Guru Kashi University

B.Sc. (Hons.) in Mathematics

Session: 2023-24

Department of Mathematics

GRADUATE ATTRIBUTES OF THE PROGRAMME

Students adapts and shows resilience in the face of challenges and focuses on solutions that make them feel empowered, happier, and more capable, also takes personal responsibility, accountability, and pride in pursuing and draws on gained knowledge, experience to contribute in a positive and ethical manner.

Program Learning Outcomes: After completion of the program, the students will be able to:

1. Develop a positive attitude towards mathematics as an interesting and valuable subject of study.
2. Enlighten with the relational understanding of mathematical concepts and concerned structures to follow the patterns involved in mathematical reasoning etc.
3. Equipped with mathematical modeling abilities, problem-solving skills, creative talent, and power of communication necessary for future advanced studies as well as employability.
4. Evolve skills and knowledge that lead to proficiency in analytical reasoning, critical understanding, analysis, and synthesis in order to solve theoretical and practical problems which can orient towards applications of mathematics in other disciplines and moreover, can also be utilized in modeling and solving real-life problems.
5. Acquire good knowledge and understanding in advanced areas of mathematics and statistics, chosen from the choice-based credit system of courses.
6. Compose and develop mathematical arguments in a logical manner. Understand, formulate, and use quantitative models arising in social science, Business, and other contexts.

Course Structure of B.Sc.(H) Mathematics for Batch: 2023-24

Semester: I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BMH101	Calculus	Core	4	0	0	**4**
BMH102	Algebra I	Core	4	0	0	**4**
BMH103	Coordinate Geometry	Core	4	0	0	**4**
BMH104	Computer Programming using C++	Technical Skill	4	0	0	**4**
BMH105	Computer Lab-I (C++ Programming)	Technical Skill	0	0	2	**1**
BMH106	Communication Skill	Ability Enhancement	2	0	0	**2**
BMH199	XXXX	MOOC	-	-	-	**2**
Total			**18**	**0**	**2**	**21**

Semester: II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BMH201	Ordinary Differential Equations	Core	4	0	0	**4**
BMH202	Real Analysis	Core	4	0	0	**4**
BMH203	MATLAB Programming- I	Technical Skill	4	0	0	**4**
BMH204	Software Lab-II (MATLAB Programming I)	Technical Skill	0	0	4	**2**
Discipline Elective-I (Any One from the Following)						
BMH205	Vector Analysis	Discipline Elective	3	0	0	**3**
BMH206	Algebra II					
Discipline Elective-II(Any One from the Following)						
BMH207	Financial Mathematics	Discipline Elective	3	0	0	**3**
BMH208	Discrete Mathematics					
Open Elective (From other Departments)						
XXXX	XXXX	Open Elective	2	0	0	**2**
Total			**20**	**0**	**4**	**22**

Open Elective (For other Departments)

BMH209	Vedic Mathematics	Open Elective	2	0	0	**2**
BMH210	Basic Mathematics					

Semester: III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BMH301	Complex Analysis	Core	4	0	0	**4**
BMH302	Advanced Calculus	Core	4	0	0	**4**
BMH303	Mechanics	Core	4	0	0	**4**
BMH304	MATLAB programming II	Technical Skill	4	0	0	**4**
BMH305	Software Lab-III (Numerical Computations using MATLAB)	Technical Skill	0	0	4	**2**
BMH399	XXXX	MOOC	-	-	-	**2**
Discipline Elective-III (Any one from the following)						
BMH306	Mathematical Modeling	Discipline Elective	3	0	0	**3**
BMH307	Combinatorial Mathematics					
Discipline Elective-IV (Any one from the following)						
BMH308	Numerical Analysis	Discipline Elective	3	0	0	**3**
BMH309	Mathematical Methods					
Value Added Course (For other Department also)						
BMH310	Quantitative Aptitude	Value Added Course	1	0	0	**1**
Total			**23**	**0**	**4**	**27**

Semester: IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BMH401	Metric Spaces	Core	4	0	0	**4**
BMH402	Algebra-III	Core	4	0	0	**4**
BMH403	Measure Theory	Core	4	0	0	**4**
BMH404	Software Lab-IV (Numerical Analysis using MATLAB/C++)	Technical Skill	0	0	4	**2**
BMH405	Research Proposal	Research Skill based	4	0	0	**4**
Discipline Elective-V (Any one of the following)						
BMH406	Mathematical Statistics	Discipline Elective	3	0	0	**3**
BMH407	Tensor Analysis					
Discipline Elective-VI (Any one of the following)						
BMH408	Riemann Integration and Series of Functions	Discipline Elective	3	0	0	**3**
BMH409	Linear Programming Problems					
Total			**22**	**0**	**4**	**24**

Semester: V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BMH501	Differential Geometry	Core	4	0	0	**4**
BMH502	Fluid Mechanics	Core	4	0	0	**4**
BMH503	Partial Differential Equations	Technical Skill	4	0	0	**4**
BMH504	Descriptive Statistics	Technical Skill	4	0	0	**4**
BMH505	Descriptive Statistics	Technical Skill	0	0	2	**1**
BMH599	XXXX	MOOC	-	-	-	**2**
Discipline Elective-VII(Any one of the following)						
BMH506	Theory of Equations	Discipline Elective	3	0	0	**3**
BMH507	Econometrics					
Total			**19**	**0**	**2**	**22**

Semester: VI						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BMH601	Number Theory	Core	4	0	0	**4**
BMH602	Group Theory	Core	4	0	0	**4**
BMH603	Functional Analysis	Core	4	0	0	**4**
BMH604	Astronomy	Technical Skill	4	0	0	**4**
BMH605	Logic and Sets	Technical Skill	4	0	0	**4**
Discipline Elective VIII(Any one of the following)						
BMH606	Differentiable Manifolds	Discipline Elective	3	0	0	**3**
BMH607	Fuzzy Theory					
Total			**23**	**0**	**0**	**23**
Grand Total			**125**	**0**	**16**	**139**

Evaluation Criteria for Theory Courses

A. Continues Assignment. (25 marks)

   a) CA – I Surprise test (Two Best out of three) (10 Marks)
   b) CA – II Assignment(s) (10 Marks)
   c) CA – III Term Paper/Quiz/Presentations (05 Marks)

B. Attendance (05 marks)
C. Mid Semester Exam [30 Marks]
D. End Semester Exam [40 Marks]

SEMESTER-I

Course Title: Calculus

Course Code: BMH101

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Recall continuity of a function illustrate the consequences of the intermediate value theorem for continuous functions.
2. Examine the value of the limit of a function at a point by using the definition of the limit.
3. Practice the formation of equations and compute symmetric functions of roots in terms of coefficients.
4. Acquire the fundamental concepts of real numbers and their applications.

Course Content

UNIT–I **15 hours**

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of type $e^{ax+b}\sin x, e^{ax+b}\cos x, (ax+b)^n \sin x, (ax+b)^n$, 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.

UNIT–II **15 hours**

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

UNIT–III **15 hours**

Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation.

UNIT–IV **15 hours**

Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *G.B. Thomas and R.L. Finney. (2005). Calculus.9thEd. Pearson Education, Delhi.*
- *M.J. Strauss, G.L. Bradley and K. J. Smith. (2007). Calculus. 3rd Ed. Pearson Education, Delhi.*
- *H. Anton, I. Bivensand S. Davis. (2002). Calculus.7thEd., JohnWileyandSons(Asia)P.Ltd. Singapore.*
- *R. Courant and F. John. (1989). Introduction to Calculus and Analysis springer- Verlag, New York, Inc.,*

Course Title: Algebra -I

Course Code: BMH102

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Evaluate roots of polynomial over rational and concepts of theory of equations.
2. Describe the concepts of finding graphs, roots and primes integer, Division, algorithm, Euclidian algorithm etc.
3. Accumulate knowledge to solve Congruence relation, vector and matrix equations etc.
4. Evolve procedures to solve system of linear equation and understand their uses in real field with various methods.

Course Content

UNIT–I **15 hours**

Polar representation of complex numbers, n-th roots of Unity, De Moivre's theorem for rational indices and its applications. Theory of equations: Relation between roots and coefficients, Transformation of equation, Descartes rule of signs.

UNIT–II **15 hours**

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. Statements of Fundamental Theorem of Arithmetic.

UNIT–III **15 hours**

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.

UNIT–IV **15 hours**

Matrix, inverse of a matrix, characterizations of invertible matrices. 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.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *TituAndreescu and DorinAndrica. (2006). Complex Numbers from A to Z. Birkhauser.*
- *Edgar G. Goodaire and MichaelM. Parmenter. (2005). Discrete Mathematics with Graph Theory. 3rdEd. Pearson Education (Singapore) P. Ltd., Indian Reprint.*
- *David C. Lay. (2007). Linear Algebra and its Applications. 3rd Ed. Pearson Education Asia, Indian Reprint.*
- *Joseph A. Gallian. (1999). Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi.*
- *S. Lang. (2005).Introduction to Linear Algebra, 2nd Ed., Springer.*

Course Title: Coordinate Geometry

Course Code: BMH103

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Describe the various forms of equation of a plane, straight line, Sphere, Cone and Cylinder.
2. Find the angle between planes, Bisector planes, Perpendicular distance from a point to a plane, Image of a line on a plane, Intersection of two lines
3. Practice critical thinking to develop innovative and well-founded perspectives related to the students' emphases.
4. Explain the angle between planes, Bisector planes, Perpendicular distance from a point to a plane, Image of a line on a plane, Intersection of two lines

Course Content

UNIT–I **15 hours**

Pair of Straight lines: Joint equation of pair of straight lines and angle between them, condition of parallelism and perpendicular, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve.

UNIT–II **15 hours**

Conic: General equation of conic, Tangents, normal, chord of contact, pole and polar, of tangents from a point, equation of chord in terms of midpoint, diameter.

UNIT–III **15 hours**

Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola.

UNIT–IV **15 hours**

Transformation of axes in two dimensions: shifting of origin, rotation of axes, the second-degree equation $S=ax^2+2hxy+by^2+2gx+2fy+c=0$, its invariants t, and O. Reduction of the second-degree equation into standard form. Identification of curves represented by S=0 (including pair of lines).

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings:-

- *P.K Jain and Khalil Ahmed. (1994).A text book of Analytical Geometry of two dimension Wiley Eastern Ltd.*
- *P.K Jain and Khalil Ahmed. (1999).A text book of Analytical Geometry of three dimensions. Wiley Eastern Ltd.*
- *Shanti Narayan and P.K Mittal. (2006). Analytical Solid Geometry 17th Revised Edition S. Chand and Co. New Delhi.*
- *S.L. Loney.(1992). The Elements of Coordinate Geometry, McMillan and Company, London.*
- *R.J.T. Bill. (1994). Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd.*

Course Title: Computer Programming using C++

Course Code: BMH104

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Analyze the advantages of a high-level language like C/C++, the programming process, and the compilation process.
2. Describe and use software tools in the programming process provided in this course.
3. Apply good programming principles to the design and implementation of C/C++ programs, demonstrate an understanding of algorithms in the problem-solving process, and identify the necessary properties of good problem-solving techniques.
4. Demonstrate an understanding of the overall syntax and semantics of C/C++ programs by writing small programs from specifications given in class, describe the fundamental components of a C/C++ program (e.g., Source files, header files, main function, functions, and libraries), explain and apply fundamental syntax rules for identifiers, declarations, expressions, Statements, and functions.

Course Content

UNIT–I **15 hours**

Introduction and Features: Fundamentals of object-oriented programming – procedure-oriented programming Vs. object-oriented programming (OOP). Object oriented programming concepts – Classes, reusability, encapsulation, inheritance, polymorphism, dynamic binding, message passing, data hiding.

