Annexure-IV

MAHATMA GANDHI CENTRAL UNIVERSITY

[Established by an Act of Parliament]
TempCamp, Zila School Campus, Motihari, District – East Champaran, Bihar – 845 401

DEPARTMENT OF MATHEMATICS

SCHOOL OF MATHEMATICS AND STATISTICAL SCIENCES

UNDERGRADUATE PROGRAMME

Under Choice Based Credit System

B.Sc. (Honours) Mathematics

(Courses effective for the Second Batch: 2017-20 onwards)

Detailed Course Outline

CORE COURSES

Course Code: MATH3001
Course Title: Calculus I

Credits Equivalent: 6 (4 Lectures, 2 Practical (in a group of 15-20 students) per week per student)
1 credit is equivalent to 15 hours of Teaching / 30 hours of Practical.

CourseObjectives:

This course is designed to develop the topics of differential and integral calculus. It emphasizes on a multi representational approach to calculus, with concepts, results, and problems being expressed geometrically, numerically and analytically.

Evaluation Criteria:

Theory

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

Practical

1. Mid Term Examination: 25%
2. End Term Examination: 50%
   a. Written Examination: 40%
   b. Viva-Voce: 10%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Practical File /Presentation: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I:

Differentiation of implicit functions and of functions in parametric forms, successive differentiation, Leibnitz theorem, indeterminate forms, L' Hospital rule.

Unit-II:

Asymptotes, monotonic functions, concavity, convexity and points of inflexion, theory of maxima and minima.

Unit-III:

Multiple points, tracing of curves in Cartesian and Polar coordinates, techniques of sketching conics, reflection properties of conics, rotation of axes,second degree equations and it's classification into conics using the discriminant, polar equations of conics.

Unit-IV:

Curvature, radius of curvature in Cartesian, Parametric, Polar and Pedal form, centre and chord of curvature.

Unit-V:

Reduction formulae of functions of the type$\int sin^n xdx$, $\int cos^n xdx$, $\int tan^n xdx$, $\int sin^n xcos^m xdx$, definite integral as limit of sum, length of curves, area of curves, volume and surface area of solid of revolution.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2012.
2. M.J. Strauss, G.L. Bradley and K.J. Smith, Calculus, Pearson Education, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus (7th Edition), John Wiley and sons (Asia), Pt Ltd., Singapore, 2002.

Suggested Readings:

1. Shanti Narayan, Differential Calculus, S. Chand & Company, New Delhi.
2. Shanti Narayan, Integral Calculus, S. Chand & Company, New Delhi.
3. L.J. Goldstein, David C. Lay, N.H. Asmer, David I. Schneider, Calculus and its Applications, Pearson, 2014.
4. Gorakh Prasad, Differential Calculus, PothishalaPvt. Ltd. Allahabad, 2000.
1. Gorakh Prasad, Integral Calculus, PothishalaPvt. Ltd. Allahabad, 2000.

List of Practical (using Matlab / Mathematica / Maple etc.)

1. Plotting of graphs of function $e^{ax+b}, \log(ax+b), 1/(ax+b), \sin(ax+b), \cos(ax+b), |(ax+b)|$ and todiscuss the effect of a and b on the graph.
2. Plotting the graphs of polynomials of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves.
4. Tracing of conics in Cartesian coordinates.
5. Obtaining surface of revolution of curves.
6. To find numbers between two real numbers and plotting of finite and infinite subset of R.
7. Computation of limit, differentiation and integration of vector functions.
8. Study the convergence of sequences through plotting.
9. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

10. Cauchy's root test by plotting nth roots.
11. Ratio test by plotting the ratio of nth and $(n+1)$th term.

Course Code: MATH3002
Course Title: Real Analysis I

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching/Tutorials.

Course Objectives:

This course presents a rigorous treatment of fundamental concepts in analysis.The course objective is to understand the axiomatic foundation of the real number system and its completeness property. It introduces students to the fundamentals of mathematical analysis and reading and writing mathematical proofs and to understand the notion of sequence and series and their nature.

Evaluation Criteria:
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I

Algebraic and order properties of $\mathbb{R}$, countable and uncountable sets and uncountability of$\mathbb{R}$, bounded and unbounded sets, supremum and infimum of a set, least upper bound property.

Unit-II

Completeness property of$\mathbb{R}$,Archimedean property, intervals, neighbourhood of a point in $\mathbb{R}$, limit points of a set, isolated points, open and closed sets, density of rational numbers in$\mathbb{R}$, Bolzano-Weierstrass theorem for sets.

Unit-III

Sequence, convergent, divergent and oscillatory sequences, bounded sequence, limit of a sequence, limit superior and limit inferior, limit theorems.

