Semester wise Details of B.Sc. (Hons) Mathematics (BHM) Course & Credit Scheme

(wef. Session 2019-20)

Semester	S. No.	Course Code	Course Name	Nature	L	T	P	Credits
First	1	MT101	Calculus	C	4	0	2	6
	2	MT103	Algebra	C	5	1	0	6
	3	ES101	Environmental Studies	AECC	4	0	0	4
	4	GE-1	Generic Elective/Interdisciplinary	GE				6
Second	1	MT102	Real Analysis	C	5	1	0	6
	2	MT104	Differential Equations	C	4	0	2	6
	3	EN105	Communicative English	AECC	4	0	0	4
	4	GE-2	Generic Elective/Interdisciplinary	GE				6
Third	1	MT201	Theory of Real Functions	C	5	1	0	6
	2	MT203	Group Theory-I	C	5	1	0	6
	3	MT205	Multivariate Calculus	C	4	0	2	6
	4	MT207	Latex and HTML	SEC	2	0	2	4
	5	GE-3	Generic Elective/Interdisciplinary	GE				6
Fourth	1	MT202	Partial Differential Equations	C	4	0	2	6
	2	MT204	Riemann Integration and Series of Functions	C	5	1	0	6
	3	MT206	Ring Theory and Linear Algebra-I	C	5	1	0	6
	4	MT208	Computer Algebra Systems and Related Software	SEC	2	0	2	4
	5	GE-4	Generic Elective/Interdisciplinary	GE				6
Fifth	1	MT301	Metric Spaces	C	5	1	0	6
	2	MT303	Group Theory-II	C	5	1	0	6
	3	DSE-1	DSE (including practical)	DSE	4	0	2	6
	4	DSE-2	DSE	DSE	5	1	0	6
Sixth	1	MT302	Complex Analysis	C	4	0	2	6
	2	MT304	Ring Theory and Linear Algebra-II	C	5	1	0	6
	3	DSE-3	DSE	DSE	5	1	0	6
	4	DSE-4	DSE	DSE	5	1	0	6
							Total Credits	148

- 4 Hours lab will be taken as 2 hours labs in two slots.

List of Discipline Specific Elective (DSE) Courses:

DSE-1 (including practical): Any one of the following

MT305	Numerical Analysis
MT307	Mathematical Modelling and Graph Theory
MT309	C++ Programming for Mathematics

DSE-2: Any one of the following

MT311	Probability Theory and Statistics
MT313	Discrete Mathematics
MT315	Cryptography and Network Security

DSE-3: Any one of the following

MT306	Mathematical Finance
MT308	Introduction to Information Theory and Coding
MT310	Biomathematics

DSE-4: Any one of the following

MT312	Number Theory
MT314	Linear Programming and Applications
MT316	Mechanics

Content Details

Bachelor of Mathematics (Hons.)

Semester I

Subject Code	MT101	Credit: 6 (L-T-P : 4-0-2) 4 Lecture (per week) 4 Hours Practical (per week per student)
Subject Name	Calculus	
Total Marks	150(Theory:70, Internal Assessment: 30, Practical: 50)	
Examination	3 Hours (Written) + 2 Hours (Practical)	

Unit 1: Derivatives for Graphing and Applications (Lectures: 12)

The first-derivative test for relative extrema, Concavity and inflection points, Second-derivative test for relative extrema, Curve sketching using first and second derivative tests; Limits to infinity and infinite limits, Graphs with asymptotes, L'Hôpital's rule; Applications in Business, Economics and Life Sciences; Higher order derivatives, Leibniz rule.

Unit 2: Sketching and Tracing of Curves (Lectures: 16)

Parametric representation of curves and tracing of parametric curves (except lines in $\mathbb{R}^3$), Polar coordinates and tracing of curves in polar coordinates; Techniques of sketching conics, Reflection properties of conics, Rotation of axes and second degree equations, Classification into conics using the discriminant.

Unit 3: Volume and Area of Surfaces (Lectures: 16)

Volumes by slicing disks and method of washers, Volumes by cylindrical shells, Arc length,Arc length of parametric curves, Area of surface of revolution; Hyperbolic functions;Reduction formulae.

