DEPARTMENT OF MATHEMATICS
KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme and Syllabus of Examination for Under Graduate Programme for Mathematics Course under Choice Based Credit System (CBCS-LOCF) –NEP w.e.f. 2022-23 (in phased manner)

1. Name of the Programme (Course): B.Sc. or B.A.
2. Definitions/ Abbreviations:

   1 credit=1 Hour Theory Lecture (L) per week
   1 credit= 2 Hours Practical (P) per week
   1 credit = 25 marks
   2 Hours = 3 periods of 45/40 minutes
   3 Hours = 4 periods of 45/40 minutes
   CC = Core Course
   DSC = Discipline Core Course
   AECC = Ability Enhancement Compulsory Course
   SEC = Skill Enhancement Course
   DSE = Discipline Specific Elective Course
   GE = Generic Elective

3. One Batch (Practical Group) will consist of 20 students.
4. Scheme will be effective from the session 2022-23 in phased manner.
5. Each End Term Examination will be of three hours.
6. Scheme and structure of the programme will be according to the framework approved by the university.

Program Outcomes (PO) for Under Graduate Programme (CBCS) in the Faculty of Sciences, Kurukshetra University, Kurukshetra

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO3	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO4	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO5	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO6	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO7	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO8	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout the life
PO9	Environment and Sustainability	Ability to design and develop modern systems which are environmentally sensitive and to understand the importance of sustainable development.
PO10	Ethics	Apply ethical principles and professional responsibilities in scientific practices
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Program Specific Outcomes (PSO) for Under Graduate CBCS Programme in the subject of Mathematics

After successful completion of the programme, a student will be able to:

PSO1	Have basic understanding and knowledge in different core areas of Mathematics such as algebra, analysis, calculus, differential equations, mechanics, numerical analysis and in some of the other elective areas. Demonstrate understanding of the concepts /theories/methods from such areas of Mathematics.
PSO2	Have **a broad background** in Mathematics and develop the essential mathematical reasoning, knowledge, skills and aptitude to pursue further studies and research in Mathematics.
PSO3	Communicate mathematics effectively and precisely by written, computational and graphical means.
PSO4	Apply knowledge, understanding, methods, techniques and skills of Mathematics to analyze, evaluate and solve problems of Mathematics and/or the mathematical problems having applications in engineering/science/technology/life sciences/social sciences so as to enhance career prospects in different fields.

Scheme of first year of programme

Sem.	Course	Course Code	Nomenclature of paper	Credits	Contact Hours	Internal Assessment Marks	Semester End Term Examination Marks	Total Marks	Duration of Exams
1	CC-1	B-MAT-N101(i)	Calculus	2	2	25	25	50	3 Hours
		B-MAT-N101(ii)	Algebra & Number Theory	2	2	25	25	50	3 Hours
		B-MAT-N101(iii)	Practical-I	2	4	25	25	50	3 Hours
2	CC-2	B-MAT-N201(i)	Advanced Calculus	2	2	25	25	50	3 Hours
		B-MAT-N201(ii)	Differential Equations	2	2	25	25	50	3 Hours
		B-MAT-N201(iii)	Practical-II	2	4	25	25	50	3 Hours

B-MAT-N101(i) : Calculus

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**25**	**25**	**50**	**3 Hours**
B.A.	**2**	**2**	**25**	**25**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Calculate the limit of functions, examine the continuity of functions, understand differentiability of different types of functions, successive differentiation of functions and series expansions.
2. Understand concepts of tangents, normals, asymptotes, curvature, evolutes and involutes of a curve; the geometrical meanings of these terms and to solve related problems
3. Determine singular points of a curve and their types. To understand rectification of curves and to apply the reduction formulae.
4. Determine area bounded by curves and volumes and surface area of solids formed by revolution of curves

Unit-I:

ε-δ definition of limit and continuity of a real valued function, basic properties of limits, types of discontinuities. Differentiability of functions. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions.

Unit-II:

Tangents and normals (Cartesian and parametric equations). Asymptotes in Cartesian and polar coordinates, intersection of a curve and its asymptotes. Curvature and radius of curvature of curves in Cartesian, polar and parametric forms. Centre of curvature. Circle of curvature.

Unit-III:

Evolutes and involutes. Points of inflexion. Multiple points. Cusps, nodes & conjugate points. Reduction formulae.

Unit-IV:

Rectification. Quadrature, Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution.

Recommended Text Books:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

B-MAT-N101(ii) : Algebra and Number theory

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**25**	**25**	**50**	**3 Hours**
B.A.	**2**	**2**	**25**	**25**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Determine rank of a matrix, eigen values, eigen vectors, characteristic equation and characteristic polynomial of square matrices. Understand unitary and orthogonal matrices and to solve related problems.
2. Find solution of homogeneous and non-homogeneous system of linear equations using matrices. Determine relation between roots and coefficients of a general polynomial equation.
3. Identify multiple roots, Apply Descarte's rule of sign, Solve cubic and biquadratic equations.
4. Understand the basic concepts of number theory and their applications in problem solving. Prove Fermat and Wilson's theorems and their applications.