Unit-IV

Monotone sequences, monotone convergence theorem, subsequence, divergence criteria, Bolzano-Weierstrass theorem for sequences, Cauchy sequence, Cauchy convergence criteria.

Unit-V

Infinite series, series of non-negative terms, convergence and divergence of infinite series, Cauchy criteria, tests for convergence: comparison test, ratio test,Raabe's, logarithmic, De Morgan and Bertrand's tests, Cauchy's n^{th}root test, integral test, Gauss's test, alternating series, Leibniz test, absolute and conditional convergence.

Reference Books:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones & Bartlett, 2010.
3. S.R. Ghorpade, B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.
4. V. Karunakaran, Real Analysis, Pearson, 2012.

Suggested Readings:

1. S. C. Malik, SavitaArora, Mathematical analysis, New Age International, 2010.
2. S.K. Mapa, Introduction to Real Analysis, Sarat Book Distributors, 2016.
3. T.M. Apostol, Calculus, Vol. 1, John Wiley.

Course Code: MATH3003
Course Title: Calculus II

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching/Tutorials.

Course Objectives:

This course is in continuation of Calculus I. This course is designed to develop an understanding about the mathematical approach to human inquiry and skill for analysing functions of two and three variables and to understand the basics of vector calculus to appreciate the interplay between the physics and the calculus that was developed to solve physical problems.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit I:

Limit ($\varepsilon - \delta$ definition), continuity and differentiability of a real-valued functions, intermediate value theorem, Darboux theorem, Rolle's Theorem, Lagrange's and Cauchy's mean value theorems and their geometrical interpretation.

Unit II:

Functions of several variables,limit and continuity of functions of two variables, partial differentiation, homogeneous functions, Euler's theorem, Change of variables, Jacobian, Envelope.

Unit III:

Total differentiation, sufficient condition for differentiability, chain rule for one and two independent variables, Maclaurin's theorem, Taylor's theorem with remainder form, maxima and minima of functions of two variables, Lagrange's multiplier method.

Unit IV:

Scalar and vector product of three vectors, vector-valued functions, differentiation and integration of vector-valued functions, scalar and vector point functions, tangent and normal vectors, directional derivative, gradient, divergence and curl and their physical interpretations.

Unit V:

Line integral, double integral, change of order of integration, triple integral, Green's, Gauss's Divergence and Stoke's theorems and their physical interpretations.

Reference Books:

1. H. Anton, I. Bivens and S. Davis, Calculus (7th Edition), John Wiley and sons (Asia), Pvt. Ltd., Singapore, 2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2012.
3. T.M. Apostol, Calculus Vol. 2, John Wiley.
4. L.J. Goldstein, David C. Lay, N.H. Asmer, David I. Schneider, Calculus and its applications, 2014.

Course Code: MATH3004
Course Title: Ordinary Differential Equations

Credits Equivalent:6 (4 Lectures, 2 Practical (in a group of 15-20 students) per week per student).
1 credit is equivalent to 15 hours of Teaching / 30 hours of Practical.

Course Objectives:

This course exhibit the techniques for obtaining solutions to ordinary differential equations and the basic ideas, theory behind those techniques and limitation of the technique. Students should be able to demonstrate and understand real situations as a solution of differential equation. It also covers the basic theory of Laplace Transform which is an important tool to solve ordinary differential equation.

Evaluation Criteria:

Theory

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

Practical

1. Mid Term Examination: 25%
2. End Term Examination: 50%
   a. Written Examination: 40%
   b. Viva-Voce: 10%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Practical File /Presentation: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I

Introduction of differential equations, Formation and general solution of ODE, differential equations of first order and first degree (separation of variables, homogeneous, reducible to homogeneous, linear and reducible to linear forms, exact and reducible to exact forms).

Unit-II

First order higher degree differential equations solvable for x, y, p, various methods of solution, Clairaut's form, singular solutions, envelops, trajectory, orthogonal trajectory, self-orthogonal family of Curves.

Unit-III

Linear differential equations with constant coefficients, complementary function, particular integral, homogeneous linear equations, linear differential equations of second order with variable coefficients,method of undetermined coefficients,Wronskian, method of variation of parameters.

Unit-IV

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients.

Unit-V

Introduction to Laplace transformation, Laplace transform of derivative and integral of functions, Laplace transformation of unit-step function and Dirac-Delta function, differential and integral of Laplace transform, inverse Laplace transform, convolution theorem, solution of initial and boundary value problems using Laplace transform.