Unit 4: Vector Calculus and its Applications (Lectures: 12)

Introduction to vector functions and their graphs, Operations with vector functions, Limits and continuity of vector functions, Differentiation and integration of vector functions; Modeling ballistics and planetary motion, Kepler's second law; Unit tangent, Normal and binormal vectors, Curvature.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Osborne, George. A. (1906). *Differential and Integral Calculus with Examples andApplications*. Revised Edition. D. C. Health & Co. Publishers. Boston, U.S.A.
3. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.

Additional Reading:

1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas*' *Calculus* (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

Teaching Plan (Theory of MT101**: Calculus):**

Week 1: The first-derivative test for relative extrema, Concavity and inflection points, Second-derivative test for relative extrema, Curve sketching using first and second derivative tests.
[3] Chapter 4 (Section 4.3)

Week 2: Limits to infinity and infinite limits, Graphs with asymptotes, Vertical tangents and cusps,L'Hôpital's rule.
[3] Chapter 4 (Sections 4.4, and 4.5)

Week 3: Applications of derivatives in Business, Economics and Life sciences. Higher orderderivatives and Leibniz rule for higher order derivatives for the product of two functions.
[3] Chapter 4 (Section 4.7)
[2] Chapter IV (Sections 57 to 60)

Week 4: Parametric representation of curves and tracing of parametric curves (except lines in R3), Polar coordinates and the relationship between Cartesian and polar coordinates.
[3] Chapter 9 [Section 9.4 (pages 471 to 475)]
[2] Chapter 10 (Sections 10.1, 10.2, up to Example 2, page 707)

Weeks 5 and 6: Tracing of curves in polar coordinates. Techniques of sketching conics**:** Parabola,Ellipse and Hyperbola.
[1] Chapter 10 [Sections 10.2 (page 707 to 717), and 10.4 up to Example 10 page 742)]

Week 7: Reflection properties of conics, Rotation of axes, Second degree equations and theirclassification into conics using the discriminant.
[1] Chapter 10 [Sections 10.4 (page 742 to 744), and 10.5]

Weeks 8 and 9: Volumes by slicing disks and method of washers, Volumes by cylindrical shells, Arclength, Arc length of parametric curves.
[1] Chapter 5 (Sections 5.2, 5.3, and 5.4)

Week 10: Area of surface of revolution; Hyperbolic functions.
[1] Chapter 5 (Section 5.5), and Chapter 6 (Section 6.8)

Week 11: Reduction formulae, and to obtain the iterative formulae for the integrals of the form**:** $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sec^n x dx$, and $\int \sin^m x \cos^n x dx$.
[1] Chapter 7 [Sections 7.2, and 7.3 (pages 497 to 503)]

Week 12: Introduction to vector functions and their graphs, Operations with vector functions, Limitsand continuity of vector functions, Differentiation and tangent vectors.
[3] Chapter 10 (Sections 10.1, and 10.2 up to page 504)

Week 13: Properties of vector derivatives and integration of vector functions; Modeling ballistics andplanetary motion, Kepler's second law.
[3] Chapter 10 (Sections 10.2 (pages 505 to 511), and 10.3)

Week 14: Unit tangent, Normal and binormal vectors, Curvature.
[1] Chapter 12 (Sections 12.4, and 12.5)

Practical / Lab work to be performed in Computer Lab.

List of the practical to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.

(i) Plotting the graphs of the following functions: ax, $[x]$ (greatest integer function), $\sqrt{ax+b}$, $|ax+b|$, $c \pm |ax+b|$, $x^{\pm n}$, $x^{1/n}$ $(n \in \mathbb{Z})$ $|x|/x$, $\sin(1/x)$, $x\sin(1/x)$, and $e^{\pm 1/x}$ for $x \neq 0$. e^{ax+b}, $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $|\sin(ax+b)|$, $|\cos(ax+b)|$. Observe and discuss the effect of changes in the real constants *a*, *b* and *c* on the graphs

(ii) Plotting the graphs of polynomial of degree 4 and 5, and their first and second derivatives, and analysis of these graphs in context of the concepts covered in Unit 1.

(iii) Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid.

(iv) Tracing of conic in Cartesian coordinates.

(v) Obtaining surface of revolution of curves.

(vi) Graph of hyperbolic functions.