Unit–I:

Rank of a matrix. Row rank and column rank of a matrix. Eigen values, eigen vectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix. Unitary and Orthogonal Matrices.

Unit–II:

Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations.

Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots. Theorems on integral, rational and complex roots of a polynomial equation.

Unit–III:

Common roots and multiple roots. Nature of the roots of an equation Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions by Ferrari and Descartes methods

Unit–IV:

Divisibility, Greatest Common Divisor(GCD), Least Common Multiple (LCM). Prime numbers, Fundamental Theorem of Arithmetic. Linear Congruences, Fermat's theorem. Euler's theorem. Wilson's theorem and its converse. Principle of mathematical induction.

Recommended Text Books:

1. I. Niven, H.S. Zuckerman and H.L. Montgomery (2012). *An Introduction to the Theory of Numbers* (5th edition). John Wiley & Sons.
2. A.I. Kostrikin (1984). *Introduction to Algebra*. Springer Verlag.
3. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.
4. S. H. Friedberg, A. L. Insel and L.E. Spence (2004). *Linear Algebra*, Prentice Hall of India Pvt. Ltd.
5. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications* (5th edition). Pearson Education Pvt. Ltd. India.
6. Gareth A. Jones & J. Mary Jones (2005). *Elementary Number Theo*ry. Springer.
7. Neville Robbins (2007). *Beginning Number Theory* (2nd edition). Narosa.
8. H.S. Hall and S.R. Knight (2016). *Higher Algebra*, Arihant Publications.
9. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)

B-MAT-N101(iii) : PRACTICAL-I

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**25**	**25**	**50**	**3 Hours**
B.A.	**2**	**4**	**25**	**25**	**50**	**3 Hours**

Note: This course has two components, Problem Solving and Practicals using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the Part A and two questions from the Part B by taking course outcomes (COs) into consideration. The examinee will be required to solve one problem from the Part A and to execute one problem successfully from the Part B. Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Handle practical problems of tracing of curves when equations are given in Cartesian, polar coordinates or in parametric form.
2. Solve practical problems of finding length of given curves, calculating volume of solids generated by revolution of curves and solving cubic and biquadratic equations.
3. Have hand on experience to find derivative and integral of different functions and to solve algebraic equations by using built in functions of MAXIMA software.
4. Attain skills to find inverse, eigen values of matrices and to solve system of linear equations by using built in functions of MAXIMA software.

A. **Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of curve tracing when equation is given in Cartesian coordinates.
2. Problems of curve tracing when equation is given in parametric form.
3. Problems of curve tracing when equation is given in polar coordinates.
4. Problem solving of determination of length of a curve expressed in Cartesian coordinates.
5. Problem solving of determination of length of a curve expressed in polar coordinates.

6. Problems of determination of volume of solids generated by revolution of curves expressed in Cartesian coordinates.
7. Problems of determination of volume of solids generated by revolution of curves expressed in polar coordinates.
8. Problems of determination of volume of solids generated by revolution of curves expressed in parametric form.
9. Problems of solving cubic equations by Cardon's method.
10. Problems of solving biquadratic equations by Ferrari method.
11. Problems of solving biquadratic equations by Descartes method.

B. **Practicals with Free and Open Source Software (FOSS) Tools-** The following practicals will be done using MAXIMA Software and record of those will be maintained in the practical Note Book:

1. To simplify expression, factor expression, expand expression and to do trigonometric simplification and complex simplification by making use of MAXIMA.
2. To find derivatives of functions using MAXIMA.
3. To find indefinite and definite integrals of different functions using MAXIMA.
4. To find roots of algebraic equations using MAXIMA.
5. To find the value of a determinant using MAXIMA.
6. To compute inverse of a square matrix using MAXIMA.
7. To find eigen values and eigen vectors of a square matrix using MAXIMA.
8. To solve system of linear equations using MAXIMA.

B-MAT-N201(i): Advanced Calculus

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**25**	**25**	**50**	**3 Hours**
B.A.	**2**	**2**	**25**	**25**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand and to prove Rolle's Theorem, mean value theorems and their geometrical interpretation. To evaluate indeterminate forms.
2. Learn conceptual variations while advancing from one variable to several variables in calculus, limit and continuity, partial differentiation of such functions. To understand composite functions, homogeneous functions and to solve related problems.
3. Understand differentiability of real valued functions of two variables and to prove associated results. To determine maximum and minimum of functions of two variables and to apply multivariable calculus in optimization problems.
4. Evaluate double and triple integrals. To learn about Dirichlet integrals, Beta and Gamma functions and to solve related problems.

Unit-I:

Mean value theorems: Rolle's Theorem and Lagrange's mean value theorem and their geometrical interpretation, Cauchy mean value theorem. Taylor's Theorem with different forms of remainders. Indeterminate forms.

