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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Load Allocation** | | | **Marks Distribution** | | | **Credits** |
| **L** | **T** | **P** | **Int** | **Ext** | **Total** |
| **MSMM 201C** | **Advanced Algebra** | **4** | **1** | **0** | **40** | **60** | **100** | **4** |
| **MSMM 202C** | **Measure Theory** | **4** | **1** | **0** | **40** | **60** | **100** | **4** |
| **MSMM 203C** | **Mathematical Methods** | **4** | **1** | **0** | **40** | **60** | **100** | **4** |
| **MSMM 204C** | **Partial Differential Equations** | **4** | **1** | **0** | **40** | **60** | **100** | **4** |
| **MSMM 205C** | **Numerical Analysis** | **4** | **1** | **0** | **40** | **60** | **100** | **4** |
| **MSMM 206C** | **Numerical Analysis Lab** | **0** | **0** | **3** | **50** | **25** | **75** | **3** |
|  | **Total** | **20** | **05** | **03** | **250** | **325** | **575** | **23** |

**SHAHEED BHAGAT SINGH STATE UNIVERSITY, FEROZEPUR**

**Study Scheme of M.Sc. (Mathematics)**

**SECOND SEMESTER Contact Hours: 25 Hrs**

**MASTER OF SCIENCE (Mathematics)**

**MSMM 201C**-**ADVANCED ALGEBRA**

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| --- | --- | --- | --- | --- | --- | --- |
| Semester | Second | | | | | |
| Course code | MSMM 201C | | | | | |
| Category | Mathematical Science | | | | | |
| Course title | Advanced Algebra | | | | | |
| Scheme and Credits | L | T | P | Internal Marks | External Marks | Credits |
| 4 | 1 | 0 | 40 | 60 | 4 |

**COURSE OBJECTIVES:** This course is designed to give students a foundation for advanced study in Algebra. The fundamental theorems of algebraic structures are explained. Students will explore the concepts of Polynomial rings, UFD, ED, PID, Field Extensions, Einstein’s irreducibility criterion, Galois extensions etc. Throughout the course, Advanced core standards are taught and reinforced as the student learns how to apply the concepts in real-life situations.

**Course Outcomes:** At the end of the course, the students will be able to

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| --- | --- |
| Co1 | Apply the knowledge of algebra to attain a good mathematical maturity and enables to build mathematical thinking and reasoning. |
| Co2 | Utilize the polynomial rings, UFD, ED, PID to solve different related problems. |
| Co3 | Identify and analyze different types of algebraic structures such as Algebraically closed fields, Splitting Fields, Finite field extensions to understand and use the fundamental results in algebra. |
| Co4 | Design, analyze and implement the concepts of Gauss Lemma, Einstein’s irreducibility criterion, separable extensions etc. |
| Co5 | Create, select and apply appropriate algebraic structures such as Galois extensions, Automorphisms of groups and fixed fields, Fundamental theorem of Galois theory to understand and use the fundamental theorem of Algebra. |
| Co6 | Identify the challenging problems in advanced algebra to pursue further research. |

**Detailed Contents**

Chapter 1:Polynomial rings, factorization of polynomials in one variable over a field. Unique factorization domains, unique factorization in R[x], where R is unique Factorization domain, Euclidean and Principal ideal domain.

Chapter 2: Gauss Lemma, irreducible polynomials and Einstein’s Irreducibility criterion, Fields, Adjunction of roots, Algebraic extensions of field.

Chapter 3: Algebraically closed fields, Splitting fields, normal extensions, finite fields, separable extensions.

Chapter 4: Automorphism of groups and fixed fields, Galois extensions. The fundamental theorem of Galois Theory, Fundamental theorem of algebra.