UNIT–II **15 hours**

Language Constructs: Review of constructs of C used in C++ : variables, types and type declarations, user defined data types; increment and decrement operators, relational and logical operators; if then else clause; conditional expressions, input and output Statements, loops, switch case, arrays, structure, unions, functions, pointers; pre-processor directives.

UNIT–III **15 hours**

Classes and Objects: Creation, accessing class members, Private Vs Public, Constructor and Destructor Objects.

Member Functions: Method definition, Inline functions implementation,

Constant member functions, Friend Functions and Friend Classes, Static functions.

Overloading Member Functions: Need of operator overloading, operator overloading, constructor overloading.

UNIT–IV **15 hours**

Inheritance: Definition of inheritance, protected data, private data, public data, inheriting constructors, and destructors, types of inheritance, single inheritance, hierarchical inheritance, multiple inheritance, hybrid inheritance, multilevel inheritance.

Polymorphism and Virtual Functions: Importance of virtual function, function call binding, virtual functions, implementing late binding, need for virtual functions

File: Components of a file, different operation of the file, communication in files.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz,Open talk, Case analysis.

Suggested Readings: -

- *R. VenugopalRajkumar and T. Ravi shanker. (1997). Mastering C++. TMH Publication.*
- *S. B. Lippman and J. Lajoie. (2000). C++ Primer 3rd Ed. Addison Wesley.*
- *Bruce Eckel. (2001).Thinking in C++.2nd Ed. President Mindview Inc. Prentice Hall.*
- *D. Parasons.(1998). Object Oriented Programming with C++. BPB Publication.*
- *BjarneStroustrup. (1999). The C++ Programming Language.3rd Ed., Addison Welsle.*

Course Title: Software Lab I (C++ Programming)

Course Code: BMH105

L	T	P	Cr
0	0	4	2

Total Hours:30

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Creating simple programs using classes and objects in C++.
2. Implement Object-Oriented Programming Concepts in C++.
3. Develop applications using stream I/O and file I/O, implement simple graphical user interfaces.
4. Execute Object-Oriented Programs using templates and exceptional handling concepts.

Course Content

List of Practical's:

1. Calculate the Sum of the series 1/1 + 1/2+ 1/3……+1/N for any positive integer N.
2. Write a user defined function to find the absolute value of an integer and use it to evaluatethe function (-1)n/|n|, for n = -2,-1,0,1,2.
3. Calculate the factorial of any natural number.
4. Read floating numbers and compute two averages: the average of negative numbers and the average of positive numbers.
5. Write a program that prompts the user to input a positive integer. It should then output amessage indicating whether the number is a prime number.
6. Write a program that prompts the user to input the value of a, b and c involved in the equation ax^2 + bx + c = 0 and outputs the type of the roots of the equation. Also the program should outputs all the roots of the equation.

7. write a program that generates random integer between 0 and 99. Given that first two Fibonacci numbers are 0 and 1, generate all Fibonacci numbers less than or equal to generated number.
8. Write a program that does the following:
   a. Prompts the user to input five decimal numbers.
   b. Prints the five decimal numbers.
   c. Converts each decimal number to the nearest integer.
   d. Adds these five integers.
   e. Prints the sum and average of them.
9. Write a program that uses *while* loops to perform the following steps:
10. Prompt the user to input two integers: first Number and second Number (first Number should be less than second Number).
11. Output all odd and even numbers between first Number and second Number.
12. Output the sum of all even numbers between first Number and second Number.
13. Output the sum of the square of the odd numbers first Number and Second Number.
14. Output all uppercase letters corresponding to the numbers between first Number and Second Number, if any.
15. Write a program that prompts the user to input five decimal numbers. The program should then add the five decimal numbers, convert the sum to the nearest integer, and print the result.
16. Write a program that prompts the user to enter the lengths of three sides of a triangle and then outputs a message indicating whether the triangle is a right triangle or a scalene triangle.
17. Write a value returning function smaller to determine the smallest number from a set of numbers. Use this function to determine the smallest number from a set of 10 numbers.

18. Write a function that takes as a parameter an integer (as a longvalue) and returns the number of odd, even, and zero digits. Also write a program to test your function.
19. Enter 100 integers into an array and short them in an ascending/ descending order and print the largest/ smallest integers.
20. Enter 10 integers into an array and then search for a particular integer in the array.
21. Multiplication/ Addition of two matrices using two dimensional arrays.
22. Using arrays, read the vectors of the following type: A = (1 2 3 4 5 6 7 8), B = (0 2 3 4 0 1 5 6) and compute the product and addition of these vectors.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *R. VenugopalRajkumar and T. Ravi shanker. (1997). Mastering C++. TMH Publication.*
- *S. B. Lippman and J. Lajoie. (2000). C++ Primer 3rd Ed. Addison Wesley.*
- *Bruce Eckel. (2001).Thinking in C++.2nd Ed. President Midview Inc. Prentice Hall.*
- *D. Parisons .(1998). Object Oriented Programming with C++. BPB Publication.*
- *BjarneStroustrup. (1999).The C++ Programming Language.3rd Ed., Addison Welsley.*

Course Title: Communication Skill

Course Code: BMH106

L	T	P	Cr
2	0	0	2

Total Hours: 30

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Brighten their awareness of correct usage of English grammar in writing and speaking.
2. Improve their speaking ability in English both in terms of fluency and comprehensibility
3. Upgrade their reading speed and comprehension of academic articles
4. Enhance fluency in reading skills through extensive reading, enrich their vocabulary, refine ability to write academic papers, essays and summaries.

Course Content

UNIT–I **8 hours**

Developing Habits of Independent and Fast Reading

Students will be required to read a prescribed prose. The essays in the anthology will be read by students at home with the help of glossary given in the book. Progressing from one lesson to another, they should learn to read fast. Students are supposed to keep a record of their reading in the form of notes, difficulties, summaries, outlines and reading time for each essay. Class teacher may use this record for awards of internal assessment (if any)

UNIT -II **8 hours**

Developing Comprehension Skills

Teacher will provide guided comprehension of the prescribed texts in the class and help students in answering the questions given at the end of each lesson. Teacher can construct more questions of factual and inferential nature to enhance the comprehension skills of the students. The teacher shall also guide students to do the grammar exercise given at the end of each lesson.

UNIT -III **7 hours**

Developing skills in Personal Writing

Students will be required to learn short personal write-ups involving skills of description and narration. The types of composition task may include personal letter writing, telegram writing. Notice writing, diary writing etc. The teacher

shall instruct the students about the appropriate format and usual conventions followed in such writings. The teacher may also prescribe composition /writing book if so required.

Business writing:
Business letters; elements of business writing; kinds of business letters – office order memorandum, report, purchase order, quotations and tenders, job application letters, personal resume and curriculum vitae etc.

UNIT -IV **7 hours**

Development of Speaking Skills: Public speaking – formal speaking-audience analysis – effective use of voice & body language – importance of confidence building – group discussion – presentation skills- seminar – interview skills development – telephone etiquettes – opinion-based speaking.
Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *Vandana R Singh. (2003). The Written Word Oxford University Press New Delhi.*
- *KK Ramchandran, Etal. (2002). Buisness Communication. Macmilan. New Delhi.*
- *Swati Samantaray. (2001) Business Communication and Communicative English. Sultan Chand, New Delhi.*
- *S.P. Dhanavel. (1999) English and Communication Skills. for Students of Science and Engineering (with Audio CD)*
- *Gimson, A.C. (2001). An Introduction to the Pronunciation of English. ELBS.*

Semester -II

Course Title: Ordinary Differential Equations

L	T	P	Cr
4	0	0	4

Course Code: BMH201

Total Hours: 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Familiarize with various methods of solving differential equations of first and second order and to have qualitative applications
2. Solve various working rule for finding solution of linear differential equations with constant coefficients.
3. Study of homogeneous linear equations or Cauchy-Euler equations, linear differential equations of second order with variable coefficients, initial and boundary value problems etc.
4. Model problems in nature using ordinary differential equations.

UNIT-I **15 hours**

Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution dy/dx= f(x,y).

UNIT-II **15 hours**

Differential equations of first order and first degree, Separation of variables, Homogeneous linear Equations, Exact Equations, Integrating Factor, Linear Equation, Equation of First order but not of first degree

UNIT-III **15 hours**

Linear differential equations with constant coefficients, Complementary function, Particular integral, working rule for finding solution of linear differential equations with constant coefficients, Homogeneous linear equations or Cauchy-Euler equations

UNIT-IV **15 hours**

Simultaneous differential equations, Differential equations of the form dx/P= dy/Q= dz/R where P, Q, R are functions of x, y, z. Exact differential equations,

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *G.F. Simmons, (2002), Differential Equations with Application and Historical Notes, Tata –McGraw Hill.*
- *B. Rai, D.P. Choudhary & H. J. Freedman, (2002), A Course of Ordinary Differential Equations, Narosa.*
- *Ian N. Snedden, (2013), Elements of Partial Differential Equations, Dover Publication.*
- *L.E. Elsgolts, (1970), Differential Equation and Calculus of variations, University Press of the Pacific.*
- *M. D. Raisinghania, (2018), Ordinary and Partial Differential Equations, S Chand.*

Course Title: Real Analysis

Course Code: BMH202

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
2. Define and recognize the basic properties of the field of real numbers, interpret the series of real numbers, evaluate the real functions and its limits, their convergence and recognize the differentiability of real functions and its related theorems.
3. Demonstrate an understanding of limits and how they are used in sequences, series etc and construct rigorous mathematical proofs of basic results in real analysis.
4. Recall the methods of classifying and analyzing data relative to single variable.

Course Content

UNIT-I **15 hours**

Review of Algebraic and Order Properties of $\mathbb{R}$, ε-neighborhood 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.

UNIT-II **15 hours**

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.

UNIT-III **15 hours**

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, liminf, lim sup. Limit Theorems. Monotone Sequences, Monotone Convergence Theorem. Sub sequences, Divergence Criteria. Monotone Subsequence Theorem (Statements only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

UNIT-IV **15 hours**

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

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *R.G. Bartle and D.R. Sherbert (2002). Introduction to Real Analysis.3rd Ed. John Wiley and Sons (Asia) Pvt. Ltd., Singapore.*
- *Gerald G. Bilodeau Paul R. Thie G. E. Keough. (2010) . An Introduction to Analysis 2nd Ed. Jones & Bartlett.*
- *Brian S. Thomson Andrew. (2001). Elementary Real Analysis Prentice Hall.*
- *S.K. Berberian. (1994). A First Course in Real Analysis Springer Verlag New York.*

Course Title: MATLAB Programing-I

Course Code: BMH203

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Outcomes: At the end of the course, the students are able to:

1. Understand the main features of the MATLAB program development environment to enable their usage in the higher learning.
2. Implement simple mathematical functions/equations in numerical computing environment
3. Interpret and visualize simple mathematical functions and operations thereon using plots
4. Write simple programs in MATLAB to solve scientific and mathematical problems

UNIT-I **15 hours**

Desktop, Variables, and Data Types: Introduction to MATLAB, Command Window, Editor Window, Figure Window, Help Window, etc. Data Types in MATLAB: Scalars, vectors, Arrays, Strings, etc. Creating Variables Some Useful MATLAB Functions, Data Types.

UNIT-II **15 hours**

Different inbuilt functions of MATLAB. Common System Commands, Syntax and Operators. Programming in MATLAB through M-file Editor. User defined functions in MATLAB. Programming in MATLAB through M-file Function. Algorithm. Simple problems.