References:

1. C.H. Edwards and D. E. Penny, Differential Equations and Boundary Value Problems: Computing and Modelling, Pearson Education, India, 2005.
2. S.L. Ross, Differential Equations, John Wiley and Sons, India, 2004.
3. M.D. Raisinghania, Ordinary and Partial Differential Equation,S.Chand Publishing House.
4. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics,Narosa Publishing House, New Delhi.
5. P.C. Biswal, Ordinary Differential Equations, PHI, New Delhi, 2012.

List of Practical (using Matlab / Mathematica / Maple etc.)

1. Plotting of second order solution family of differential equation
2. Plotting of third order solution family of differential equation
3. Solving first order differential equation numerically(Euler's Method)
4. Solving first order differential equation using separation of variable.
5. Compare of exact solution and numerical solution (Euler' Method) by plotting.
6. Solving system of differential equation.
7. Exact solution of second order differential equation.
8. Application of differential equation(Newton's Law of Cooling).
9. Application of differential equation(RL circuit).
10. Determination of time response of an R-L-C circuit.

Course Code: MATH3005
Course Title: Group Theory I

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching/Tutorials.

Course Objectives:

It contains a basic course in Group Theory, which is an integral part of Abstract Algebra. Group theory has applications in almost all major branches of science. Students should be helped to develop the ability to identify, assess and interpret complex situations with the basic rules of logic including axioms or assumptions and construct solution to an abstract mathematical problem.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
    a. Assignment/ Class Test / Quiz/Presentation/Seminar: 20%
    b. Attendance: 5%

COURSE CONTENTS:

Unit-I:

Types of matrices,elementary transformations, rank of a matrix, Echelon form, solutions of system of linear equations.

Unit-II:

Sets and functions, equivalence relations, partition of sets, binary operation, definition of a group with examplesincluding$\mathrm{GL}(\mathrm{n}, \mathbb{R})$ and $\mathrm{SL}(\mathrm{n}, \mathbb{R})$, basic properties of a group, Abelian group, subgroup, centre of group.

Unit-III:

Cyclic group, order of a group, order of an element of a group, Permutation group, Symmetric groupS_n, Alternating group A_n, Dihedral groupD_n.

Unit-IV:

Cosets,Normal subgroup,Quotient group, Lagrange's theorem, group homomorphism and group isomorphism, Kernel of a group homomorphism.

Unit-V:

Cayley's theorem, fundamental theorem of group homomorphism, isomorphism theorems.

Reference Books:

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd. New Delhi, 1975.
2. J.A. Gallian, Contemporary Abstract Algebra, Narosa Publishing House, New Delhi, 1999.
3. David C. Lay, Linear Algebra and its Applications, Pearson Education, 2007.
4. D.S. Dummit, R.M. Foote, Abstract Algebra, Wiley, 2014.
5. V.K. Khanna and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House, 2014.
6. J.B. Frailegh, A First Course in Abstract Algebra, Narosa Publishing House.

Course Code: MATH3006
Course Title: Real Analysis II

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching/Tutorials.

Course Objectives:

This course is in continuation of Real Analysis I. The objective of this course is to develop an understanding about the fundamentals of mathematical analysis like Riemann integral, improper integral and convergence of sequence and series of functions.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
    a. Assignment/ Class Test / Quiz/Presentation/Seminar: 20%
    b. Attendance: 5%

COURSE CONTENTS:

Unit I

Functions of bounded variation, total variation, additive property of total variation, functions of bounded variation expressed as the difference of increasing functions, rectifiable curves.

Unit II

Uniform continuity, some theorems and examples, non-uniform continuity criteria, Improper integrals, Beta and Gamma functions.

Unit III

Riemann integral, additive and linearity properties of upper and lower integrals, Darboux theorem, Riemann integration of monotone, continuous and discontinuous functions, fundamental theorem of integral calculus, intermediate value theorem for integrals.

Unit IV

Pointwise and uniform convergence of sequence and series of functions, Cauchy criteria for uniform convergence, Weierstrass M-test.

Unit V

Theorems on continuity, differentiability and integrabilityfor uniform convergence, Dirichlet's test, Abel's test, power series, exponential and logarithmic functions.

References:

1. R. G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons (2003).
2. K. A. Ross, Elementary Analysis: The Theory of Calculus, Springer (2004).
3. E. Marsden, A. J. Tromba and A. Weinstein, Basic multivariable calculus, Springer (SIE), Indian reprint, 2005.
4. S. C. Malik, SavitaArora, Mathematical analysis, New Age International, 2010.
5. T.M. Apostol, Calculus, Vol. 1, John Wiley.

