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

Semester wise Course Structures

Semester	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

Semester	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, cosnx, tan nx, sec nx, $(\log x)^n$, $\sin^n x \sin^m x$, 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,Strum's theorem **8L**

Inequality: The inequality involving AM≥GM≥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 R^n, dimension of subspaces of 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 :

- TituAndreescu and DorinAndrica, 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 uncountabilityof $\mathbb{R}$. 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,derivedset,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, 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.**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 nth roots.
6. Ratio test by plotting the ratio of nth 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. Speigel, Schaum's outline of Vector Analysis

SYLLABUS FOR

GENERIC ELECTIVES OF MATHEMATICS

(For Other HonoursDescipline)

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	**Choose any one from the following courses for Generic Elective of Semester-I.**						
	GE	BMOHD1GE11	Calculus, Geometry & Differential Equations	5:1:0	6	75	6
	GE	BMOHD1GE12	Algebra	5:1:0	6	75	6
	GE	BMOHD1GE13	Real Analysis	5:1:0	6	75	6
II	**Choose any one from the following courses for Generic Elective of Semester-II.**						
	GE	BMOHD2GE21	Differential Equations and Vector Calculus	5:1:0	6	75	6
	GE	BMOHD2GE22	Theory of Real Functions & Introduction to Metric Spaces	5:1:0	6	75	6
	GE	BMOHD2GE23	Group Theory I	5:1:0	6	75	6
III	**Choose any one from the following courses for Generic Elective of Semester-III.**						
	GE	BMOHD3GE31	Numerical Methods&Numerical Methods Lab	4:0:2	8	75 (50+25)	6
	GE	BMOHD3GE32	Ring Theory and Linear Algebra I	5:1:0	6	75	6
	GE	BMOHD3GE33	Number Theory	5:1:0	6	75	6
IV	**Choose any one from the following courses for Generic Elective of Semester-IV.**						
	GE	BMOHD4GE41	Multivariate Calculus	5:1:0	6	75	6
	GE	BMOHD4GE42	Linear Programming	5:1:0	6	75	6
	GE	BMOHD4GE43	Partial Differential Equations and Applications	5:1:0	6	75	6
	GE	BMOHD4GE44	Mathematical Modeling	5:1:0	6	75	6

Course :BMOHD1GE11

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, cosnx, tan nx, sec nx, $(\log x)^n$, $\sin^n x \sin^m x$, 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 :

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- 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 :BMOHD1GE12

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. **6L**

Inequality: The inequality involving AM≥GM≥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. Subspaces of R^n, dimension of subspaces of 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.**20L**

Books Recommended :

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- 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 : BMOHD1GE13

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, 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. **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 nth roots.
6. Ratio test by plotting the ratio of nth 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 :BMOHD2GE21

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. Speigel, Schaum's outline of Vector Analysis

Course :BMOHD2GE22

Theory of Real Functions & Introduction to Metric Space (Marks : 75)

Total lecture hours: 60

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. **18L**

Unit -2 :Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremumtheorem.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.**15L**

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.

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. **15L**

Unit-4 :Metric spaces: Definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, subspaces, dense sets, separable spaces. **12L**

Books Recommended :

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
3. A, Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006.
5. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House
6. Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
7. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
8. Terence Tao, Analysis II, Hindustan Book Agency, 2006
9. SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006
10. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
11. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.

Course :BMOHD2GE23

Group Theory–I (Marks : 75)

Total lecture hours: 60

Unit-1 : Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups. **10L**

Unit-2: Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. **5L**

Unit-3 : Properties of cyclic groups, classification of subgroups of cyclic groups. 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. **20L**

Unit-4: External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. **10L**

Unit-5: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.**15L**

.**Books Recommended :**

- 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.
- Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., 1995.
- I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.

.Course :BMOHD3GE31

Numerical Methods & Numerical Methods Lab

(Theory : 50 & Practical : 25)

Total lecture hours: 60

Unit-1:Algorithms. Convergence. Errors: Relative, Absolute. Round off. Truncation. **5L**

Unit-2 :Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.**7L**

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 **7L**

Unit-4:Interpolation: Lagrange and Newton's methods. Error bounds.Finite difference operators. Gregory forward and backward difference interpolation.
Numerical differentiation: Methods based on interpolations, methods based on finite differences. **7L**

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.
The algebraic eigenvalue problem: Power method.
Approximation: Least square polynomial approximation **9L**

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**. 5L**

Unit -7: Numerical Methods Lab 40L

List of practical (using C programming)

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ….+ 1/ N.
2. Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by
    a. Bisection method

b. NewtonRaphsonmethod.

c. Secant method.

d. RegulaFalsi method.