UNIT-III **15 hours**

Script Files, : Plotting, Introduction to Arrays Graphing, Input and output statement, Conditional statement- Logical Operators, : if, else, and elseif.

UNIT-IV **15 hours**

Introduction to Loops, For Loops, While Loops, Nested Loops Breaks.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz.

Suggested Readings:-

- *Gilat, Amos (2004). MATLAB: An Introduction with Applications 2nd Edition. John Wiley &Sons. ISBN 978-0-471-69420-5.*
- *Quartertone, Alfio; Saleri, Fausto (2006). Scientific Computing with MATLAB and Octave. Springer. ISBN 978-3-540-32612-0.*
- *Ferreira, A.J.M. (2009). MATLAB Codes for Finite Element Analysis. Springer. ISBN 978-1-4020- 9199-5.*
- *Lynch, Stephen (2004). Dynamical Systems with Applications using MATLAB. Birkhäuser. ISBN 978-0-8176-4321-8*
- *MATLAB, (2013): A Practical Introduction to Programming and Problem Solving, 3rd edition, Stormy Attaway, Elsevier .*

Course Title: Software Lab II (MATLAB Programming I)

Course Code: BMH204

L	T	P	Cr
0	0	4	2

Total Hours: 30

Course Learning Outcomes: On successful completion of this course, the students will be able to**:**

1. Understand the main features of the MATLAB program development environment.
2. Design simple algorithms to solve mathematical problems by using operators and conditional statements.
3. Write simple programs in MATLAB to solve scientific and mathematical problems.
4. Increase the computer efficiency

List Of Programing

1. Operating MATLAB desktop.

2. Sum of any finite number of terms.

3. Product of any finite number of terms.

4. Computation of Factorial.

5. Computation of e^x,sinh(x), cosh(x), cos(x), sin(x) etc.

6. LCM and GCD of finite number of positive integers.

7. Sorting of numbers in ascending or descending order.

8. Addition and Subtraction, multiplication of vectors.

9. Addition subtraction, multiplication of matrices.

10. Plotting of different curves along with styles, width etc.

11. Plotting of different surfaces along with styles, width etc.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Course Title: Vector analysis

Course Code: BMH205

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Evaluate derivation of functions of several variables, directional derivatives and their related elements, calculate Jacobian matrices of functions of several variable
2. Represent vector fields (gradient, divergence, rotational) Evaluate the integrals of functions and vector fields on surfaces
3. Formulate exterior derivative and know basic properties of the induced mappings by using Stokes's Theorem for integrals of differential forms.
4. Analyse the integrals of functions and vector fields on surfaces express and prove Stokes's and Divergence Theorems.

Course Content

UNIT-I **11 hours**

Vector Analysis: Scalar and vector functions of a single variable, magnitude of a vector function, limit and continuity of vector functions and their properties. Differentiation of a vector function. Geometrical interpretation and properties of the derivatives.

UNIT-II **11 hours**

Scalar field: Directional derivative and gradient, vector field; curl and divergence, del operator and their elementary properties.

UNIT-III **11 hours**

Curvilinear coordinates and curves in E 3 , tangent , principal normal, bi normal, curvature, torsion, Serret – Frenet formulae . Fundamental planes .

UNIT-IV **12 hours**

Connected and simply connected regions. Riemann integral ,line integral, multiple integral, Line integrals as integrals of vectors. Circulation ,irrotational vector. Work done, conservative force, potential . Orientation. Statements of Stokes, Green's and Divergence theorems and simple problems related to these theorems.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings:-

- *M.C. Chaki.(1999).Vector Analysis.*
- *B. Spain .(2001).Vector Analysis.*
- *C.E. Weatherburn.(2001).Advance Vector Analysis.*
- *H. Lass.(2000).Vector and Tensor Analysis.*
- *I.S. Sokolnikoff.(2004)Vector Analysis, Theory and Applications.*

Course Title: Algebra II

Course Code: BMH206

L	T	P	Cr
3	0	0	3

Total Hours: 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Compute with the characteristic polynomial, eigen values, eigenvectors, and eigen spaces, as well as the geometric and the algebraic multiplicities of an eigen value and apply the basic diagonalization result.
2. Build the concrete structure of modern algebra with the basic concepts of Group, abelian group, subgroup etc. and with their properties.
3. Explore the concepts for understanding and analyzing more advanced topics like Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups etc. for strong grip on modern algebra.
4. Create an understanding of rings, various types of rings, characteristic of a ring, field, skew field etc. on the previous concepts of groups.

Course Content

UNIT-I **11 hours**

Eigen values and Eigen vectors: Eigen vectors and Eigen values of a matrix, product of characteristic roots of a matrix and basic results on characteristic roots, nature of the characteristic roots of Hermitian, skew-Hermitian, unitary and orthogonal matrices, characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.

UNIT-II **11 hours**

Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups. Order of an element of a group, Group homomorphism, Isomorphism on groups, theorems on subgroups, Coset decomposition, Cayley's theorem, Cyclic group, generating system of group.

UNIT-III **11 hours**

Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.

UNIT-IV **12 hours**

Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings. Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring. Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorization Domain, Euclidean rings.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz.

Suggested Readings:-

- *Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). Linear Algebra (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.*
- *Hadley, G, (2002), Linear Algebra, Narosa Publishing House, New Delhi.*
- *H. Helson, (1994),Linear Algebra, Hindustan Book Agency, New Delhi.*
- *Dutta, K. B. (2004), Matrix and Linear Algebra, Prentice Hall of India.*
- *S. Lang, (1987), Linear Algebra, Springer.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*
- *J. B. Fraleigh, (2003), A first course in Abstract Algebra, Addison-Wiley.*
- *I. N. Herstein, (2006), Topics in Algebra, John Wiley & Sons.*
- *Thomas W Hungerford, (1990), Abstract Algebra–An Introduction, Sauders College Publishing.*
- *Joseph A Gallian, (2016), Contemporary Abstract Algebra, Brooks/ Cole Cengage Learning.*
- *V. K. Khanna and S. K. Bhambri, (2014), A course in Abstract Algebra, Vikas Publishing House Pvt (Ltd).*
- *P.R. Vittal, (2013), Analytical Geometry, 2d & 3D, Pearson.*
- *S.L. Loney, (2018), The Elements of Coordinate Geometry, McMillan and Company, London.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Financial Mathematics

Course Code: BMH207

L	T	P	Cr
3	0	0	3

Total Hours: 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Study basic Mathematical introduction, Growth and decay curves Simple interest, bank discount Compound interest.
2. Illustrate model problems in economic equivalence.
3. Express an Depreciation and depletion Breakeven analysis.
4. Study Risk premium, Portfolio diversification Life Insurance, Endowment, and annuities, Insurance policies.

Course Content

UNIT-I **11 hours**

Mathematical introduction, Growth and decay curves Simple interest, bank discount Compound interest, discrete compounding

UNIT-II **11 hours**

Compounding frequency of interest, Economic equivalence Method of comparison of alternatives, Project balance Credit and loan, Cost of credit and amortization

UNIT-III **11 hours**

Depreciation and depletion Breakeven analysis, Leverage Stocks and bonds, Valuation of stocks and bonds

UNIT-IV **12 hours**

Mutual funds, Options, Cost of capital and ratio analysis, Decision under risk &uncertainty, Risk premium, Portfolio diversification Life Insurance, Endowment, and annuities, Insurance policies.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz.

Suggested Readings:-

- *Marek Capinski and Tomasz Zastawniak, "Mathematics for Finance", Springer.*
- *Ambad Nazri Wahidudin, "Financial Mathematics and its Applications", Ventus Publishing ApS.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Discrete Mathematics

Course Code: BMH208

L	T	P	Cr
3	0	0	3

Total Hours: 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Acquire the basic principles of sets and operations in sets Apply counting principles to determine probabilities Demonstrate different traversal methods for trees and graphs
2. Illustrate model problems in computer science using trees and graphs determine when a function is one- one and onto.
3. Express an argument using logical notation and determine if the argument is or is not valid
4. Prove basic set equalities Demonstrate the ability to write and evaluate a proof.

Course Content

UNIT-I **12 hours**

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

UNIT-II **11 hours**

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

UNIT-III **11 hours**

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix.

UNIT-IV **11 hours**

weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd Warshall algorithm.

Suggested Readings:-

- *B A. Davey and H. A. Priestley .(1990).Introduction to Lattices and Order. Cambridge University Press, Cambridge.*
- *Edgar G. Goodaire and Michael M. Parmenter .(2003). Discrete Mathematics with Graph.*
- *Theory. (2nd Edition), Pearson Education (Singapore) Pte. Ltd., Indian Reprint .*
- *Rudolf Lidland Günter Pilz. (2004). Applied Abstract Algebra(2nd Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.*
- *R.P. Grimaldi. (1998). Discrete Mathematics and Combinatorial Mathematics, Pearson Education.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Vedic Mathematics

L	T	P	Cr
2	0	0	2

Course Code: BMH209

Total Hours 30

Course Learning Outcomes: At the end of the course, the students are able to:

1. Students should be able to speed up calculations which are stumbling blocks in mathematics.
2. Students should be able to understand the concept of addition and subtraction using completing the whole and from left to right.
3. Students should be able to manage to solve the multiplication by using Vedic sutras of multiplication.
4. Students should be able to distinguish between squaring numbers ending in % and squaring numbers near number 50 and manage to simplify algebraic squaring.

Course Content

UNIT-I **8 hours**

History of Vedic mathematics, Advantages to Vedic mathematics, salient features of Vedic mathematics, Vedic mathematics formulas: 16 sutras, 13 sub sutras, Digital root of the number, Vinculum numbers, conversion of normal numbers to Vinculum number and vice-versa. Content Summary: Place-wise Addition method, Addition by Shuddha Method, Subtraction by Shuddha Method, Vinculum Subtraction, Simultaneous Addition and Subtraction, Divisibility tests, Divisibility of Sums and products.

UNIT-II **8 hours**

Multiplication of complementary numbers like 23 X 27, Multiplication by numbers consisting of all 9s, Multiplication by numbers above the base, Multiplication by numbers below the base, Multiplication by 11, 101, 1001, Multiplication by 12, Multiplication of any number by 9, 99, 999, Multiplication by two-digit numbers, Multiplication by three and four-digit numbers, Decimal number Multiplications, Sum of products & product of sums, Division with single digit number, Division with double digit Divisor, Division with three digit Divisor, Division with four digit Divisor, Division of sums, Division of Product, Division of Sums of Products, Division of Product of sums, Division of Squares andCubes.

UNIT-III **7 hours**

Anur upyena method, Duplex Method, Square of two-digit, three-digit, four-digit number, Square of the number by Nikhilam method, Square of Number ending with 5, Squares of numbers near 50, 500 or 5000, Duplex method for sum and difference of Squares, Nikhilam method for Sum and differences of squares, Multiplication with squares of a number, Anur upyena method for cube of number, Sum or difference of cubes, Nikhilam method for cube of number, Product with cubes of two digit numbers.

UNIT-IV **7 hours**

Content Summary: Square roots by Vilokanam, Square roots by Dwandvayoga Method, Square roots of sum or product of numbers, Square roots of sums of squares, Cube Roots by Vilokanam, Cube Roots by Division Method, Pythagoras' Theorem.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:

- *Vedic Mathematics by Swami Bharati Krishna Tirtha.*
- *Enjoy Vedic Mathematics by Shriram M. Chauthaiwale, Dr. R. Kolluru.*
- *Speed Math by Gaurav Tekriwal.*
- *The power of Vedic Maths by Atul Gupta.*
- *Advanced Vedic Mathematics by Rajesh Kumar Thakur.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Basic Mathematics

Course Code: BMH210

L	T	P	Cr
2	0	0	2

Total Hours 30

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Define sets and functions with related concepts.
2. Define the concept of functions and relations.
3. Express an argument using logical notation and determine if the argument is or is not valid.
4. Prove basic set equalities Demonstrate the ability to write and evaluate a proof.