Course Code: MATH3007
Course Title: Numerical Analysis

Credits Equivalent:6 (4 Lectures, 2 Practical (in a group of 15-20 students) per week per student).
1 credit is equivalent to 15 hours of Teaching / 30 hours of Practical.

Course Objectives:
The objective of this course is to provide a basic understanding of numerical methods to solve polynomial equation, non-linear equation, IVP, numerical differentiation and integration and to improvestudent'sskill in numerical methods by using mathematical software.

Evaluation Criteria:
Theory
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
    a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
    b. Attendance: 5%

Practical
1. Mid Term Examination: 25%
2. End Term Examination: 50%
    a. Written Examination: 40%
    b. Viva-Voce: 10%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
    a. Practical File /Presentation: 20%
    b. Attendance: 5%

COURSE CONTENTS:
Unit-I
Solutions of algebraic and transcendental equations, bisection method, Secant method, Newton-Raphsonmethod, Picard's iteration method and their rate of convergence.
Unit-II
Linear system of equations:Consistency of Linear System of equations, Solutions of Linear Systems by direct methods as LU and Choleskidecomposition, Gauss elimination, Gauss-Jordon and iterative methods as Gauss-Jacobi, Gauss-Siedel method and their convergence.
Unit-III
Finite differences, central differences, interpolating polynomials using finite differences, Newton-Gregory forward and backward difference interpolation,Lagrange's and Hermite interpolation.
Unit-IV
Numerical differentiation, method of differentiation based on interpolation, methods based on finite difference operators. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpsons's 3/8 rule, Newton Cotes quadrature formula,
Unit-V
Numerical solution of Ordinary Differential Equations: Euler method, Picards method, Runge-Kutta method of order two and four.

References:

1. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 2016.
3. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
4. G. Shankar Rao, Numerical Analysis, New Age International, 2013.

List of Practical (using Matlab / Mathematica / Maple etc.)

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Bisection Method.
(v) Newton-Raphson Method.
(vi) Secant Method.
(vii) LU decomposition Method.
(viii) Gauss-Jacobi Method.
(ix) Gauss-Siedel Method.
(x) Lagrange Interpolation
(xi) Newton Interpolation
(xii) Trapezoidal Method
(xiii) Simpson's rule
(xiv) Euler's Method

Course Code: MATH3009
Course Title: Partial Differential Equations

Credits Equivalent:6 (4 Lectures, 2 Practical (in a group of 15-20 students) per week per student).
1 credit is equivalent to 15 hours of Teaching / 30 hours of Practical.

Course Objectives:
The objective of this course is to provide techniques for obtaining solutions of PDE and the basic ideas, theoryand limitations of those techniques. Also, students should be able to demonstrate and understand real problems such as: Laplace, heat and wave equations.

Evaluation Criteria:
Theory
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

Practical

1. Mid Term Examination: 25%
2. End Term Examination: 50%
   a. Written Examination: 40%
   b. Viva-Voce: 10%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Practical File /Presentation: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit: I

Partial Differential Equations (PDE)- Basic concepts and Definitions. Solutions of PDE, first order PDE: Classification, Construction and Geometrical Interpretation,Lagrange's method, Canonical formof first order linear PDE and solutions by method of separation of variables.

Unit: II

Non-linear PDE of order one, Singular solution, Charpit's method, Jacobi's method, Cauchy's method of characteristics for solving non-linear PDE.

Unit: III

Solutions of homogeneous and non-homogeneous linear PDE with constant and variable coefficients.

Unit: IV

Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear PDE as hyperbolic, parabolic or elliptic, Reduction of second order linear PDE to canonical forms, Cauchy problem.

Unit- V

Cauchy problem of an infinite string. Initial-Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions, non-homogeneous Wave Equation,method of separation of variables: Wave, Heat and Laplace equations.

Recommended Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Son Inc., NewYork, 1999.
2. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill Book, Company 1988.
3. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
4. S.B. Rao and H.R. Anuradha, Differential Equations, University Press, 1996.
5. W.T.H. Piaggio, Elementary Treatise on Differential Equations and Their Applications, CBS Publishers New Delhi,1985.
6. K. SankaraRao, Introduction to Partial Differential Equations, PHI Learning.

Suggested Readings:

1. Ioannis P Stavroulakis and Stepan A Tersian, Partial Differential Equations: An Introduction with Mathematica and MAPLE, World Scientific, Second Edition, 2004.
2. M.D. Raisinghania, Advanced Differential Equations, S. Chand., India.
3. K.S. Bhamra, Partial Differential Equations An Introductory Treatment with Applications,PHI Learning, 2010.

List of Practical (using Matlab / Mathematica / Maple etc.)

