

SYLLABUS FOR B.A/B.SC. (HONOURS)
IN
MATHEMATICS

Under Choice Based Credit System (CBCS)

Effective from 2017-2018



The University of Burdwan
Burdwan-713104
West Bengal

Outlines of Course Structures

The main components of this syllabus are as follows :

1. Core Course
2. Elective Course
3. Ability Enhancement Course

1. Core Course (CC)

A course, that should compulsorily be studied by a candidate as a core requirement, is termed as a core course.

2. Elective Course

2.1 Discipline Specific Elective (DSE) Course : A course, which may be offered by the main discipline/subject of study, is referred to as Discipline Specific Elective.

2.2 Generic Elective (GE) Course : An elective course, chosen generally from an unrelated discipline/subject of study with intention to seek an exposure, is called a Generic Elective Course.

3. Ability Enhancement Course (AEC)

The Ability Enhancement Course may be of two kinds :

3.1 Ability Enhancement Compulsory Course (AECC)

3.2 Skill Enhancement Course (SEC)

Details of Courses of B.A./B.Sc. (Honours) under CBCS

Course		Credit		Marks
1.	Core Course (14 papers)	Theory + Practical $14 \times (4+2) = 84$	Theory + Tutorial $14 \times (5+1) = 84$	$14 \times 75 = 1050$
2.	Elective Course (8 Papers)			
	A. DSE (4 Papers)	$4 \times (4+2) = 24$	$4 \times (5+1) = 24$	$4 \times 75 = 300$
	B. GE (4 Papers)	$4 \times (4+2) = 24$	$4 \times (5+1) = 24$	$4 \times 75 = 300$
3.	Ability Enhancement Course			
	A. AECC (2 Papers) AECC1 (ENVS) AECC2 (English/MIL)	$4 \times 1 = 4$ $2 \times 1 = 2$	$4 \times 1 = 4$ $2 \times 1 = 2$	100 50
	B. SEC (2 Papers)	$2 \times 2 = 4$	$2 \times 2 = 4$	$2 \times 50 = 100$
	Total Credit :	142	142	Total Marks = 1900

Semester wise Course Structures

Sem ester	Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Total class hrs./week	Marks	Credit	
I	CC	BMH1CC01	Calculus, Geometry & Differential Equations	5:1:0	6	75	6	
		BMH1CC02	Algebra	5:1:0	6	75	6	
	AECC		Environmental Studies	4:0:0	4	100	4	
	GE		To be offered by other discipline.				6	
II	CC	BMH2CC03	Real Analysis	5:1:0	6	75	6	
		BMH2CC04	Differential Equations and Vector Calculus	5:1:0	6	75	6	
	AECC		English/Modern Indian Language	2:0:0	2	50	2	
	GE		To be offered by other discipline.				6	
III	CC	BMH3CC05	Theory of Real Functions & Introduction to Metric Spaces	5:1:0	6	75	6	
		BMH3CC06	Group Theory I	5:1:0	6	75	6	
		BMH3CC07	Numerical Methods & Numerical Methods Lab	4:0:2	8	75 (50+25)	6	
		Choose any one from the following courses for Skill Enhancement Courses (SECs).						
	SEC	BMH3SEC11	Logic and Sets	2:0:0	2	50	2	
		BMH3SEC12	Computer Graphics	2:0:0	2	50	2	
		BMH3SEC13	Object Oriented Programming in C++	2:0:0	2	50	2	
GE		To be offered by other discipline.				6		
IV	CC	BMH4CC08	Riemann Integration and Series of Functions	5:1:0	6	75	6	
		BMH4CC09	Multivariate Calculus	5:1:0	6	75	6	
		BMH4CC10	Ring Theory and Linear Algebra I	5:1:0	6	75	6	
		Choose any one from the following courses for Skill Enhancement Courses (SECs).						
	SEC	BMH4SEC21	Graph Theory	2:0:0	2	50	2	
		BMH3SEC22	Operating System (Linux)	2:0:0	2	50	2	
		BMH3SEC23	MATLAB Programming	2:0:0	2	50	2	
GE		To be offered by other discipline.				6		