4. Solution of system of linear equations

a. LU decomposition method

b. Gaussian elimination method

c. Gauss-Jacobi method

d. Gauss-Seidel method

5. Interpolation

a. Lagrange Interpolation

b. Newton Interpolation

6. Numerical Integration

a. Trapezoidal Rule

b. Simpson's one third rule

c. Weddle's Rule

d. Gauss Quadrature

7. Method of finding Eigenvalue by Power method

8. Fitting a Polynomial Function

9. Solution of ordinary differential equations

a. Euler method

b. Modified Euler method

c. RungeKutta method

Books Recommended :

- Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
- M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering
- Computation, 6th Ed., New age International Publisher, India, 2007.
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
- Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
- John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
- Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
- Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
- YashavantKanetkar, Let Us C , BPB Publications.

Course : BMOHD3GE32

Ring Theory and Linear Algebra I (Marks : 75)

Total lecture hours: 60

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. 20L

Unit 2 : Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients.10L

Unit 3 : Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.15L

Unit 4 : Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix. 15L

Books Recommended :

- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
- S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
- Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
- 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.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.

Course : BMOHD3GE33
Number Theory (Marks : 75)

Total lecture hours: 60

Unit 1 : Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.20L

Unit 2 : Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues. some properties of Euler's phi-function. 20L

Unit 3 : Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last theorem.20L

Books Recommended :

- David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
- Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

Course : BMOHD4GE41

Multivariate Calculus (Marks : 75)

Total lecture hours: 60

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, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems 25L

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 co-ordinates. Change of variables in double integrals and triple integrals.20L

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. 10L

Unit-4 :Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem. 5L

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) Pvt. Ltd. (Pearson Education), Delhi, 2007.
- E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
- James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001
- Tom M. Apostol, Mathematical Analysis, Narosa Publishing House
- Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
- W. Rudin, Principles of Mathematical Analysis, 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).
- Terence Tao, Analysis II, Hindustan Book Agency, 2006
- M.R. Speigel, Schaum's outline of Vector Analysis.reprint, 2005.

Course : BMOHD4GE42

Linear Programming (Marks : 75)

Total lecture hours: 60

Unit 1 : Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison. 22L

Unit 2 : Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. **8L**

Unit 3 : 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, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. 18L

Unit 4 : 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. 12L

Books Recommended :

- Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
- 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.

Course : BMOHD4GE43

Partial Differential Equations and Applications (Marks : 75)

Total lecture hours: 60

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. Method of Separation of Variables for solving first order partial differential equations. 15L

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.

10L

Unit 3: The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string, Initial Boundary Value Problems. 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 15L

Unit 4: Central force. Constrained motion, varying mass, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.10L

Graphical Demonstration (Teaching Aid) 10L

1. Solution of Cauchy problem for first order PDE.

2. Finding the characteristics for the first order PDE.

3. Plot the integral surfaces of a given first order PDE with initial data.

4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - \frac{\partial^2 u}{\partial x^2} = 0$for the following associated conditions:

(a) $u(x,0) = \phi(x)$, $u(x,0) = \psi(x)$, $x \in R$, $t > 0$.

(b) $u(x,0) = \phi(x)$, $u(x,0) = \psi(x)$,$u(0, t) = 0$ $x \in (0,\infty)$, $t > 0$.

5. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$for the following associated conditions:

(a) $u(x,0) = \phi(x)$, $u(0, t) = a$,$u(l, t) = b$, $0 < x < l$, $t > 0$.

(b)$u(x,0) = \phi(x)$, $x \in R$, $0 < t < T$.

Books Recommended:

- TynMyint-U and LokenathDebnath, 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., Elsevier Academic Press, 2004.
- Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.
- Miller, F. H., Partial Differential Equations, John Wiley and Sons.
- Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press

Course :BMOHD4GE44
Mathematical Modelling(Marks : 75)

Total lecture hours: 60

The modeling process. Arguments from scales: Dimensional analysis 8L

Arguments from data: Least squares, parameter estimation. 8L

Linear models: Generalized least squares estimators. 9L

Mathematical models in biology: Population models, predator-prey systems. 10L

Stability analysis: Equilibria, oscillations, growth and decay. 10L

Difference equations: Modeling of traffic flows. 8L

Poisson process: Waiting in line. 7L

Books Recommended :

- R. Illner et al., MathematicalModelling: A Case Studies Approach. AMS, 2005.
- E. Bender, Introduction to Mathematical Modelling. Dover, 2000.
- J. Kapur, Maximum-entropy Models in Science and Engineering. Wiley, 1989.