(i) Solution of Cauchy problem for first order PDE.

(ii) Finding the characteristics for the first order PDE.

(iii) Plot the integral surfaces of a given first order PDE with initial data.

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

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

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

(c) $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u_x(0,t) = 0,\ x \in (0,\infty), t > 0$

(d) $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, u(1,t) = 0, 0 < x < l, t > 0$

(v) Solution of heat equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:

(a) $u(x,0) = \phi(x), u(0,t) = a, u(1,t) = 0, x \in (0,l), t > 0.$

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

(c) $u(x,0) = \phi(x), u(0,t) = a, x \in (0,\infty), t \geq 0.$

Course Code: MATH3010
Course Title: Ring Theory

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:

This course is in continuation of MATH3005 which was an introduction to group theory. It covers the basics of Ring Theory, the characteristic of a field, factorisation and ideal theory in polynomial ring.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring.

Unit-II

Ideals, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Unit-III

Ring homomorphism and isomorphism, properties of ring homomorphisms, isomorphism theorems, field of quotients and embedding theorems.

Unit-IV

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion,

Unit-V

Unique factorization in Z[x].Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

References:

1. Joseph A. Gallian,Contemporary Abstract Algebra, Narosa Publishing House.
2. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited.
3. Bhattacharya, Jain and Nagpaul, Basic Abstract Algebra, Cambridge University Press.
4. D.S. Dummit, R.M. Foote, Abstract Algebra, Wiley.
5. V.K.Khanna and S.K.Bhambri,A Course in Abstract Algebra, Vikas Publishing House, 2014.

Course Code: MATH3011
Course Title: Discrete Mathematics

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:

The objective of this course is to provide the students basic concepts of Discrete Mathematics and Graph Theory.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit: I

Basic concept of sets, definition, examples and basic properties of ordered sets, partially and totally ordered sets, maps between ordered sets, duality principle.

Unit: II

Logic, truth table, negation, conjunction and disjunction, Implications, Bi-conditional propositions, converse, contra positive and inverse propositions and precedence of Logical operators, Propositional equivalence, Logical equivalences, Predicates and quantifiers, Binding variables and Negations.

Unit: III

Lattices, lattices as algebraic structures, sub-lattices, products and homomorphisms, definition, examples and properties of modular and distributive lattices, complemented and complete lattices.

Unit: IV

Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McClukey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Unit: V

Definition, examples and basic properties of graphs, pseudographs, complete graphs, bipartite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Recommended Books:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. B A. Davey and H. A. Priestley, Introduction to Lattices and order, Cambridge University press, Cambridge, 1990.
3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, Pearson Education (Singapore) Pvt. Ltd. Indian Reprint 2003.
4. Kenneth H. Rosen, Discrete Mathematics and its Applications, McGraw Hill International, 2012.
5. C.L. Liu, Elements of Discrete Mathematics, McGraw HillInternational Edition, 1986.
6. RudolfLidland GunterPilz, AppliedAbstractAlgebra, Undergraduate Textin Mathematics, Springer, Indian reprint, 2004.

SKILL ENHANCEMENT COURSES (SEC)

Course Code: MATH3008
Course Title: MATLAB

Credits Equivalent:2(1 credit is equivalent to 15 hours of Teaching / Tutorials).

Course Objectives:

The objective of this course is to develop skill of students to solve geometric, computational and symbolic problems for different concepts in mathematics and to use technology appropriately to analysemathematical problems.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I

Introduction, Help Feature, MATLAB Windows, , Types of Files, input and output, arithmetic, algebraic or symbolic computation, Some Useful MATLAB Commands.

Unit-II

Scalars and Vectors, Entering data Matrices, Line Continuation, Matrix Subscripts/Indices, arithmetic operation between matrices, Generation of special matrices, solving linear system of equation.

Unit-III

Introductions, Entering polynomial, Polynomial evaluation, Roots of a polynomial, Polynomial addition and subtraction, polynomial multiplication, polynomial division,

Unit-IV

Formulation of polynomial equation, characteristic polynomial of a matrix, polynomial differentiation, polynomial integration,

Unit-V

Introduction, Two-Dimensional Plots, Three-Dimensional Plots, figure windows, Sub plots, change of plot style.

References:

1. Essential MATLAB® for Engineers and Scientists, Third edition,Brian D. Hahn and Daniel T. Valentine, Published by Elsevier Ltd, 2007.
2. MATLAB® for Engineers, Third Edition, Holly Moore, Pearson, 2012.
3. A Guide to MATLAB® for Beginners and Experienced Users, Second Edition, Brian R. Hunt Ronald L. Lipsman Jonathan M. Rosenberg With Kevin R. Coombes, John E. Osborn Garrett J. Stuck, Cambridge University Press, 2006.