Sem ester	Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Total class hrs. /week	Marks	Credit	
V	CC	BMH5CC11	Partial Differential Equations and Applications	5:1:0	6	75	6	
		BMH5CC12	Mechanics I	5:1:0	6	75	6	
	Choose any one from the following courses for Discipline Specific Electives.							
	DSE	BMH5DSE11	Linear Programming	5:1:0	6	75	6	
		BMH5DSE12	Number Theory	5:1:0	6	75	6	
		BMH5DSE13	Point Set Topology	5:1:0	6	75	6	
	Choose any one from the following courses for Discipline Specific Electives.							
	DSE	BMH5DSE21	Probability & Statistics	5:1:0	6	75	6	
		BMH5DSE22	Portfolio Optimization	5:1:0	6	75	6	
		BMH5DSE23	Boolean Algebra and Automata Theory	5:1:0	6	75	6	
	VI	CC	BMH5CC13	Metric Spaces and Complex Analysis	5:1:0	6	75	6
BMH5CC14			Ring Theory and Linear Algebra II	5:1:0	6	75	6	
Choose any one from the following courses for Discipline Specific Electives.								
DSE		BMH6DSE31	Mathematical Modeling	5:1:0	6	75	6	
		BMH6DSE32	Industrial Mathematics	5:1:0	6	75	6	
		BMH6DSE33	Group Theory II	5:1:0	6	75	6	
Choose any one from the following courses for Discipline Specific Electives.								
DSE		BMH6DSE41	Bio Mathematics	5:1:0	6	75	6	
		BMH6DSE42	Differential Geometry	5:1:0	6	75	6	
		BMH6DSE43	Mechanics II	5:1:0	6	75	6	
Optional Dissertation or project work in place of one Discipline Specific Elective (DSE) Paper.								
PW	BMH6PW01	Project Work	0:0:6	6	75	6		

Detailed Syllabus

Course : BMH1CC01

Calculus, Geometry & Differential Equations(Marks : 75)

Total lecture hours: 60

Unit -1: Hyperbolic functions, higher order derivatives, Leibnitz 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, envelopes, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences. **12L**

Unit-2 : Reduction formulae, derivations and illustrations of reduction formulae for the integration of $\sin nx$, $\cos nx$, $\tan nx$, $\sec nx$, $(\log x)^n$, $\sin^n x \cos^m x$, parametric equations, parametrizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Techniques of sketching conics.**12L**

Unit -3: Reflection properties of conics, translation and rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

Spheres.Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, Generating lines, classification of quadrics, Illustrations of graphing standard quadric surfaces like cone, ellipsoid. **12L**

Unit – 4: Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation.Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.**12L**

Graphical Demonstration (Teaching Aid) 12L

1. *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*
2. *Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.*
3. *Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).*
4. *Obtaining surface of revolution of curves.*
5. *Tracing of conics in Cartesian coordinates/polar coordinates.*

6. *Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates*

Books Recommended :

- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
- S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
- G.F.Simmons, Differential Equations, Tata Mcgraw Hill.
- T. Apostol, Calculus, Volumes I and II.
- S. Goldberg, Calculus and Mathematical analysis.

Course : BMH1CC02

Algebra(Marks : 75)

Total lecture hours: 60

Unit -1 : Polar representation of complex numbers, n-th roots of unity, De Moivre's theorem for rational indices and its applications. **5L**

Theory of equations: Relation between roots and coefficients, Transformation of equation, Descartes rule of signs, Cubic and biquadratic equations, reciprocal equation, separation of the roots of equations, Sturm's theorem **8L**

Inequality: The inequality involving $AM \geq GM \geq HM$, Cauchy-Schwartz inequality **.4L**

Unit -2 : Equivalence relations and partitions, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set. Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm. Congruence relation between integers. Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic. **15L**

Unit -3: 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. **10L**

Unit 4: Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Vector spaces, Subspaces of \mathbb{R}^n , dimension of subspaces of \mathbb{R}^n , rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix. **18L**

Books Recommended :

- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
- David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
- K.B. Dutta, Matrix and linear algebra.
- K. Hoffman, R. Kunze, Linear algebra.
- W.S. Burnstine and A.W. Panton, Theory of equations.