**Recommended Books:-**

1. Bhattacharya, P.B. Jain, S.K and Nagpaul, S.R. Basic Abstract Algebra, 2nd Edition. U.K.: Cambridge University Press, 2004.
2. Dummit, David.S., and Foote, Richard M., Abstract Algebra, 3rd Edition, New Delhi: Wiley,2011.
3. Herstein, I.N. Topics in Algebra, 7th Edition, New Delhi: Wiley, 2006.
4. Singh, Surjeet and Q.Zameeruddin, Modern Algebra, 7th Edition, New Delhi: Vikas Publishing House, 1993.
5. Ash. R., Abstract Algebra: The Basic Graduate Year, Dover Publications Inc, 2006

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| Semester | Second | | | | | |
| Course code | MSMM 202C | | | | | |
| Category | Mathematical Science | | | | | |
| Course title | Measure Theory | | | | | |
| Scheme and Credits | L | T | P | Internal Marks | External Marks | Credits |
| 4 | 1 | 0 | 40 | 60 | 4 |

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| **Course Objective** : This course is designed to consider theoretical foundations of concepts of mathematical analysis, viz derivative, MVTs, functions of several variable, measure theory and integration that have many important applications in different branches of pure and applied mathematics. Further, the objective is enabling students familiar with these concepts and their fruitful applications.  **Course outcomes**: At the end of the course, the students will be able to | |
| **C01** | Apply the knowledge of concepts of functions of several variables and measure theory in order to study theoretical development of different mathematical concepts and their applications. |
| **C02** | Understand the nature of abstract mathematics and explore the concepts in further details. |
| **C03** | Recognize the need of concept of measure from a practical view point. |
| **C04** | Understand measure theory and integration from theoretical point of view and apply its tools in different fields of applications. |
| **C05** | Extend their knowledge of Lebesgue theory of integration by selecting and applying its tools for further research in this and other related areas. |

**Detailed Contents**

Chapter1:Lebesgue measure: Introduction ,Lebesgue outer measure,Measurable sets ,Properties of Measurable sets,Non Measurable Sets .

Chapter 2: Measurable functions, properties of Measurable functions, Characteristic functions, Step Functions and simple functions , borel and lebesgue measurability, littlewood's three principles .

Chapter 3: Lebesgue Integral: The Riemann integral, The lebesgue integral of a bounded function over a set of finite measure, the integral of a non negative function, the general lebesgue integral, convergence in measure.

Chapter 4: Differentiation and integration: Differentiation of monotone functions, the four derivatives, functions of bounded variation, differentiation of an integral, Lebesgue differentiation theorem. Absolute continuity, convex functions.

**Recommended Books:**

1. Royal ,H.L. and Fitz patrick, P.M., Real; Analaysis,4th edition. New Delhi: Pearson, 2010.
2. Barra, G.de., measure theory and Integration, New Delhi:Woodhead publishing, 2011.
3. Rudin, W.,principles of mathematical analysis, 3rd edition. New Delhi:McGraw-Hill

Inc.,2013.

4. Carothers, N.L., Real Analysis, Cambridge University Press, 2000.

5. Apostol, T.M., Mathematical Analysis- A modern approach to Advanced Calculus. New

Delhi: Narosa Publishing house, 1957.

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| Semester | Second | | | | | |
| Course code | MSMM 203C | | | | | |
| Category | Mathematical Science | | | | | |
| Course title | Mathematical Methods | | | | | |
| Scheme and Credits | L | T | P | Internal Marks | External Marks | Credits |
| 4 | 1 | 0 | 40 | 60 | 4 |

**COURSE OBJECTIVES:** The objective of the course is to acquaint the students with the knowledge of mathematical techniques frequently applied in various branches of engineering and sciences, Also, one of the objectives of this course is to equip the students with the mathematical background required for the development of such techniques.

**COURSE OUTCOMES:** At the end of the course, the students will be able to

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| --- | --- |
| Co1 | Understand the theory and applications of integral transforms. |
| Co2 | Explain how integral transforms can be used to solve a variety of differential equations. |
| Co3 | Solve integro-differential equations of Fredholm and Volterra type. |
| Co4 | Understand the properties of various kinds of integral equations. |
| Co5 | Develop their attitude towards problem solving. |

**Detailed Contents**

Chapter 1:Laplace Transforms: Laplace Transform, Properties of laplace Transform, Inverse Laplace Transform, Convolution theorem, Laplace transform of periodic functions unit step function and impulsive function, Application of Laplace Transform in solving ordinary and partial differential equations and Simultaneous linear equations

Chapter 2: Fourier Transforms: Fourier transform, properties of Fourier transform, inversion formula, convolution, parseval's equality, Fourier transform of generalized functions, application of Fourier transforms in solving heat, wave and Laplace equation. Fast Fourier transform.