Course Code: MATH3012
Course Title: LaTeX

Credits Equivalent:2(1 credit is equivalent to 15 hours of Teaching / Tutorials).

Course Objectives:

The objective of this course is to develop skill of students to have a working knowledge of the LaTeX typesetting language.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I:

Introduction, DVI & PS files, environments, preamble, class file, TeXnic centre.

Unit-II:

Alignments, array, pictures, figures and tables, Commands: Mathematical commands.

Unit-III:

Special characters and symbols,Packages.

Unit-IV:

Page style and page numbering, creating a simple document.

Unit-V:
Creating Chapters, Sections, Bibliography etc., some common errors.

References:

1. A guide to LATEX 2ε: document preparation for beginners and advanced users, Helmut Kopka and Patrick W. Daly, Addison-Wesley (1995).
2. The LATEX companion, Michel Goossens, Frank Mittelbach and Alexander Samarin, Addison-Wesley (1994).

Suggested Readings:

1. The TEX Archive. http://www.tex.ac.uk/

GENERIC ELECTIVES (GE) (FOR OTHER DEPARTMENTS)

Course Code: MATH3201
Course Title: Calculus

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:

This course is designed to develop an understanding about the mathematical approach to human inquiry and skill for analysing functions of two and three variables and to understand the basics of vector calculus to appreciate the interplay between the physics and the calculus that was developed to solve physical problems.

Evaluation Criteria:
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:
Unit I:
Limit, continuity and differentiability of a real-valued functions,Rolle's theorem, Lagrange Mean-value theorem and their geometrical interpretations, indeterminate forms, L' Hospital rule,intervals, monotonic functions, concavity, convexity, point of inflection, theory of maxima and minima for one variable.
Unit II:
Partial differentiation,homogeneous functions, Euler's theorem,Taylor's theorem with remainder form, theory of maxima and minima for two variable, change of variables, Jacobian.
Unit III:
Scalar and vector product of three vectors, vector-valued functions, differentiation and integration of vector-valued functions, scalar and vector point functions.

Unit IV:

Tangent and normal vectors, directional derivative, gradient, divergence, curl andtheir geometrical interpretations.

Unit V:

Line integral, double and triple integral, change of order of integration, Green's, Gauss Divergence and Stoke's theorems (without proof) and their physical interpretations.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2012.
2. M.J. Strauss, G.L. Bradley and K.J. Smith, Calculus, Pearson Education, 2007.
3. T.M. Apostol, Calculus, Vol. 2, John Wiley.

Suggested Readings:

5. Shanti Narayan, Differential Calculus, S. Chand & Company, New Delhi.
6. Shanti Narayan, Integral Calculus, S. Chand & Company, New Delhi.
7. L.J. Goldstein, David C. Lay, N.H. Asmer, David I. Schneider, Calculus and its Applications, Pearson, 2014.
8. Gorakh Prasad, Differential Calculus, PothishalaPvt. Ltd. Allahabad, 2000.
9. Gorakh Prasad, Integral Calculus, PothishalaPvt. Ltd. Allahabad, 2000.

Course Code: MATH3202
Course Title: Algebra

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:

It contains a basic course in Group Theory and Linear Algebra. Group theory has applications in almost all major branches of science. Students should be helped to develop the ability to identify, assess and interpret complex situations with the basic rules of logic including axioms or assumptions and construct solution to an abstract mathematical problem.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive ContinuousInternal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I:

Types of matrices, elementary transformations, rank of a matrix, Echelon form, solutions of system of linear equations, sets and functions, equivalence relations, binary operation, definition of a group with

examples including $\mathrm{GL}(n, \mathbb{R})$ and $\mathrm{SL}(n, \mathbb{R})$, basic properties of a group, Abelian group, subgroup, cyclic group, order of a group, order of an element of a group.

Unit-II:

Permutation group, Symmetric group S_n, Alternating group A_n, Dihedral group D_n, cosets, index of a subgroup, Lagrange's theorem, Normal subgroup, Quotient group, group homomorphism and group isomorphism, kernel of a group homomorphism, fundamental theorem of group homomorphism, Cayley's theorem (statement only).

Unit-III:

Ring, subring, integral domains and fields, ideals, ring homomorphism and isomorphism.

Unit-IV:

Vector spaces, subspaces, linear combination, linear span, linear dependence and linear independence of vectors, basis and dimension, linear transformations and their representation as matrices, kernel and image of a linear transformation, rank-nullity theorem.