Course : BMH2CC03

Real Analysis (Marks : 75)

Total lecture hours: 60

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. 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. **20L**

Unit-2 : Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, \liminf , \limsup . 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. **15L**

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. Alternating series, Leibniz test. Absolute and Conditional convergence. **15L**

Graphical Demonstration (Teaching Aid) 10L

1. Plotting of recursive sequences.

2. Study the convergence of sequences through plotting.
3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
4. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
5. Cauchy's root test by plotting n th roots.
6. Ratio test by plotting the ratio of n th and $(n+1)$ th term.

Books Recommended :

- R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
- Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
- S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
- Tom M. Apostol, Mathematical Analysis, Narosa Publishing House
- Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
- Terence Tao, Analysis I, Hindustan Book Agency, 2006
- S. Goldberg, Calculus and mathematical analysis.

Course : BMH2CC04

Differential Equation and Vector Calculus (Marks : 75)

Total lecture hours: 60

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, Euler's equation, method of undetermined coefficients, method of variation of parameters. **20L**

Unit -2 : 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. **20L**

Unit-3 : Equilibrium points, Interpretation of the phase plane

Power series solution of a differential equation about an ordinary point, solution about a regular singular point. **6L**

Unit- 4 :Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions. **10L**

Graphical Demonstration (Teaching Aid) : 4L

1. Plotting of family of curves which are solutions of second order differential equation.
2. Plotting of family of curves which are solutions of third order differential equation.

Books Recommended :

- Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
- C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
- 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., Elsevier Academic Press, 2004.
- Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
- Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.
- G.F.Simmons, Differential Equations, Tata McGraw Hill
- Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
- Maity, K.C. and Ghosh, R.K., Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
- M.R. Spiegel, Schaum's outline of Vector Analysis

SYLLABUS FOR
GENERIC ELECTIVES OF MATHEMATICS
(For Other Honours Discipline)

Under Choice Based Credit System (CBCS)

Effective from 2017-2018



The University of Burdwan

Burdwan-713104

West Bengal

Generic Electives of Mathematics

Semester	Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Total class hrs./week	Marks	Credit
I	GE	MATH-GE1	Differential Calculus	5:1:0	6	75	6
II	GE	MATH-GE2	Differential Equations	5:1:0	6	75	6
III	GE	MATH-GE3	Real Analysis	5:1:0	6	75	6
IV	GE	MATH-GE4	Algebra	5:1:0	6	75	6

Note : The detailed syllabi of MATH-GE1, MATH-GE2, MATH-GE3 and MATH-GE4 will be same as BMG1CC1A, BMG2CC1B, BMG3CC1C and BMG4CC1D of B.A./B.SC. (General) in Mathematics respectively.

Course : BMOHD1GE1

Differential Calculus (Marks : 75)

Total lecture hours: 60

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. 20L

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates. 15L

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(1+x)$, $(1+x)^n$, Maxima and Minima, Indeterminate forms. 25L

Books Recommended:

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

Course : BMOHD2GE2

Differential Equations (Marks : 75)

Total lecture hours: 60

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x , y , p . Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties.

Solving a differential equation by reducing its order. 15L

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations. 16L

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method. 15L

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only. 9L

Books Recommended:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

Course : BMOHD3GE3

Real Analysis (Marks : 75)

Total lecture hours: 60

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of \mathbb{R} , Archimedean property of \mathbb{R} , intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem. 15L

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof). 15L

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p -series, Root test, Ratio test, alternating series, Leibnitz's

test(Tests of Convergence without proof). Definition and examples of absolute and conditional convergence. 15L

Sequences and series of functions, Pointwise and uniform convergence. M_n -test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence. 15L

Books Recommended :

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P.Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

Course : BMOHD4GE4

Algebra (Marks : 75)

Total lecture hours: 60

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n . Cyclic groups from number systems, complex roots of unity, circle group, the general linear group $GL_n(n, R)$, groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group $Sym(n)$, Group of quaternions. 20L

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups. 20L

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n , ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p , Q , R , and C . Field of rational functions. 20L

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, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.