Course Content

UNIT-I **8 hours**

Sets: Basic Definitions, subsets, power set, set operations. Ordered pairs, Cartesian product of sets. Functions and Relations: Definition of relation, domain, co-domain and range of a relation. Binary relations, equivalence relations, partition. Function as a special kind of relation from one set to another. Domain, co-domain and range of a function. Composition, inverse. Real valued function of the real variable, constant, identity, Polynomial, rational, Functions. Activity: Students will try to find the applications of functions and relations.

UNIT-II **8 hours**

Sequence and series, Arithmetic Progression (A.P), Arithmetic Mean (A.M), Geometric Progression (G.P), general term of a G.P, sum of n terms of a G.P. Arithmetic and Geometric series, infinite G.P. and its sum. Geometric mean (G .M), relation between A.M and G.M. Activity: Students will solve some problems related to these sequences and series.

UNIT-III **7 hours**

Need for complex numbers, especially $\sqrt{-1}$, to be motivated by inability to solve every Quadratic equation. Brief description of algebraic properties of complex

numbers. Argand plane and polar representation of complex numbers, Statement of Fundamental Theorem of Algebra, nth roots of Unity. Activity: Students will solve some problems related to the complex number.

UNIT-IV 7 hours Matrices and types of matrices, Operations on Matrices, Determinants of Matrix and Properties of Determinants, Minors and Cofactor and Adjoint of a square matrix, Singular and non-singular Matrices, Inverse of a Matrix, Eigenvalues and Eigenvectors, Cayley Hamilton theorem.

Transaction Mode: Lecture/Demonstration/Project Method/ Co Operative learning/ Seminar/Group discussion/Team teaching /Tutorial/Problem solving/E-team teaching/Self-learning.

Suggested Readings:-

- *E. Kreyszig. (1990).Advanced Engineering Mathematics.9th edition, John Wiley & Sons.*
- *E.Kreyszig. (2002).Advanced Engineering Mathematics. 9th edition, John Wiley & Sons.*
- *G. B. Thomas and R. L. Finney. (2015). Calculus and Analytic Geometry. 11th edition, Pearson India.*
- *R. K. Jainand S.R.K. Iyengar. (2002).Advanced Engineering Mathematics.8th Edition, Narosa Publications.*

Semester-III

Course Title: Complex Analysis

Course Code: BMH301

L	T	P	Cr
4	0	0	4

Total Hours 60

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Acquire the basic ideas of analysis for complex functions in complex variables with visualization through relevant practical situations.
2. Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
3. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
4. Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

Course Content

UNIT-I **15 hours**

Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.

UNIT-II **15 hours**

Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals,

UNIT-III **15 hours**

Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.

UNIT-IV **15 hours**

Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz, Case analysis.

Suggested Readings:-

- *Brown, James Ward, & Churchill, Ruel V. (2014). Complex Variables and Applications (9th ed.). McGraw-Hill Education. New York.*
- *Bak, Joseph & Newman, Donald J. (2010). Complex analysis (3rd ed.). Undergraduate Texts in Mathematics, Springer. New York.*
- *Zills, Dennis G., & Shanahan, Patrick D. (2003). A First Course in Complex Analysis with Applications. Jones & Bartlett Publishers, Inc.*
- *Mathews, John H., & Howell, Rusell W. (2012). Complex Analysis for Mathematics and Engineering (6th ed.). Jones & Bartlett Learning. Narosa, Delhi. Indian Edition.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Advanced Calculus

Course Code: BMH302

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Discuss the basic concepts and apply the basic techniques of differential and integral calculus of functions of several variables.
2. Compute derivatives using the chain rule or total differentials, set up and solve optimization problems involving several variables, with or without constraints.
3. Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids.
4. Illustrate problems involving maxima and minima, line integral and surface integral, and vector calculus, develop mathematical maturity to undertake higher level studies in mathematics and related fields.

Course Content

UNIT-I **15hours**

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 gradient, tangent planes.

UNIT-II

15hours Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Change of variables in double integrals and triple integrals.

UNIT-III

15hours 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.

UNIT-IV **15hours**

Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Transaction Mode- Video Based Teaching, Collaborative teaching, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching,

Quiz, Open talk, Case analysis.

Suggested Readings:-

- *G.B. Thomas and R.L. Finney .(2005).Calculus. 9th Ed. Pearson Education, Delhi.*
- *M.J. Strauss, G.L. Bradley and K. J. Smith .(2007). Calculus.3rd Ed., (Pearson Education), Delhi.*
- *H. Anton, I. Bivens and S. Davis. (2002). Calculus. 7th Ed.,JohnWileyandSons(Asia)P.Ltd., Singapore.*
- *R. Courant and F. John (1989) Introduction to Calculus and Analysis (Volumes I&II),springer- Verlag, New York, Inc.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Mechanics

Course Code: BMH303

L	T	P	Cr
4	0	0	4

Total Hours 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. To understand the concept of Moment and couple moment of a force about a point and an axis.
2. To learn Laws of Coulomb friction, its applications
3. To understand the general relationship between time derivatives of a vector for different references
4. Understand the concept of Conservative force field and translation and rotation of rigid bodies.

UNIT-I **15hours**

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, Newton's Laws of forces.

UNIT-II **15hours**

Newton's Laws of Motion, general equations of equilibrium, Lami's theorem .

UNIT-III

15hours Conservativeforce field, Wok, power and Energy.

UNIT-IV **15hours**

Projectile, Motion in a circle, motion under constraints. Simple harmonic function.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz, Case analysis.

Suggested Readings:-

- *I.H. Shames and G. Krishna Mohan Rao.(2009). Engineering Mechanics: Statics and Dynamics. (4th Ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.*
- *R.C. Hibbeler and Ashok Gupta (2007). Engineering Mechanics: Statics and Dynamics.11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: MATLAB Programming-II

Course Code: BMH304

L	T	P	Cr
4	0	0	4

Total Hours 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. To learn features of MATLAB as a programming tool.
2. To promote new teaching model that will help to develop programming skills and technique to solve mathematical problems.
3. To understand MATLAB graphic feature and its applications.
4. To use MATLAB as a simulation tool.

UNIT-I. Introduction to MATLAB **15hours**

- The MATLAB Environment
- MATLAB Basics – Variables, Numbers, Operators, Expressions, Input and output.
- Vectors, Arrays – Matrices

UNIT-II. MATLAB Functions **15hours**

- Built-in Functions
- User defined Functions
- Files and File Management – Import/Export
- Basic 2D, 3D plots

UNIT-III. Graphics with MATLAB **15hours**

- Graphic handling
- Conditional Statements, Loops
- MATLAB Programs – Programming and Debugging.
- Applications of MATLAB Programming.

UNIT-IV. Mathematical Programming with MATLAB 15hours•
Algebraic equations

- Basic Symbolic Calculus and Differential equations
- Numerical Techniques and Transforms

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz, Case analysis.

Suggested Readings:

- *"A Guide to MATLAB - for Beginners and Experienced Users", 2nd ed., Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Cambridge University Press, (2006).*
- *"Essentials of MATLAB Programming", 2nd ed., Stephen J. Chapman, Cengage Learning, (2009).*
- *"MATLAB Demystified", David McMahon, The McGraw-Hill Companies, (2007).*
- *"MATLAB® for Engineers", 3rd ed., Holly Moore, Pearson Education, Inc., (2012).*
- *"Engineering computation with MATLAB", 2nd ed., David M. Smith, Pearson Education, Inc., (2010).*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Software Lab-III (Numerical computations using MATLAB)

Course Code: BMH305

L	T	P	Cr
0	0	4	2

Total Hours 30

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Characterize the basic concepts of operators like Solution of algebraic and transcendental equations.
2. To study of the practically Solution of Bisection method.
3. The basic concepts of operators like Solution of False position method,
4. To use software lab of Fixed-point iteration method.

Numerical methods lab
List of experiments

1. To find the roots of non-linear equation using bisection method.
2. To find the roots of non-linear equation using newton's method.
3. Curve fitting by least – square approximations.
4. To solve the system of linear equations using gauss - elimination method.
5. To solve the system of linear equations using gauss - seidal iteration method.
6. To solve the system of linear equations using gauss - jorden method.
7. To integrate numerically using trapezoidal rule.
8. To integrate numerically using simpson's rules.
9. To find the largest eigen value of a matrix by power - method.
10. To find numerical solution of ordinary differential equations by euler's method.
11. To find numerical solution of ordinary differential equations by runge-kutta method.
12. To find numerical solution of ordinary differential equations by milne's method.
13. To find the numerical solution of laplace equation.
14. To find the numerical solution of wave equation.
15. To find the numerical solution of heat equation.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz, Case analysis.

Suggested readings:

- *Numerical methods by B.S.Grewal*
- *Numerical method :E. Balagurusamy T.M.H*

Course Title: Mathematical Modeling

Course Code: BMH306

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. To understand the concept of Modeling
2. To learn Various Laws of Mathematical modeling, its applications
3. To understand the general relationship between variable and parameters
4. Understand the concept of real world problems

UNIT-I **12hours**

Simple situations requiring mathematical modelling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models, Some simple illustrations. Mathematical modelling in population dynamics, Mathematical modelling of epidemics through systems of ordinary differential equations of first order Mathematical Models in Medicine, Arms Race, Battles and international Trade in terms of Systems of ordinary differential equations.

UNIT-II **11hours**

The need for Mathematical modelling through difference equations, linear growth and decay models, Non-linear growth and decay models, Basic theory of linear difference equations with constant coefficients, Mathematical modelling through difference equations in economics and finance. Mathematical modelling through difference equations in population dynamics and genetics.

UNIT-III **11hours**

Mathematical Modelling through difference equations in probability theory. Miscellaneous examples of Mathematical modelling through difference equations. Situations that can be modelled through graphs, Mathematical models in terms of directed graphs Mathematical models in terms of signed graphs, Mathematical models in terms of weighted graphs.

UNIT-II **11hours**

Graph Theory - Definition of Graphs, Paths, Circuits, Cycles and Subgraphs, Induced Subgraphs, Degree of a vertex, Connectivity, Planar Graphs and their properties, Trees, Euler's Formula for Connected Planar Graph, Complete and Complete Bipartite Graphs.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz, Case analysis.

Suggested Readings:

- *D. J. G. James and J. J. Macdonald, Case studies in Mathematical Modelling, Stanly Thames, Cheltonham.*
- *J.N. Kapur, Mathematical entropy Models.*
- *M. Crossand A. O. Moscrcadini, The art of Mathematical Modelling, Ellis Harwood and John Wiley.*
- *C. Dyson, Elvery, Principles of Mathematical Modelling, Academic Press, New York.*
- *D. N. Burghes, Modelling with Difference Equations, Ellis Harwood and John Wiley*
- *C.L. Liu, Elements Of Discrete Mathematics, Mcgraw-Hili Book Co.*
- *N. Deo, Graph Theory With Applications To Engineering And Computer Sciences, Prentice Hall Of India.*

Course Title: Combinatorial Mathematics

Course Code: BMH307

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Apply diverse counting strategies to solve varied problems involving strings, combinations, distributions, and partitions,
2. Evaluate and analyses combinatorial, algebraic, inductive, and formal proofs of combinatorics identities.
3. Illustrate permutations and combinations to solve counting problems with sets and multi sets Compute a generating function and apply them to combinatorial problems
4. Examine and apply the basic concepts of graph theory, including Eulerian trails, Hamiltonian cycles, bipartite graphs, planar graphs, and Euler characteristics.