Unit-V:

Eigen values and eigen vectors of a square matrix, Cayley-Hamilton theorem and its application, inner product spaces, Cauchy-Schwarz inequality, orthogonal vectors, orthonormal sets and bases, Gram-Schmidt orthogonalization process.

Recommended Readings:

1. Joseph A. Gallian, Contemporary Abstract Algebra,Narosa Publishing House.
2. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited.
3. Bhattacharya, Jain and Nagpaul, Basic Abstract Algebra, Cambridge University Press.
4. D.S. Dummit, R.M. Foote, Abstract Algebra, Wiley.
5. V.K. Khanna and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House.
6. Surjith Singh, Linear Algebra, Vikas Publishing House.
7. Seymour Lipschutz, Theory and Problems of Linear Algebra, Schaum's Outline Series.

Course Code: MATH3203
Course Title: Differential Equations

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course objectives:

This course exhibits the techniques for obtaining solutions to ODE and PDE and the basic ideas, theory and limitation of those techniques. Students should be able todemonstrate and understand real situations as a solution of differential equations.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit-I

Introduction of differential equations, Formation and general solution of ODE, differential equations of first order and first degree (separation of variables, homogeneous, reducible to homogeneous, linear and reducible to linear forms, exact and reducible to exact forms).

Unit-II

First order higher degree differential equations solvable for x, y, p, various methods of solution, Clairaut's form, Singular solution,envelops, trajectory, orthogonal trajectory, self-orthogonal family of Curves.

Unit-III

Linear differential equations with constant coefficients, complementary function, particular integral, homogeneous linear equations, linear differential equations of second order with variable coefficients, Wronskian, method of variation of parameters, method of undetermined coefficients.

Unit-IV

Order and degree of partial differential equation (PDE), Formation and solutions of PDE, Classification and geometrical interpretation of first order PDE,Lagrange's method, Non-linear PDE of order one, Charpit's method, Jacobi's method.

Unit-V

Wave equation,Cauchy problem of an infinite string. Initial-Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions, non-homogeneous Wave Equation,method of separation of variables.

Recommended Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Son Inc., NewYork, 1999.
2. Ian N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill Book, Company 1988.
3. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006
4. S.B. Rao and H.R. Anuradha, Differential Equations, University Press, 1996.
5. W.T.H. Piaggio, Elementary Treatise on Differential Equations and Their Applications,CBS Publishers, New Delhi,1985.
6. M.D. Raisinghania, Advanced Differential Equations, S. Chand., India.

Course Code: MATH3204
Course Title: Elements of Analysis

Credits Equivalent: 6 (5 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:

This course presents a rigorous treatment of fundamental concepts in analysis. The course objective is to understand the axiomatic foundation of the real number system and its completeness property. It introduces students to the fundamentals of mathematical analysis and notion of sequence and series and their nature.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

Unit I

Finite and infinite sets, illustration of countable and uncountable sets with examples, the Real line: absolute value, bounded sets, suprema and infima, statement of order completeness property of R, Archimedean property of R, intervals.

Unit II

Real sequences, Convergence, sum and product of convergent sequences, proof of convergence of some simple sequences such as $(-1)^n/n,\ 1/n^2,\ (1+1/n)^n, x^n$with $|x|<1, a_n\ /n$, where $\{a_n\}$ is a bounded sequence, divergent and oscillatory sequences, limit point and isolated point, derived set.

Unit III

Bolzano-Weierstrass theorem (without proof),statement and illustration of Cauchy convergence criteria for sequences, Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence.

Unit IV

Definition and a necessary condition for convergence of an infinite series, Cauchy convergence criteria for series, series of positive terms, geometric series, comparison test, limit comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test, definition and examples of absolute and conditional convergence.

Unit V

Definition of power series: radius of convergence, Cauchy-Hadamard theorem, statement and illustration of term-by-term differentiation and integration of power series, power series expansions for $\exp(x)$, $\sin(x),\ \cos(x), \log(1+x)$ and their properties.

References:

1. R.G. Bartle and D.R. Sherbert: Introduction to Real Analysis, John Wiley and Sons (Asia) Pvt. Ltd., 2000.
2. S. C. Malik and SavitaArora, Mathematical analysis, New Age International, 1992.
3. S.R. Ghorpade, B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.
4. V. Karunakaran, Real Analysis, Pearson, 2012.
5. S.K. Mapa, Introduction to Real Analysis, Sarat Book Distributors, 2016.

Course Code: MATH3301
Course Title: Engineering Mathematics I

Credits Equivalent:4 (3 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:
This course is designed to develop the topics of differential and integral calculus. It also covers topics from Matrices and Vector Calculus which are helpful in solving some physical problems.