Unit-II:

Functions of several variables, Limits and continuity. Partial differentiation. Total Differentials; Composite functions & implicit functions. Chain rule. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two or more variables.

Unit-III:

Differentiability of real valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Extrema of functions of two and more variables; Maxima, Minima critical points, Method of Lagrange multipliers.

Unit-IV:

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates. Jacobian. Change of order of integration. Triple integral over a parallelepiped and solid regions, Triple integration in cylindrical and spherical coordinates. Beta and Gamma functions.

Recommended Text Books:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.
7. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.
8. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.

B-MAT-N201(ii): Differential Equations

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**25**	**25**	**50**	**3 Hours**
B.A.	**2**	**2**	**25**	**25**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: The course will enable the students to:

1. Understand the basic concepts of ordinary differential equations and to learn various techniques of finding exact solutions of certain solvable first order differential equations.
2. Develop the skills of solving homogeneous and non-homogeneous second order linear ordinary differential equations with constant coefficients and with variable coefficients.
3. Understand total differential equations and basic concepts of partial differential equations. To learn methods and techniques for solving linear PDEs of first order.
4. Apply theory of PDEs to determine integral surfaces through a given curve and to find orthogonal surfaces. To understand compatible systems and Charpit method, Jacobi method methods for solving PDEs. To learn techniques of solving second order PDEs with constant coefficients.

Unit-I:

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, equations reducible to homogeneous, Linear differential equations and equations reducible to linear form. Exact differential

equations, Integrating factor. First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions.

Unit-II:

Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, linear non-homogeneous differential equations. Linear differential equation of second order with variable coefficients. Method of reduction of order, method of variation of parameters. Cauchy-Euler equation.

Unit-III:

Solution of simultaneous differential equations, total differential equations.

Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs. Complete solution, general solution and singular solution of a PDE. Linear PDE of first order. Lagrange's method for PDEs of the form: $P(x,y,z)\ p + Q(x,y,z)\ q = R(x,y,z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$.

Unit-IV:

Second Order Partial Differential Equations with Constant Coefficients. Integral surfaces passing through a given curve. Surfaces orthogonal to a given system of surfaces. Compatible systems of first order equations. Charpit's method, Special types of first order PDEs, Jacobi's method. Solutions of second order linear partial differential equations (homogeneous and non-homogeneous) with constant coefficients.

Recommended Text Book:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). J. Wiley & Sons
2. B. Rai & D. P. Choudhury (2006). *Ordinary Differential Equations - An Introduction*. Narosa Publishing House Pvt. Ltd. New Delhi.
3. Shepley L. Ross (2007). *Differential Equations* (3rd edition). Wiley.
4. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

B-MAT-N201(iii) : PRACTICAL-II

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**25**	**25**	**50**	**3 Hours**
B.A.	**2**	**4**	**25**	**25**	**50**	**3 Hours**

Note: This course has two components, Problem Solving and Practicals using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the Part A and two questions from the Part B by taking course outcomes (COs) into consideration. The examinee will be required to solve one problem from the Part A and to execute one problem successfully from the Part B. Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Practical problems of checking continuity and differentiability, finding maxima and minima of functions of several variables, evaluating double and triple integrals.
2. Develop skills of solving ODEs and PDEs.
3. Have hand on experience to find partial derivatives, total derivative and to plot graphs of functions by using built in functions of MAXIMA software.
4. Have hand on experience to evaluate double and triple integrals, solve ordinary differential equations by using built in functions of MAXIMA software.

A. **Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of finding continuity of functions of several variables.
2. Problems of finding differentiability of functions of several variables.
3. Problems of finding maxima and minima of functions of two variables.
4. Solving optimization problems.
5. Problem solving of determination surface area through application of double integrals in Cartesian and polar coordinates.
6. Problems of determination of volume using triple integrals.
7. Problems of solving differential equations which are reducible to homogeneous.
8. Problems of solving differential equations which are reducible to linear.
9. Problems of solving differential equations by method of undetermined coefficients.
10. Problems of solving different PDEs using Lagrange's method.
11. Problems of solving PDEs with Charpit's method.

12. Problems of solving second order PDEs with variable coefficients which can be reduced to those with constant coefficients.

B. **Practicals with Free and Open Source Software(FOSS) Tools-** The following practicals will be done using MAXIMA Software and record of those will be maintained in the practical Note Book:

1. To find partial derivatives of a function using MAXIMA.
2. To find total differential of a function of several variables using MAXIMA.
3. To find partial derivatives by chain rule and implicit differentiation.
4. To plot a curve in two dimensions, three dimensional plots and level surfaces using MAXIMA.
5. To find exact solutions of first and second order ODEs using ode2 and ic1/ic2 built in functions of MAXIMA.
6. To find exact solutions of first and second order ODEs using desolve and atvalue built in functions of MAXIMA.
7. To evaluate double and triple integrals using MAXIMA.
8. To find numerical solution of a first order ODE using plotdf built in function of MAXIMA.