Chapter 3: Integral Equations: Relations between differential and integral equations, Green's function, Linear equations in cause and effect, Integral equations of Fredholm and Volterra type, solution by successive substitution and successive approximation, integral equations with degenerate kernels.

Chapter 4: Integral equations of convolution type and their solutions by Laplace transform, Fredholm's theorems, integral equations with symmetric kernel, Solutions with separable kernels, Characteristic numbers, Resolvent kernel, Eigen values and Eigen functions of integral equations and their simple properties.

**Text and Reference Books**:

1. Sneddon, I.N., The use of Integral Transforms. McGraw Hill, 1985.
2. Goldberg, R.R., Fourier Transforms. Cambridge University Press, 1970.
3. Smith, M.G. Laplace Transforms Theory. Van Nostrand Inc.,2000.
4. Elsegolc, L., Calculus of Variation. Dover Publications, 2010.
5. Kenwal, R.P., Linear Integral Equation. Theory and Techniques. Academic Press, 1971.
6. Hildebrand, F.B., Methods of applied mathematics (Latest Reprint). Dover publications.
7. Pal, S. and Bhunai, S.C., Engineering mathematics. Oxford University Press,2015.
8. Higher Engineering mathematics, B.S. Grewal, Khanna Publishers, 36th Edition, 2010.
9. Advanced Engineering mathematics, Erwin Kreyszig, 2008, Wiley India.

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| Semester | Second | | | | | |
| Course code | MSMM 204C | | | | | |
| Category | Mathematical Science | | | | | |
| Course title | Partial Differential Equations | | | | | |
| Scheme and Credits | L | T | P | Internal Marks | External Marks | Credits |
| 4 | 1 | 0 | 40 | 60 | 4 |

**Course objective:** The objective of this course is to introduce first and higher order partial differential equations and their classification. This course explains various analytic methods for computing the solutions of various partial differential equations. It also explains various applications of partial differential equations in real physical phenomenon like wave equation of string, diffusion equations and heat flow equation to students.

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

|  |  |
| --- | --- |
| Co1 | Understand partial differential equations of first order(linear and non linear), second and higher order |
| Co2 | Apply various analytic methods for computing solutions of various PDEs |
| C03 | Determine integral surfaces passing through a curve, characteristics curves of second order PDE and compatible systems |
| Co4 | Understand the formation and solution of some significant PDEs like wave equation, heat equation and diffusion equation. |
| Co5 | Apply the knowledge of PDEs and their solutions in order to understand physical phenomena. |

**Detailed Contents**

Chapter 1:First order PDE: Partial differential equations; its order and degree; origin of first order PDE; determination of integral surfaces of linear first order partial differential equations passing through a given curve; surfaces orthogonal to given system of surfaces; non-linear PDE of first order, Cauchy's method of characteristic; compatible system of first order PDE; Charpit's method of solution, solutions satisfying given conditions, Jacobi's method of solution.

Chapter 2 : Second and Higher Order PDE: Origin of second order PDE; linear second and higher order PDE with constant and variable coefficients; characteristic Curves of the second order PDE; Monge's method of solution of non-linear PDE of second order.

Chapter 3: Separation of Variable Method: Separation of variables for PDE; wave diffusion and Laplace equations and their solutions by separation of variables method, Elementary solutions of Laplace equations.

Chapter 4 : Vibrations governed by one and two dimensional wave equations; vibrations of string and membranes; three dimensional problems; diffusion equation; resolution of boundary value problems for diffusion equations and elementary solutions of diffusion equations.