Evaluation Criteria:
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:
Unit - I: Differential Calculus – I
Successive Differentiation, Leibnitz's theorem, Partial derivatives, Euler's theorem for homogeneous functions,Total derivatives, Change of variables, Curve tracing: Cartesian and Polar coordinates.
Unit - II: Differential Calculus - II
Taylor's and Maclaurin's Theorem, Expansion of function of several variables, Jacobian,Approximation of errors, Extrema of function of two variables, Lagrange's method of
multipliers (Simple applications).
Unit - III: Matrix Algebra
Types of Matrices, Inverse of a matrix by elementary transformations, Rank of a matrix, Linear dependence, Consistency of linear system of equations andtheir solution, Characteristic equation, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization, a brief introduction to Vector Spaces, Subspaces, Linear transformations, Rank & Nullity of a linear transformation.
Unit -IV: Multiple Integrals
Double and triple integrals, Change of order of integration, Change of variables, Application ofintegration:Arc length, Surface area and Volume – Cartesian and Polar coordinates. Beta and Gamma functions, Dirichlet's integral and its applications.
Unit - V: Vector Calculus
Scalar and vector point functions, Gradient, Divergence and Curl and their physical interpretations, Vector identities, Tangent and Normal, Directional derivatives, Line, Surface and Volume integrals, Applications of Green's, Stoke's and Gauss's divergence theorems (without proof).

Reference Books:
1. E. Kreyszig, Advanced Engineering Mathematics, John-Wiley & Sons
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw- Hill Publishing Company Ltd.

3. R.K. Jain & S.R.K. Iyenger, Advance Engineering Mathematics, Narosa Publishing House.

Suggested Readings:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
2. Peter V. O' Neil, Advanced Engineering Mathematics, Thomas (Cengage) Learning.
3. Thomas & Finley, Calculus, Narosa Publishing House.
4. Rukmangadachari, Engineering Mathematics – I, Pearson Education.
5. A.C.Srivastava& P.K.Srivastava, Engineering Mathematics, Vol.I, PHI Learning Pvt. Limited,New Delhi.

Course Code: MATH3302
Course Title: EngineeringMathematics II

Credits Equivalent:4 (3 Lectures, 1 Tutorial per week per student).

1 credit is equivalent to 15 hours of Teaching / Tutorials.

Course Objectives:

Objective of this course is to exhibit the techniques for obtaining solutions of differential equations and the basic ideas, theory behind those techniques and limitation of the technique. Students should be able to demonstrate and understand real situations as a solution of differential equation. It also covers the basic theory of Laplace Transform which is an important tool to solve ordinary differential equation.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Comprehensive Continuous Internal Assessment (CCIA): 25%
   a. Assignment/Class Test / Quiz/Presentation/Seminar: 20%
   b. Attendance: 5%

COURSE CONTENTS:

UNIT - I: Ordinary Differential Equations

Introduction of differential equations, Linear differential equations of nth order with constant coefficients, Complementary function and Particular integral, Simultaneous linear differential equations, Solution of second order differential equations by changing dependent & independent variables, Method of variation of parameters, Applications to Engineering problems (without derivation).

UNIT - II: Series Solution and Special Functions

Ordinary and Singular points, Series solution of second order ordinary differential equations with variable coefficient (Frobenius method), Legendre and Bessel equations and their series solutions, Some Properties of Bessel function and Legendre polynomials.

UNIT - III: Laplace Transform

Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac-delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve differential equations.

UNIT - IV: Fourier Series and Partial Differential Equations

Periodic functions, Dirichlet's Conditions, Fourier series of arbitrary periods, Euler's Formulae, Even and odd functions, Half range sine and cosine series, Solution of first order Lagrange's linear partial differential equations, Second order linear partial differential equations with constant coefficients.

UNIT - V: Applications of Partial Differential Equations

Classification of second order partial differential equations, Method of separation of variables for solving partial differential equations, Solution of one and two dimensional wave and heat conduction equations, Laplace equation in two dimensions.

Reference Books:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw- Hill Publishing Company Ltd.
3. R.K. Jain& S.R.K. Iyenger, Advance Engineering Mathematics, Narosa PublishingHouse.

Suggested Readings:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
2. Peter V. O' Neil, Advanced Engineering Mathematics, Thomas (Cengage) Learning.
3. Chandrika Prasad, Advanced Mathematics for Engineers, Prasad Mudranalaya
4. A. C. Srivastava& P. K. Srivastava, Engineering Mathematics, Vol. – II, PHI LearningPvt. Ltd.
5. Rukmangadachari, Engineering Mathematics – II, Pearson Education.