Course Content

UNIT-I **11hours**

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, counting subsets, Set-partitions, Sterling numbers. Principle of Inclusion and Exclusion, Derangements, Inversion formulae.

UNIT-II **11hours**

Generating functions: Algebra of formal power series, generating function models, Calculating generating functions, Exponential generating functions.

UNIT-III **11hours**

Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.

UNIT-IV **11hours**

Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project

based learning, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *J.H. van Lint and R.M. Wilson. (2001). A Course in Combinatorics. 2nd Ed., Cambridge University Press.*
- *V. Krishnamurthy.(1985).Combinatorics, Theory and Application. Affiliated East-West Press .*
- *P.J. Cameron.(1995).Combinatorics, Topics, Techniques, Algorithms. Cambridge University Press.*
- *M. Jr. Hall.(1986).Combinatorial Theory.2nd Ed., John Wiley & Sons.*
- *S.S. Sane. (2013).Combinatorial Techniques. Hindustan Book Agency.*
- *R.A. Brualdi. (2009). Introductory Combinatorics. 5th Ed., Pearson Education Inc.*

Course Title: Numerical Analysis

Course Code: BMH308

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Apply numerical methods to find our solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations.
2. Work out numerical differentiation and integration whenever and wherever routine methods are not applicable.
3. Illustrate numerically on the ordinary differential equations using different methods through the theory of finite differences.
4. Evaluate various interpolation methods and finite difference concepts partial differential equations using different methods through the theory of finite differences.

Course Content

UNIT-I **11hours**

Algorithms, Convergence, Errors: Relative, Absolute. Round off, Truncation.Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method, Regulafalsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

UNIT-II **11hours**

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis, LU Decomposition

UNIT-III **11hours**

Interpolation: Lagrange and Newton's methods, Error bounds, Finite difference operators. Gregory forward and backward difference interpolations. Numerical differentiation: Methods based on interpolations; methods based on finite differences.

UNIT-IV **12hours**

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons $3/8^{th}$ 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.
Ordinary Differential Equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *Brian Bradie. (2007). A Friendly Introduction to Numerical Analysis. Pearson Education, India.*
- *M.K.Jain, S.R.K. Iyengar and R.K. Jain .(2007). Numerical Methods for Scientific and Engineering Computation. 6th Ed., New age International Publisher, India.*
- *C.F. Gerald and P.O. Wheatley. (2008). Applied Numerical Analysis. Pearson Education, India.*
- *Uri M. Ascher and Chen Greif. (2013). A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited.*
- *John H. Mathews and Kurtis D. (2012). Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited.*

Course Title: Mathematical Methods

Course Code: BMH309

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Students will be able to Integral Transforms.
2. Understand the basic concepts of wavelet transforms.
3. Discuss the Differential forms on R_n.
4. Understand the method of reduction of IVPs BVPs and Eigen value problems. Apply regular and singular perturbation methods.

Course Content

UNIT-I **11hours**

Integral Transforms: General definition of Integral transforms, Kernels, etc. Development of Fourier integral, Fourier transforms – inversion, Illustration on the use of integral transforms, Laplace, Fourier, Hankel and Mellin transforms to solve ODEs and PDEs - typical examples.

UNIT-II **12hours**

Discrete orthogonality and Discrete Fourier transform. Wavelets with examples, wavelet transforms. Integral Equations: Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series resolvent kernel and transform methods, Convergence for Fredholm and Volterra types.

UNIT-III **10hours**

Reduction of IVPs BVPs and eigenvalue problems to integral equations. Hilbert Schmidt theorem, Raleigh Ritz and Galerkin methods.

UNIT-IV **12hours**

Regular and singular perturbation methods: Parameter and co-ordinate perturbations. Regular perturbation solution of first and second order differential equations involving constant and variable coefficients.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:

- *I.N. Sneddon (1974) – The use of Integral Transforms, Tata Mc Graw Hill, Publishing Company Ltd, New Delhi.*
- *R.P. Kanwal(1971): Linear integral equations theory and techniques, Academic Press, New York.*
- *C.M. Bender and S.A. Orszag (1978) – Advanced mathematical methods for scientists and engineers, McGraw Hill, New York.*

Course Title: Quantitative Aptitude

Course Code: BMH310

L	T	P	Cr
1	0	0	1

Total Hours 15

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Students will be able to qualify any competitive examination.
2. Understand the basic concepts of mathematics.
3. Discuss the various numerical problems.
4. Understand various shortcut techniques.

Course Content

UNIT-I **4hours**

Arithmetic is a branch of mathematics which deals with problems relating to Number system, Decimals

UNIT-II **5hours**

Fractions, Simplification, HCF and LCM, Ratio and Proportion, Percentage, Partnership

UNIT-III **4hours**

Average, Profit and Losses, Simple Interest and Compound Interest, Mensuration,

UNIT-III **4hours**

Time and Work, Time and Distance, Data Interpretation, Trigonometry, etc.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:

Competitive Examination: B S Grewal

Semester-IV

Course Title: Metric Space

Course Code: BMH401

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Provide the basic knowledge pertaining to metric spaces such as open and closed balls, neighborhood, interior, closure, subspace, continuity, compactness, connectedness etc.
2. Understand the topology of metric space and its necessity.
3. Correlate these concepts to their counter parts in real analysis.
4. Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.

Course Content

UNIT-I **15hours**

Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.

UNIT-II **15hours**

Topology of Metric Spaces: Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.

UNIT-III **15hours**

Continuity & Uniform Continuity in Metric Spaces: Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.

UNIT-IV **15hours**

Connectedness, Connected subset, Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group

Discussion, ted talks, E team Teaching, Quiz.

Suggested Readings:-

- *Dhananjay Gopal, (2020.), An Introduction to Metric Spaces, Chapman and Hall/CRC; 1st edition*
- *Kumaresan, S., (2014), Topology of Metric Spaces Narosa Publishing House, 2014*
- *Simmons, G. F. (2004). Introduction to Topology and Modern Analysis, Tata McGraw Hill. New Delhi.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Algebra III

Course Code: BMH402

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the fundamental concepts of advanced algebra such as groups and rings and their role in modern mathematics and applied contexts,
2. Write precise and accurate mathematical objects in ring theory for checking the irreducibility of higher degree polynomials over rings, understand the concepts like ideals and quotient rings, ring homomorphism etc and their applications.
3. Express the basic ideas of vector algebra, linear dependence and independence and spanning.
4. Discuss how to find the row space, column space and null space of a matrix, and be familiar with the concepts of dimension of a subspace and the rank and nullity of a matrix, and to understand the relationship of these concepts to associated systems of linear equations.

Course Content

UNIT-I **15hours**

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.

UNIT-II **15hours**

Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients.

UNIT-III **15hours**

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT-IV **15hours**

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. Isomorphism's. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Transaction Mode- Video Based Teaching, Collaborative teaching, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *John B. Fraleigh.(2002).A First Course in Abstract Algebra.7th Ed., Pearson.*
- *M. Artin.(2011). Abstract Algebra. 2nd Ed., Pearson.*
- *Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence (2004). Linear Algebra. 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi.*
- *Joseph A. Gallian. (1999).Contemporary Abstract Algebra. 4th Ed., Narosa Publishing House, New Delhi.*
- *S. Lang. (2005). Introduction to Linear Algebra, 2nd Ed., Springer.*

Course Title: Measure Theory

Course Code: BMH403

L	T	P	Cr
4	0	0	4

Total Hours 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the fundamental concepts of measure theory
2. Understand the concepts, definitions and their applications.
3. Express the basic ideas of distances
4. Discuss various proofs of theorems

Course Content

UNIT-I **15hours**

Lebesgue outer measure, Lebesgue measurable sets and measurable functions.

UNIT-II **15hours**

Algebra of measurable functions . Egoroff's theorem. Lebesgue integral of bounded function over a set of finite measure.

UNIT-III **15hours**

Bounded convergence theorem. Fatou's lemma. General Lebesgue integral. Lebesgue's monotone convergence theorem.

UNIT-IV **15hours**

Lebesgue General (Dominated) convergence theorem. Differential of an integral Lp space. Completeness of Lp-space. Unit 5: Product Measure, Fubini theorems, Radon-Nikodym theorem.

Transaction Mode- Video Based Teaching, Collaborative teaching, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:

- *H.L.Royden: Real Analysis (Chapter 1,3,4,5 and 6).3rd Edition,MacMillan,NewYork(1963)*
- *Inder Kumar Rana, Measure Theory and Integration, Narosa.*
- *C.Goffman : Real Functions,Holt,Rinehart and Winston Inc.New York (1953) 4. P.K.Jain and V.P.Gupta : Lebesgue Measure and Integration, Wiley Eastern Ltd.(1986).*
- *P.Halmos, Measure Theory, Narosa Publishers.*

Course Title: Software Lab-IV (Numerical Analysis using MATLAB/C++)

Course Code: BMH404

L	T	P	Cr
0	0	4	2

Total Hours 30

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

- Characterize the basic concepts of operators like Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method.

Numerical methods lab
List of experiments

1. To find the roots of non-linear equation using bisection method.
2. To find the roots of non-linear equation using newton's method.
3. Curve fitting by least – square approximations.
4. To solve the system of linear equations using gauss - elimination method.
5. To solve the system of linear equations using gauss - seidal iteration method.
6. To solve the system of linear equations using gauss - jorden method.
7. To integrate numerically using trapezoidal rule.
8. To integrate numerically using simpson's rules.
9. To find the largest eigen value of a matrix by power - method.
10. To find numerical solution of ordinary differential equations by euler's method.
11. To find numerical solution of ordinary differential equations by runge-kutta method.
12. To find numerical solution of ordinary differential equations by milne's method.
13. To find the numerical solution of laplace equation.
14. To find the numerical solution of wave equation.
15. To find the numerical solution of heat equation.

REFRENCES:

- *Numerical methods by B.S.Grewal*
- *Numericalkmethod :E. Balagurusamy T.M.H.*

Course Title: Research Proposal

Course Code: BMH405

L	T	P	Cr
4	0	0	4

Total Hours 60

Course Outcomes: On completion of this course, the successful students will be able to:

1. Develop research questions and hypotheses.
2. Carry out a critical literature review, using well developed analytical and synthesis skills.
3. Understand research design, and be able to choose rigorous and practical research methods to address a problem focused research question(s).
4. Structure, present and write a research proposal, using high level written and verbal communication skills.

Course Content

The research proposal is a document of around 3000-4000 words outlining the research the students will undertake. Generally, a research proposal should contain all the key elements involved in the research process and include sufficient information for the readers to evaluate the proposed study. Regardless of the research area and the methodology students choose, all research proposals must address the following questions:

What students plan to accomplish, why they want to do it and how they are going to do it.

Introduction:

- Topic area
- Research question
- Significance to knowledge

Make sure the proposal starts on a general level with some type of introductory remarks before going into the details of the specific research question you are proposing. This can be accomplished by providing
a frame of reference, a definition, or a discussion of the significance of the topic in the field. Make sure the research question is fully stated in one place.

Literature Review:

- Previous research: others & yours
- Interlocking findings and unanswered questions

- Your preliminary work on the topic
- The remaining questions and inter-locking logic
- Reprise of your research question(s) in this context

The literature review demonstrates the applicant's knowledge of the main research achievements in the area of study. Pay attention to provide some of the key references in your area of research which requires doing extensive research on your part. Make sure whether you can easily determine how the proposal is building on earlier studies, as well as exploring a line of research that is new.