**Recommended Books:**

1. Sneddon, I.N., Elements of Partial differential equation 3rd Edition. McGraw Hill book company, 1998.
2. Copson, E.T., Partial differential equations, 2nd Edition. Cambridge University Press, 1995.
3. Strauss, W.A., Partial differential equations : An introduction, 2nd Edition, 2007.
4. Sharma, J.N. and Singh, K. Partial differential equations for engineers and scientists, 2nd Edition. New Delhi: Narosa publication house, 2009.

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| Semester | Second | | | | | |
| Course code | MSMM 205C | | | | | |
| Category | Mathematical Science | | | | | |
| Course title | Numerical Analysis | | | | | |
| Scheme and Credits | L | T | P | Internal Marks | External Marks | Credits |
| 4 | 1 | 0 | 40 | 60 | 4 |

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| --- | --- |
| **Course Objectives:** This course is designed to introduce the basic concepts of Numerical Mathematics in order to solve the problems arising in various fields of application, for example in science, engineering and economics etc. that do not possess analytical solutions or difficult to deal with analytically. This course addresses development, analysis and application of different numerical methods to solve the problems, viz. System of linear & nonlinear equations, numerical initial and boundary value problems of ordinary differential equations etc. | |
| **Course Outcomes:** At the end of the course, the students will be able to | |
| **CO1** | Identity and analyze different types of errors encountered in numerical computing. |
| **CO2** | Apply the knowledge of Numerical Mathematics to solve problems efficiently arising in science, engineering and economics etc. |
| **CO3** | Utilize the tools of the Numerical Mathematics in order to formulate the real-world problems from the view point of numerical mathematics. |
| **CO4** | Design, analyze and implement of numerical methods for solving different types of problems, viz. initial and boundary value problems of ordinary differential equations etc. |
| **CO5** | Create, select and apply appropriate numerical techniques with the understanding of their limitations so that any possible modification in these techniques could be carried out in further research. |
| **CO6** | Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically) and find their appropriate solutions accurately and efficiently. |

**Detailed Contents**

Chapter 1:Numerical computation and Error analysis: Numbers and their accuracy, Floating point arithmetic, Errors in numbers, Error estimation, General error formulae, Error propagation in computation. Inverse problem of error analysis and Numerical instability. Algebraic and transcendental equations: Bisection method, Iteration method, Regula-Falsi method, Secant method, Newton-Raphson’s method. Convergence of these methods. Lin- Bairstow’s method, Muller’s method, Graeffe’s root squaring method, Solution of system of nonlinear equations, Complex roots by Newton- Raphson’s method.

Chapter 2: System of linear algebraic equations. Gauss elimination method without pivoting and with pivoting, Gauss-Jordon method, LU-factorization method, Jacobi and Gauss-Seidal methods, Convergence of iteration methods, Round-off errors and refinement, ill-conditioning, Partitioning method, Inverse of matrices. Eigenvalues and eigenvectors: Rayleigh Power method, Given’s method and Householder’s method.

Chapter 3: Interpolation: Finite differences, Newton’s interpolation formulae, Gauss, Stirling’s and Bessel’s formulae, Lagrange’s. Hermite’s and Newton’s divided difference formulae. Numerical differentiation and integration: differentiation at tabulated and non-tabulated points, Maximum and minimum values of tabulated function, Newton-Cotes Formulae-Trapezoidal, Simpson’s, Boole’s and Weddle’ rules of integration with errors, Romberg integration, Gaussian integration, Double integration by Trapezoidal and Simpson’s rules.

Chapter 4: Ordinary differential equations: Taylor series and Picard’s methods, Euler’s and modified Euler methods, Runge-Kutta methods, Predictor- Corrector methods: Adams – Bashforth’s and Milne’s methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary value problems: Finite difference and Shooting methods.