(vii) Computation of limit, Differentiation, Integration and sketching of vector-valued functions.

(viii) Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representation of polar form.

(ix) Find numbers between two real numbers and plotting of finite and infinite subset of $\mathbb{R}$.

(x) **Matrix Operations:** Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors, Eigenvalues, Characteristic equation and verification of the Cayley-Hamilton theorem, Solving the systems of linear equations.

Subject Code	MT103	Credit: 6 (L-T-P : 5-1-0)
Subject Name	Algebra	5 Lecture (per week) 1 Tutorial (per week per student)
Total Marks	100(Theory:70, Internal Assessment: 30)	
Examination	3 Hours (Written)	

Unit 1: Theory of Equations and Complex Numbers **(Lectures: 20)**

Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots; Polar representation of complex numbers, The *n*th roots of unity, DeMoivre'stheorem for integer and rational indices and its applications.

Unit 2: Equivalence Relations and Functions **(Lectures: 10)**

Equivalence relations, Functions, Composition of functions, Invertibility and inverse of functions, One-to-one correspondence and the cardinality of a set.

Unit 3: Basic Number Theory **(Lectures: 10)**

The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering principle.

Unit 4: Row Echelon Form of Matrices and Applications **(Lectures: 30)**

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation $A\mathbf{x} = b$, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Applications to Computer Graphics, Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.

References:

1. Andreescu, Titu&AndricaDorin. (2014). *Complex Numbers from A to...Z.* (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (1922). *First Course in The Theory of Equations*. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.
3. Goodaire, Edgar G., & Parmenter, Michael M. (2005). *Discrete Mathematics withGraph Theory* (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.
4. Kolman, Bernard, & Hill, David R. (2001). *Introductory Linear Algebra withApplications* (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.
5. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). *Linear Algebra and itsApplications* (5th ed.). Pearson Education

Additional Readings:

1. Andrilli, Stephen, & Hecker, David (2016). *Elementary Linear Algebr*a (5th ed.). Academic Press, Elsevier India Private Limited.
2. Burton, David M. (2007). *Elementary Number Theory* (7th ed.). Tata Mc-Graw Hill Edition, Indian Reprint.

Teaching Plan (MT103**: Algebra):**

Weeks 1 and 2: Elementary theorems on the roots of an equation, Polynomials, The remainder andfactor theorem, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots.
[2] Chapter II (Sections 12 to 16, 19 to 21, 24 and 27, Statement of the Fundamental theorem of algebra)

Weeks 3 and 4: Polar representation of complex numbers, The*n*th roots of unity, DeMoivre's theoremfor integer and rational indices and its applications.
[1] Chapter 2

Weeks 5 and 6. Equivalence relations, Functions, Composition of functions, Invertibility and inverseof functions, One-to-one correspondence and the cardinality of a set.
[3] Chapter 2 (Section 2.4), and Chapter 3

Weeks 7 and 8: The division algorithm, Divisibility and the Euclidean algorithm, The fundamentaltheorem of arithmetic (statement only), Modular arithmetic and basic properties of congruences. Principles of mathematical induction and well ordering principle.
[3] Chapter 4 [Sections 4.1 up to 4.1.6, 4.2 up to 4.2.11, 4.3 (4.3.7 to 4.3.9), and 4.4 up to 4.4.8)], and Chapter 5 (Sections 5.1.1 and 5.1.4)

Weeks 9 and 10: Systems of linear equations, Row reduction and echelon forms, Vector equations,The matrix equation $A\mathbf{x} = b$, Solution sets of linear systems, Linear independence, The rank of a matrix and applications (Definition and examples).
[5] Chapter 1 (Sections 1.1 to 1.5)
[4] Chapter 6 [Section 6.6 (pages 287 to 291)]

Week 11: Introduction to linear transformations, The matrix of a linear transformation.[5] Chapter 1 (Sections 1.7 to 1.9)

Weeks 12 and 13: Matrix operations, The inverse of a matrix, Characterizations of invertible matrices,Applications to Computer Graphics.
[5] Chapter 2 (Sections 2.1 to 2.3, and 2.7 up to Example 6, page 142)

Week 14: Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.
[4] Chapter 5 (Sections 5.1 and 5.2, Supplementary exercises 5 and 7, page 328)