Methodology / Theoretical Framework:

- Approach
- Data needs
- Analytic techniques
- Plan for interpreting results
- Expected results

Provide a full description of your general research design, as well as the specific methods and procedures used in your research project. This section discusses what measures the researcher will take in order to
test the study's hypothesis.

i) Describe your theoretical approach or type of analysis, if applicable
ii) Explain the details of your methods

Objectives:

i) Give a concise and clear outline of what you intend to find out in your project and what objectives you want to achieve.
ii) Research questions may take the form of a hypothesis to be tested against a specific set of criteria or a more open-ended inquiry.
iii) Objectives should establish the relevance and value of the proposed research in the context of current academic thinking.
iv) Your proposal needs to show why the intended research is important and to justify the reason for doing the research.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-based Learning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

References:

Provide a list of all references that you have cited in the proposal.

Course Title: Mathematical Statistics

Course Code: BMH406

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Describe the Probability and its distributions such as binomial distributions, Poisson distribution and basic laws of total probability and compound probability in statistics.
2. Categorize appropriate sampling processes such as random sampling, large sample tests of means and proportion. T-student, (chi square) and F distributions (without derivation) and testing of hypothesis based on them. x2
3. Recall the methods of classifying and analyzing data relative to single variable and multiple variables.
4. Distinguish between the practical purposes of a large and a small sample and understand that correlation coefficient is independent of the change of origin and scale.

Course Content

UNIT-I **11hours**

Sample space and events, algebra of events, axiomatic approaches, conditional probability, basic laws of total probability and compound probability, Byes' theorem, Independence.

UNIT-II **11hours**

Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function, Binomial, Poisson, Normal and Rectangular distributions.

UNIT-III **11hours**

Two-dimensional random variables, joint distribution functions, marginal distributions, covariance, linear regression and correlation, rank correlation, least square method of fitting regression lines.

UNIT-IV **12hours**

Sampling, random sampling, large sample tests of means and proportion. t-student, (chi square)
and F distributions (without derivation) and testing of hypothesis based on them. 2x

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *Irwin Miller and MaryleesMiller,(1975).John E. Freund's Mathematical Statistics with Applications, Pearson Education.*
- *Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean,(2002). Introduction to Mathematical Statistics, Pearson Education*
- *Sheldon M. Ross, (2009). Introduction to probability and statistics for engineers and scientists, Elsevier Academic Press.*
- *Goon, A.M., Gupta and M.K., Das Gupta, (1991). Fundamental of Statistics. Vol 1. World , B. Press. Calcutta.*
- *Chung, K.L. (1974). A Course in Probability theory. Linear Statistical Inference and its applications, Wistern.*
- *Goon, A.M., Gupta, M.K. and Das Gupta, B. (1985). An Outline of Statistical Theory. Vol. I, , 3rd ed. World Press.*
- *Bhat, B. R., Srivenkatraman, T., and Rao Madhava, K. S. (1997). Statistics: A Beginner's Text, Vol. I. New Age International (P) Ltd.*
- *Croxton F.E., Cowden D. J., and Kelin, S (1982). Applied General Statistics, Prentice-Hall of India, 3rd Edition.*

Course Title: Tensor Analysis

Course Code: BMH407

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Learn about some of the classes and properties multiple dimensions
2. Know about stress and strain functions.
3. Learn about metric and Riemann properties.
4. Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum.

Course Content

UNIT-I **11hours**

Tensor analysis: Transformation of coordinates, The summation convention, Contravariant vectors, Invariants, Covariant vectors, Tensors, The Christofell 3-index symbols and their relations, Riemann symbols and the Riemann tensor, The Ricci tensor, Quadratic differential forms, The equivalence of symmetric quadratic differential forms, Covariant differentiation with respect to a tensor gij,

UNIT-II **11hours**

Introduction to a metric: Definition of a metric, N-tuply orthogonal systems of hypersurfaces in a Vn,Metric properties of a space Vn immersed in a Vm, Geodesics, Riemannian, Normal and geod esic coordinates, Geodesic form of the linear element, Finite equations of geodesics, Curvature of acurve, Parallel displacement and the Riemann tensor.

UNIT-III **11hours**

Fields of parallel vectors, Associate directions, Curvature of Vn at appoint, The Bianchi identity, The theorem of Schur, Isometric correspondence of spaces of constant curvature, Conformal spaces, Spaces conformal to flat space, Orthogonal ennuples: The Frenet formulas Principal directions determined by a symmetric covariant tensor ofthe second order,

UNIT-IV **12hours**

The Ricci principal tensors, Condition that a congruence of an orthogonal ennuplebe normal, N-tuply orthogonal systems of hypersurfaces, N-tuply orthogonal systems ofhypersurfaces in a space conformal to a flat space,

Congruence canonical with respect to a given congruence, Recent developments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *L.P. Lebedev, Tensor Analysis, World Scientific*
- *E. Nelson, Tensor Analysis, Princeton University Press*
- *Albert Joseph McConnell, Applications of Tensor Analysis, Dover Publications*
- *Mikhail Itskov, Tensor Algebra and Tensor Analysis for Engineers: With Applications to Continuum Mechanics, Springer*

Course Title: Riemann Integration and Series of Function

Course Code: BMH408

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
2. Know about improper integrals including, beta and gamma functions.
3. Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence.
4. Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum.
5. Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.

Course Content

UNIT-I **11 hours**

Riemann Integration Definition of Riemann integration, Inequalities for upper and lower Darboux sums, Necessary and sufficient conditions for the Riemann integrability, Definition of Riemann integration by Riemann sum and equivalence of the two definitions, Riemann integrability of monotone functions and continuous functions, Properties of Riemann integrable functions,

UNIT-II **11 hours**

Definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability, intermediate value theorem for integrals. Improper Integral Improper integrals of Type-I, Type-II and mixed type, Convergence of beta and gamma functions, and their properties.

UNIT-III **12 hours**

Sequence and Series of Functions Pointwise and uniform convergence of sequence of functions, Theorem on the continuity of the limit function of a sequence of functions, Theorems on the interchange of the limit and derivative, and the interchange of the limit and integrability of a sequence of functions. Pointwise and uniform convergence of series of functions, Theorems on the continuity, derivability and integrability of the sum function of a series of functions,

UNIT-IV **11hours**

Cauchy criterion and the Weierstrass M-test for uniform convergence. Power Series Definition of a power series, Radius of convergence, Absolute convergence (Cauchy−Hadamard theorem), Uniform convergence, Differentiation and integration of power series, Abel's theorem.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis (4th ed.). Wiley India Edition. Delhi.*
- *Denlinger, Charles G. (2011). Elements of Real Analysis. Jones & Bartlett (Student Edition). First Indian Edition. Reprinted 2015.*
- *Ghorpade, Sudhir R. & Limaye, B. V. (2006). A Course in Calculus and Real Analysis. Undergraduate Texts in Mathematics, Springer (SIE). First Indian reprint.*
- *Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer.*

Course Title: Linear Programming Problems

Course Code: BMH409

L	T	P	Cr
3	0	0	3

Total Hours 45

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Describe the LPP.
2. Categorize LPP for concave and convex set.
3. Classifying and analyzing data relative to Duality, Dual simplex Method.
4. Application related game theory.

UNIT-I **11 hours**

Operational Research and Linear programming Origin & Development of OR, Different Phases of Operation Research study, Methodology of OR, Scope and Limitations of OR, OR in decision making, Applications of Operation Research.

UNIT-II **11 hours**

Linear Programming: Linear combination of vectors, linearly independent/ dependent vectors, Basis of a vector space, convex set and its properties, Extreme points. General Linear programming problem (LPP), Standard and canonical form of LPP. Formulation of LPP, Graphical solution. Simplex method.

UNIT-III **11 hours**

Solving system of linear equations using Simplex method. Duality: Definition of the dual problem, Primal-dual relationships, Economic Interpretation of Duality, Dual simplex Method. Sensitivity analysis: Shadow Price, Graphical and simplex method-based approach for changes in cost and resource vector.

UNIT-IV **12 hours**

Theory of Games: Introduction to Game theory, Formulation of two-person zero-sum rectangular game; Solution of rectangular games with saddle points; dominance principle; rectangular games without saddle point – mixed strategy, Graphical, algebraic and linear programming solution of m x n games.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:

- *G. Hadley: Linear Programming. Narosa, 2002 (reprint).*
- *A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research-Principles and Practice, John Wiley & Sons, 2005.*
- *Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 9th Edition, 2010.*
- *F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill. 2010.*
- *P. R. Thie and G. E. Keough: An Introduction to Linear Programming and Game Theory, Wiley, NewJersey, 3rd edition, 2008.*
- *F.S. Hillier and G.J. Lieberman: Introduction to Operations Research-Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.*

Semester V

Course Title: Differential Geometry

Course Code: BMH501

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Outcomes: On completion of this course, the successful students will be able to:

1. Understand combinatorial surfaces and their curvatures.
2. Understand the exterior product and Differential forms.
3. Know about the curvature of Discrete surfaces and curvature flow.
4. Explain different designs and decompositions of surfaces.

Course Content

UNIT-I **15 hours**

Combinatorial Surfaces: Abstract Simplicial Complex, Anatomy of a Simplicial Complex, Star, Closure, and Link, Simplicial Surfaces, Adjacency Matrices, Halfedge Mesh. The Geometry of Surfaces, Derivatives and Tangent Vectors, The Geometry of Curves, Curvature of Surfaces, Geometry in Coordinates.

UNIT-II **15 hours**

Exterior Algebra, Examples of Wedge and Star in Rn, Vectors and 1-Forms, Differential Forms and the Wedge Product, Hodge Duality, Differential Operators, Integration and Stokes' Theorem, Discrete Exterior Calculus.

UNIT-III **15 hours**

Curvature of Discrete Surfaces: Vector Area, Area Gradient, Volume Gradient, Other Definitions, Gauss-Bonnet, Numerical Tests and Convergence. The Laplacian: Basic Properties, Discretization via FEM, Discretization via DEC, Meshes and Matrices, The Poisson Equation, Implicit Mean Curvature Flow.

UNIT-IV **15 hours**

Surface Parameterization: Conformal Structure, The Cauchy-Riemann Equation, Differential Forms on a Riemann Surface, Conformal Parameterization, Eigenvectors, Eigenvalues, and Optimization.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:

- *Alexander I. Boenko and Yuri B. Suris (2009), Discrete Differential Geometry: Integrable Structure: 98 (Graduate Studies in Mathematics), American Mathematical Society; New ed. edition.*
- *Alexander I. Bobenko (2018), Advances in Discrete Differential Geometry Springer; Paperback.*
- *Jiri Matousek (2002), Lectures on Discrete Geometry: Springer- 212, GTM, 2nd edition.*
- *ChuanmingZong (1996), Strange Phenomena in Convex and Discrete Geometry, Springer (Universitext) Paperback 1st edition.*

Course Title: Fluid Mechanics

Course Code: BMH502

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Outcomes: On completion of this course, the successful students will be able to:

1. understanding basic laws, principles and phenomena in the area of fluid mechanics
2. To solve simplified examples of fluid mechanics.
3. Theoretical and practical preparation enabling students to apply the acquired knowledge and skills in professional and specialist courses.
4. Study of velocity profile of fluids fractional losses.

Course content

UNIT-I **15 hours**

Introduction: Basic concepts of fluid mechanics. Fundamental terms. Physical values. Fluids and their properties. Forces inside fluid. Fluid Statistics: Pascal's law. Euler's equation of fluid statics. Measurement of pressure. Relative statics of fluid – constant acceleration, rotation.

UNIT-II **15 hours**

Forces of hydrostatic pressure. Buoyancy. Flotation. Stability. Fluid Kinematics: Euler and Lagrangian specification of fluid flow. Streamlines. Pathlines. Stream surface. Stream tube. Mass/volume flow. Control volume.

