Oxford, 1990.*
10. *Liang-shin Hahn & Bernard Epstein, Classical Complex Analysis. Jones and Bartlet Pub. International London, 1996.*
11. *S. Lang. Complex Analysis, Addison Wesley. 1970.*
12. *D. Sarason, Complex Function Theory, HindustanBook Agency, Delhi, 1994.*
13. *E. Hille, Analytic Function Theory (2 vols), Gonn & Co, 1959*
14. *W.H.J. Fuchs, Topics in the Theory of Functions of one complex variable, D. Van Nostrand Co., 1967.*
15. *M. Heins, Complex Function Theory. Academic Press, 1968.*
16. *W. A. Veech, A Second Course in Complex Aanlysis. W. A. Benjamin, 1967*
17. *S. Ponnusamy, Foundations of Complex Analysis, Narosa Pub. House, 1997*

MATH-CCT-106: Ordinary Differential Equations and Special Functions

Total Lectures: 50 Hrs. **Marks: 50+10=60** **Credit: 2.4**

Review of solution methods for first order as well as second order equations, Power Series methods with properties of Bessel functions and Legendré polynomials.

Existence and Uniqueness of Initial Value Problems: Picard's Theorem, Gronwall's inequality, continuation of solutions and maximal interval of existence.

Higher Order Linear Equations and linear Systems: fundamental solutions, Wronskian, variation of constants, matrix exponential solution.

Boundary Value Problems for Second Order Equations, eigenvalue problems.

Hypergeometric Equation: Solution near zero, one and infinity, integral formula, hypergeometric functions, properties of hypergeometric function.

Bessel Equation: Solution of Bessel's equation, Bessel function and its properties, generating function, integral representation of Bessel's function, Hankel functions, recurrence relations, asymptotic expansion of Bessel functions.

Legendre Equation: Solution of Legendre equation, Legendre functions, Generating function, Legendre functions of the first and second kinds, Laplace integral, Legendre polynomials, orthogonality, recurrence relation, Schlaefli's integral.

Recommended Books:

1. *S. L. Ross, Differential Equations, 3rd Edn., Wiley India, (1984).*
2. *G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata-McGrawHill, (2003).*
3. *M. Brown, Differential Equations and Their Applications, Springer, (1983).*
4. *W. Boyce, R. Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley, (2009).*
5. *E. A. Codington, Theory of Ordinary Differential Equations, Dover Publications, (2012).*
6. *G. Birhoff & G.C. Rofa, Ordinary Differential Equations, Wily, (1978).*
7. *I. N. Sneddon, Special Functions of Mathematical Physics & Chemistry, Oliver & Boyd, London.*
8. *N. N. Lebedev, Special Functions and their Applications, Dover Publications, (1965).*
9. *E. D. Rainville, Special Functions, Chelsea Publishing Company, (1971).*

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