**Recommended Books:**

1. Sharma J.N., Numerical methods for Engineers and Scientists, 2nd Edition. Narosa Publ. House New Delhi/Alpha Science International Ltd. Oxford UK, 2007, Reprint 2010.
2. Jain, M.K. Iyengar, S.R.K., Numerical Methods for Scientific and Engineering Computation, 5th Edition. New Age International Publ. New Delhi,2010.
3. Bradie, B.A, Friendly Introduction to Numerical Analysis. Pearson Prentice Hall,2006.
4. Atkinson, K.E., Introduction to Numerical Analysis, 2nd Edition. John Wiley, 1989.
5. Scarborough, J.B. Numerical Mathematical Analysis. Oxford & IBH Publishing Co. 2001.
6. B.S. Grewal, Numerical Methods in Engineering & Science with programs in C,C++ & Matlab, Khanna Publishers,2010.
7. Steven C. Chapra, Advanced Numerical Methods with MATLAB for Engineers &Scientists, Tata McGraw Hill.
8. E Balagurusamy, Numerical Methods, Tata Mc Graw Hill.

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| Semester | Second | | | | | |
| Course code | MSMM 206C | | | | | |
| Category | Mathematical Science | | | | | |
| Course title | Numerical Analysis (Lab) | | | | | |
| Scheme and Credits | L | T | P | Internal Marks | External Marks | Credits |
| 0 | 1 | 3 | 50 | 25 | 3 |

**Course Objectives** : This course is designed to provide understanding of implementation of basic numerical methods for solving different problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical initial and boundary value problems of ordinary differential equations etc. Further, this course will develop programming skills in the students in order to write and implement their own computer programs for solving problems arising in science, engineering and economics.

**Course Outcomes** : At the end of the course, the student will be able to

|  |  |
| --- | --- |
| Co1 | Apply their knowledge of computer programming to develop and implement their own computer codes of numerical methods for solving different types of complex problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical initial and boundary value problems of ordinary differential equations etc. |
| Co2 | Understand different implementation modes of numerical method in order to solve a given problem efficiently. |
| Co3 | Analyze and modify computer codes available in the scientific literature. |
| Co4 | Utilize the symbolic tools of Computer Algebra System (CAS) for example MATLAB, MATHEMATICA and MAPLE independently and in their computer codes for solving a given problem. |
| Co5 | Develop, select and apply numerical methods as a computer code with the understanding of their limitations so that they can be implemented in order to get acceptable results |
| Co6 | Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically and find their appropriate solutions accurately and efficiently using computer codes. |

**Detailed Contents**

The following programs of following methods are to be practiced:

1. To find a real root of an algebraic/transcendental equation by using Bisection method.
2. To find a real root of an algebraic/transcendental equation by using Regula -Falsi method.
3. To find a real root of an algebraic/transcendental equation by using Newton-Raphson method.
4. To find a real root of an algebraic/transcendental equation by using Iteration method.
5. Implementation of Gauss-Elimination method to solve a system of linear algebraic equations.
6. Implementation of Jacobi's method to solve a system of linear algebraic equations.
7. Implementation of Gauss-Seidel method to solve a system of linear algebraic equations.
8. To find differential coefficients of 1st and 2nd orders using interpolation formulae.
9. To evaluate definite integrals by using Newton –Cotes integral formulae.
10. To evaluate definite integrals by using Gaussian Quadrature.
11. To evaluate double integrals by using Trapezoidal and Simpson Method.
12. To compute the solution of ordinary differential equations with Taylor's series method.
13. To compute the solution of ordinary differential equations by using Euler's method.
14. To compute the solution of ordinary differential equations by using Runge-Kutta methods.
15. To compute the solution of ordinary differential equations by using Milne-Simpson method.
16. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Finite Difference method.
17. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Shooting method.

**Recommended Books:**

1. Fausett, L.V.,Applied Numerical Analysis using MATLAB, 2nd Edition. Pearson Prentice Hall , 2007
2. Mathews, J.H. and Fink, K.D., Numerical Methods using MATLAB, 4th Edition. Pearson Prentice Hall , 2004.
3. Balagurusamy ,E., Object Oriented Programming with C++. New Delhi: Tata McGraw Hill 1999.
4. Conte, S.D. and Boor, C. D., Numerical Analysis. New York : McGraw Hill, 1990.