UNIT-III **15 hours**

Fluid Dynamics: Continuity equation. Basic laws of fluid dynamics conservation of mass, conservation of linear momentum, conservation of energy. Ideal fluid flow. Application of Bernoulli's equation. Real fluid flow. Viscosity. Determination of losses. Reynolds experiment. Laminar and turbulent flow. Boundary layer.

UNIT-IV **15 hours**

Velocity profile. Losses in pipes. Frictional losses. Nikuradse experiments. Moody's diagram. Local losses. Coefficients of resistance. Hydraulic design of pipeline: Different approaches in designing the pipeline – pressure drop, mass/volume low, diameter of pipeline. Graphical view. Energy properties of pumps and hydraulic machines. Dimensional analysis. Theory of similarity. Flow of fluid in open channels. Non- stationary flow and hydraulic shock.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:

- *Streeter VL, Wylie EB, Bedford KW; Fluid Mechanics; Mc Graw Hills FOX , McDonald Pritchard ,*
- *Fluid Mechanics Wiley students edition 3.*
- *Fluid Mechanics ; Mc Graw Hills*
- *Cengal; Fluid Mechanics; Mc Graw Hills*
- *R Mohanty; Fluid Mechanics; PHI.*
- *K L Kumar Fluid Mechanics .*
- *Fluid Mechanics & hydraulic Machines , Modi & Seth.*
- *CS Jog , Fluid Mechanics Volume II CAMBRIDGE IISc Series , Third Edition*

Course Title: Partial Differential Equations

Course Code: BMH503

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Outcomes: On completion of this course, the successful students will be able to:

1. Understand combinatorial surfaces and their curvatures.
2. Understand the exterior product and Differential forms.
3. Know about the curvature of Discrete surfaces and curvature flow.
4. Explain different designs and decompositions of surfaces.

Course Content

UNIT-I **15 hours**

Partial differential equations. Formation of partial differential equations. Types of solutions. PDEs of the first order. Lagrange's solution. Some special types of equations which can be solved easily by methods other than the general methods. Charpit's and Jacobi's general method of solution.

UNIT-II **15 hours**

Partial differential equations of second and higher order. Classification of linear partial differential equations of second order. Homogeneous and non-homogeneous equations with constant coefficients. Partial differential equations reducible to equations with constant coefficients.

UNIT-III **15 hours**

Monge's methods. Calculus of variations. Variational problems with fixed boundaries - Euler's equation for functionals containing first-order derivative and one independent variable. Extremals. Functionals dependent on higher order derivatives. Functionals dependent on more than one independent variable.

UNIT-IV **15 hours**

Variational problems in parametric form. Invariance of Euler's equation under coordinate transformation. Variational problems with moving boundaries. Functionals dependent on one and two functions. One sided variation.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:

- *Simmons, Differential Equations.*
- *Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.*

Course Title: Descriptive Statistics (Theory)

Course Code: BMH504

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Define the sample space and concept of random variables (discrete and continuous).
2. Explore the concept of Moment generating function and characteristic functions with examples.
3. Illustrate various properties of Discrete and continuous Distributions.
4. Explain concepts of sampling distribution and its standard error, Chisquare, t and F distribution.

Course Content

UNIT-I **15 hours**

Elements of statistics: Random sample. Population and samples. Collection, tabulation and graphical representation. Frequency distribution. Sample characteristics- mean, variance, skewness, kurtosis, excess, mode, median, semi -interquartile range. Bivariate samples- correlation coefficient, regression lines, parabolic curve fitting,
goodness of fit.

UNIT-II **15 hours**

Sampling distributions: Sampling distribution of statistics. Sampling distribution of the sample mean and variance. Sampling distribution for the normal population.

UNIT-III **15 hours**

Theory of estimation: Estimation and estimate – consistent and biased. Maximum likelihood estimation. Applications to binomial, Poisson and normal populations. Confidence interval. Interval estimation for parameters of normal population. Confidence intervals for mean and standard deviation of a normal population. Approximate confidence limits for the parameter of a binomial population.

UNIT-IV **15 hours**

Statistical hypothesis: Simple and composite hypotheses. Best critical region of a test. Neyman – Pearson theorem (Statement only) and its application to normal population. Likelihood ratio testing and its application to normal population. Tests of hypothesis - Test on mean and standard deviation of

normal population. Comparison of means and standard deviations of two normal populations.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings:-

- *Medhi, J. (2000). Statistical Methods: An introductory Text, New Age International (P) Ltd.*
- *Gupta, S.C. and Kapoor, V. K.(2007). Fundamentals of Mathematical Statistics, S. Chand & Co.*
- *Cochran, W.G. (1977). Sampling Techniques, third edition,John Wiley & Sons.*
- *Feller, W.(2005). An Introduction to Probability Theory and Its Applications, Vol. I, Wiley.*
- *Uspensky, J.V.(2005). Introduction to Mathematical Probability,(McGraw Hill.*

Course Title: Descriptive Statistics (Practical)

Course Code: BMH505

L	T	P	Cr
0	0	2	1

Total Hours:30

Course Learning Outcomes: On completion of this course, the successful students will be able to The purpose of this lab is to show you how to compute basic descriptive statistics, including measures of central tendency (mean, mode, median) and variation (range, variance, standard deviation).

1. Compute measures of central tendency using software
2. Compute measures of variation using software
3. Ask some questions of a data set using descriptive statistics

Software: INTRODUCTION about R

1. Lab 1: Graphing Data
2. Lab 2: Descriptive Statistics
3. Lab 3: Correlation
4. Lab 4: Normal Distribution & Central Limit Theorem
5. Lab 5: Fundamentals of Hypothesis Testing
6. Lab 6: t-Test (one-sample, paired sample)
7. Lab 7: t-test (Independent Sample)
8. Lab 8 One-way ANOVA
9. Lab 9 Repeated Measures ANOVA
10. Lab 10: Factorial ANOVA
11. Lab 11: Mixed Factorial ANOVA

Course Title: Theory of Equations

Course Code: BMH506

L	T	P	Cr
3	0	0	3

Total Hours:45

Course Learning Outcomes: On successful completion of this course, the successful students will be able to :Tentative topics to be covered are listed below.

1. Number systems, such as rational field Q, real field R and complex field C.
2. Axiom of nonzero divisors — the fundamental principle for solving equations.
3. Division algorithm, unique factorization of polynomials over arbitrary fields and its applications (such as in partial fractions).
4. Factorizations over fields Q, R and C, the Fundamental Theorem of Algebra, and the applications in solving polynomial equations.

Course Contents

UNIT-I **11 hours**

Commutative ring and integral domain Concepts of commutative ring and integral domain, cancellation law and zero divisors, and some elementary properties of commutative rings. Fields Concepts of field and subfield. Verify that Q, R, and C are fields. n-th roots of complex numbers Introduce complex numbers, and their absolute value and argument from both algebraic point of view and geometric point of view. Discuss solutions to z n = c, and the n-th roots of unity.

UNIT-II **11 hours**

Polynomials and Polynomial Equations Polynomials in an element α over an integral domain D and their basic properties. Principle to solve equations cancellation law. Quadratic equations Solve quadratic equations, which are over a number field, in complex field C. Cubic equations Solve cubic equations, which are over a number field, in complex field C. Quartic equations Solve quartic equations, which are over a number field, in complex field C.

UNIT-III **11 hours**

Divisibility and factorization of integers divisibility, primes, Euclidean algorithm, GCD, fundamental theorem of arithmetic. Congruences, residue classes mod n and finite commutative rings (Z/nZ) , linear congruence equations, the Chinese Remainder Theorem, Fermat's little theorem, Euler's

theorem. Divisibility and factorization of polynomial functions, division algorithm, units and irreducible polynomials, unique factorization theorem, Gauss lemma, polynomial ring.

UNIT-IV **12 hours**

Polynomials over several fields, Eisenstein's criterion Eisenstein's criterion and irreducible polynomials over Q. Rational roots of polynomials over Q Introduce method of finding rational roots of a polynomial over, Fundamental theorem of algebra without proof. Its impact on prime factorization of polynomials over R and C. Partial fractions over R and C Consider decomposition of partial fractions as sum of simplified partial fractions over R and C. Polynomials over finite fields Investigate polynomials over finite rings and finite fields.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *G.F. Simmons, (2002), Differential Equations with Application and Historical Notes, Tata –McGraw Hill.*
- *B. Rai, D.P. Choudhary & H. J. Freedman, (2002), A Course of Ordinary Differential Equations, Narosa.*
- *Ian N. Snedden, (2013), Elements of Partial Differential Equations, Dover Publication.*
- *L.E. Elsgolts, (1970), Differential Equation and Calculus of variations, University Press of the Pacific.*
- *M. D. Raisinghania, (2018), Ordinary and Partial Differential Equations, S Chand.*

Course Title: Econometrics

Course Code: BMH507

L	T	P	Cr
3	0	0	3

Total Hours:45

Course Learning Outcomes: On successful completion of this course, the successful students will be able to: Tentative topics to be covered are listed below.

1. This course covers the statistical tools needed to understand empirical economic research
2. Plan and execute independent research projects
3. Discuss statistical inference
4. Evaluation of government policies and programs.

Unit - I

Review of probability and statistics

1. Probability and distribution

2. Expectation and moments

Review of statistical inference

3. Sampling distributions and inference

4. The Central Limit theorem (Asymptotic distribution of the sample mean)

5. Confidence intervals

Unit – II

Regression basics

6. Conditional expectation functions, bivariate regression

7. Sampling distribution of regression estimates; Gauss-Markov theorem

8. How classical assumptions are used; asymptotic distribution of the sample slope

9. Residuals, fitted values, and goodness of fit

Multivariate regression

10. Regression, causality, and control; anatomy of multivariate regression coefficients

11. Omitted variables formula, short vs. long regressions

12a. Dummy variables and interactions; testing linear restrictions using F-tests

12b. Regression analysis of natural experiments, differences-in-differences

Unit – III

Inference problems - heteroscedasticity and autocorrelation

13a. Heteroscedasticity, consequences of; weighted least squares; the linear probability model

13b. Serial correlation in time series, consequences of; quasi-differencing; common-factor restriction; Durbin-Watson test for serial correlation

Instrumental variables, simultaneous equations models, measurement error

14a. Using IV to solve omitted-variables problems

14b. Measurement error (Time-permitting)

14c. Regression-discontinuity designs (Time-permitting)

Unit – IV

Simultaneous equation models

Simultaneous equations models I

- a. The use of structural models
- b. Simultaneous equations bias
- c. The identification problem
- d. The structure and the reduced form
- e. Indirect least squares

Simultaneous equations models II

- a. IV for the SEM
- b. Two-stage least squares
- c. Sampling variance of 2SLS estimates

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *Wooldridge, Jeffrey M.* Introductory Econometrics: A Modern Approach. *3rd ed. Mason, OH: Thomson/South-Western, 2006. ISBN: 9780324289787.*
- *Goldberger, Arthur S.* A Course in Econometrics. *Cambridge, MA: Harvard University Press, 1991. ISBN: 9780674175440.*
- *DeGroot, Morris H., and Mark J. Schervish.* Probability and Statistics. *3rd ed. Boston, MA: Addison-Wesley, 2001. ISBN: 9780201524888.*

Semester VI

Course Title: Number Theory

Course Code: BMH601

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Define and interpret the concepts of divisibility, congruence, the greatest common divisor, prime, and prime-factorization.
2. Express the concepts and results of divisibility of integers effectively and solve challenging problems related to Chinese remainder theorem effectively.
3. Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.
4. Demonstrate the logics and methods behind the major proofs in Number Theory and Describe the properties of prime numbers.

Course Contents

UNIT-I **15 hours**

Introduction, Divisibility, The Division Algorithm, GCD and LCM, The Euclidean Algorithm, Primes and their properties, Infinitude of primes.

UNIT-II **15 hours**

The Fundamental Theorem of Arithmetic, The Prime Number Theorem (statement only). Congruence - Definition and properties of it, Solutions of Congruence, Euler's phi function.

UNIT-III **15 hours**

Fermat's Theorem, Euler's Theorem, Wilson's Theorem, The Chinese Remainder Theorem, Multiplicative property of Euler's phi function, Primitive Roots.

UNIT-IV **15 hours**

Quadratic Reciprocity,Quadratic Residues, The Legendre Symbol and its proper-ties, Lemma of Gauss, The Gaussian Reciprocity Law, The Jacobi symbol. Arithmetic functions $\mu(n)$, $d(n)$, $\Phi(n)$, $\sigma_\alpha(n)$, Mobious inversion formula.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group

Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Reference Books:-

- *G. H. Hardy and E. M. Wright, (2008). An Introduction to Theory of Numbers, Oxford University Press, 6th Ed ,*
- *I. Niven, H. S. Zuckerman and H. L. Montgomery, (2004). An Introduction to the Theory of Numbers, John Wiley and Sons, (Asia) 5th Ed., 107*
- *H. Davenport, (1999). The Higher Arithmetic, Camb. Univ. Press, 7th edition,*
- *David M. Burton, (2007). Elementary Number Theory, Tata McGraw Hill, 6th Edition,*
- *Hardy, G. H., and Wright, E. M., (1979). An Introduction to the Theory of Numbers, 5th Edition, Clarendon Press (Oxford).*

Course Title: Group Theory

Course Code: BMH602

L	T	P	Cr
4	0	0	4

Total Hours 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the basic theorems and their proofs, demonstrate when a binary algebraic structure forms a group, identify factor group etc.
2. Extend group structure to finite permutation groups By Cayley Hamilton Theorem and automorphism group.
3. Generate groups under given specific conditions, implement group axioms, apply a range of mathematical techniques to solve a variety of quantitative problems and analyse and solve problems individually.
4. Apply definitions and theorems to solve problems in Group Theory, and prove new theorems.

Course Content

UNIT-I **15 hours**

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

UNIT-II **15 hours**

Group automorphisms, inner automorphisms. Automorphism groups and their computations. Conjugacy relation. Normalizer. Counting principle and the class equation of a finite group. Center of a group. Free abelian groups. Structure theorem of finitely generated abelian groups. Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

UNIT-III **15 hours**

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.

UNIT-IV **15 hours**

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *John B. Fraleigh.(2002).A First Course in Abstract Algebra. 7th Ed., Pearson.*
- *M. Artin .(2001). Abstract Algebra 2nd Ed., Pearson.*
- *Joseph A. Gallian.(1999). Contemporary Abstract Algebra,4thEd.,NarosaPublishingHouse,New Delhi.*
- *Joseph J. Rotman.(1995). An Introduction to the Theory of Groups 4th Ed., Springer Verlag.*
- *I.N. Herstein (1975) Topics in AlgebraWiley Eastern Limited, India.*

Course Title: Functional Analysis

L	T	P	Cr

Course Code: BMH603

4	0	0	4

Total Hours: 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the basic theorems and their proofs Banach Space.
2. Study of Banach Steinhaus theorem Boundedness and continuity of linear transformation, Dual Spaces, embedding in second dual.
3. Generate Hilbirt space under given specific conditions, Hilbert space, orthonormal basis, Bessel's inequality, bounded Linear functional.
4. Apply definitions and theorems to solve problems in Projections, Riesz Representation theorem, and prove new theorems.

Course Content

UNIT-I **15 hours**

Banach Spaces with examples of LP([a,b]) and C ([a,b]), Hahn Banach theorem, open mapping theorem, closed graph theorem, Baire Category theorem.

UNIT-II **15 hours**

Banach Steinhaus theorem (uniform boundedness principle), Boundedness and continuity of linear transformation, Dual Spaces, embedding in second dual.

UNIT-III **15 hours**

Hilbert space, orthonormal basis, Bessel's inequality, Riesz Fischer theorem, Parseval's identity, bounded Linear functionals;

UNIT-IV **15 hours**

Projections, Riesz Representation theorem, adjoint operators, self-adjoint, normal, unitary and isometric operators.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *S.K. Berberian. (1999). Introduction to Hilbert Spaces. American Mathematical Society.*
- *F.K. Riesz and Bela Sz Nagy. (2003). Functional Analysis. Dover Publication Inc.*
- *A.H. Siddiqui . (1986). Functional Analysis. Tata-McGraw Hill 4. Walter Rudin. (1921). Real and Complex, Mc Graw hill Book Company.*
- *Walter, R. (1976). Principal of mathematical Analysis. McGraw-Hill. 3rd Edition.*
- *B.V. Limaye. (1985).Functional Analysis. Wiley Eastern Ltd.*

Course Title: Astronomy

Course Code: BMH604

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the basic theorems and their proofs of Astronomy.
2. Study of Stellar Processes (Nuclear) and spectral classification of Stars O, B, A, F, G, K, M.
3. Application on Magnetic field.
4. Apply definitions and theorems to solve problems in Asteroids, Meteors, Comets and Galaxies.

UNIT-I **15 hours**

History of Astronomy and Apparent Luminosity of Stars: Ptolemy's astronomical work, Copernican helio centrism and Tychonian system, Luminosity (Apparent and Absolute) of stars, Magnitude scale, Luminosity measurement: Visual Method, Photographic method and, Photoelectric method.

UNIT-II **15 hours**

Stellar Evolution (HR diagram): Life cycle; Stellar Processes (Nuclear) and spectral classification of Stars O, B, A, F, G, K, M.

UNIT-III **15 hours**

The Sun and Planets Origin of the solar system, Internal structure and surface features of sun, Sun spots and Magnetic field on the sun and Solar activity. Surface features of planets, Atmospheres and Magnetic fields of Planets and their moons. (8)

UNIT-IV **15 hours**

Asteroids, Meteors, Comets and Galaxies: Asteroids: Discovery and designation, Origin, Nature and Orbits of Asteroids. Meteors: Meteor showers and sporadic meteors. Comets: Periodic comets, Brightness variation in Comets. Gas production rates, dust and ion tails.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings:-

- *Astronomy structure of the Universe. A.E. Roy and D. Clarke, Adam Hilger Pub.*
- *Source Book of Space Sciences, Samuel Galsstone; D.VanNostrand Co. Inc.*
- *Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, NarosaPub.*
- *Structure of the Universe, J.V. Narlikar*
- *Introduction to Astrophysics - Baidyanath Basu.*
- *Astrophysics: Stars and Galaxies- K.D.Abhyankar: Tata McGraw Hill Publication(Chap.2)*
- *"Astrophysics: A modern Perspective" - K. S. Krishnaswami New Age International.*
- *K. S. Krishnaswami, "Understanding cosmic Panorama" New Age International.*
- *Frontiers in Astronomy by Jastrow*

Course Title: Logic and Sets

Course Code: BMH605

L	T	P	Cr
4	0	0	4

Total Hours: 60

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Introduce concepts of mathematical logic for analyzing propositions and proving theorems.
2. Develop logical thinking and its application to computer science (to emphasize the importance of proving statements correctly and de-emphasize the hand-waving approach towards correctness of an argument).
3. Analyses logical propositions via truth tables. Prove mathematical theorems using mathematical induction.
4. Determine properties of relations, identify equivalence and partial order relations, sketch relations, identify functions and determine their properties.

Course Content

UNIT-I **15 hours**

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

UNIT-II **15 hours**

Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

UNIT-III **15 hours**

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principles. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

UNIT-IV **15 hours**

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. Partial ordering relations, n- array relations.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings: -

- *R.P. Grimaldi. (1998). Discrete Mathematics and Combinatorial Mathematics. Pearson Education.*
- *P.R. Halmos. (1974). Naive Set Theory. Springer.*
- *E. Kamke. (1950). Theory of Sets. Dover Publishers.*

Course Title: Differentiable Manifolds

Course Code: BMH606

L	T	P	Cr
3	0	0	3

Total Hours: 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

1. Describe the various Concepts of Differentiable Manifolds
2. To Study Tensors and various forms.
3. Practice critical thinking to develop Riemannian connections.
4. Explain the Torsion tensor and curvature tensor.

UNIT-I **11 hours**

Differentiable Manifolds, examples of differentiable manifolds, Differentiable maps on manifolds, tangent vectors and tangent space, cotangent space, Vector Fields, Lie-bracket of vector fields. Jacobian of a map. Integral curves, Immersions and embeddings.

UNIT-II **11 hours**

Tensors and forms. Exterior product and Grassman algebra, Connections, Difference tensor, existence of parallelism and geodesics, covariant derivative, exterior derivative , Contraction, Lie-derivative.

UNIT-III **11 hours**

Torsion tensor and curvature tensor of a connection, properties of torsion and curvature tensor, Bianchi's identities, Structure equations of Cartan. Riemannian manifolds, Fundamental theorem of Riemannian geometry.

UNIT-IV **12 hours**

Riemannian connection. Riemannian curvature tensor and its properties. Bianchi's identities, Sectional curvature, Theorem of Schur. Sub-manifolds and hyper-surfaces, Normal, induced connection, Gauss and Weingartan formulae.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings:

1. Y. Matsushima.(1972). Differentiable Manifolds, Marcel Dekker, Inc. New York.
2. U.C. De .(2007). Differential Geometry of Manifolds, Alpha Science Int. Ltd., Oxford, U.K.
3. Hicks, N. J. (2012) Notes on Differential Geometry (Relevant Portion), Van Nostrand Reinhold Company, New York and Canada

Course Title: Fuzzy Mathematics

Course Code: BMH607

L	T	P	Cr
3	0	0	3

Total Hours: 45

Course Learning Outcomes: On completion of this course, the successful students will be able to:

5. Describe the various Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set
6. To Study Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number. Function with Fuzzy Constraint, Maximizing and Minimizing Set.
7. Practice critical thinking to develop innovative and well-founded perspectives related to the students' emphases.
8. Explain the Composition of Fuzzy Relation, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets. Graph and Fuzzy Graph.

UNIT-I **11 hours**

Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T- norms and T- conorms. Interval, Fuzzy Number, Operation of Interval, Operation of - cut Interval, Examples of Fuzzy Number Operation.

UNIT-II **11 hours**

Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers. Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number. Function with Fuzzy Constraint, Propagation of Fuzziness by Crisp Function, Fuzzifying Function of Crisp Variable, Maximizing and Minimizing Set, Maximum Value of Crisp Function.

UNIT-III **11 hours**

Integration and Differentiation of Fuzzy Function Product Set, Definition of Relation, Characteristics of Relation, Representation Methods of Relations, Operations on Relations, Path and Connectivity in Graph, Fundamental Properties, Equivalence Relation, Compatibility Relation, Pre-order Relation, Order Relation, Definition and Examples of Fuzzy Relation, Fuzzy Matrix, Operations on Fuzzy Relation.

UNIT-IV **12 hours**

Composition of Fuzzy Relation, - cut of Fuzzy Relation, Projection and

Cylindrical Extension, Extension by Relation, Extension Principle, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets. Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, - cut of Fuzzy Graph.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings:

- *Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.*
- *Chander Mohan , An Introduction to Fuzzy Set Theory and Fuzzy Logic, Anshan Publishers.*
- *H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.*
- *John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.*