School of Basic Science

Scheme of Studies and Syllabus

CHOICE BASED CREDIT SYSTEM

B. Sc. (Hons.) MATHEMATICS

2017-18

Semester – I				
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**
1	BMA-117	Algebra	5-1-0	6
2	BMA-111	Calculus	5-1-0	6
3	BEN-101	English Communication (AECC-1)	2-0-0	2
4	BMA-116	Object Oriented Programming in C++(GE-1)	4-0-0	4
5	BMA-166	Object Oriented Programming in C++(Lab)	0-0-2	2
6	PD-191A	Hobby club	0-0-2	2
		Total		**22**

Semester – II				
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**
1	BMA-114	Real Analysis	5-1-0	6
2	BMA-113	Ordinary Differential Equations	5-1-0	6
3	BMA-115	Econometrics& Statistics (GE-2)	5-1-0	6
4	CEA-101A	Environmental Science (AECC-2)	3-1-0	2
5	PD-192A	Hobby Club	0-0-2	2
		Total		**22**

Semester – III				
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**
1	BMA-220	Group Theory-I	5-1-0	6
2	BMA-221	Theory of Real function	5-1-0	6
3	BMA-222	PDE and systems of ODE	5-1-0	6
4	BMA-223	Logic and sets(SEC-1)	4-0-0	4
5	BMA-224	Information Security (GE-3)	5-1-0	6
		Total		**28**

Semester – IV				
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**
1	BMA-229	Numerical Methods	4-0-0	4
2	BMA-279	Numerical Methods Lab	0-0-2	2
3	BMA-225	Riemann Integration and series of functions	5-1-0	6
4	BMA-226	Ring Theory and Linear Algebra-I	5-1-0	6
5	BMA-227	Graph Theory (SEC-2)	4-0-0	4
6	BMA-228	Application of Algebra (GE-4)	5-1-0	6
7	PD-293	PDP/Interpersonal Skills	2-0-0	2
		Total		**30**

Semester – V				
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**
1	BMA-325	Multi Variate Calculus	5-1-0	6
2	BMA-326	Group Theory II	5-1-0	6
3	BMA-327	Analytical Geometry (DSE-1)	5-1-0	6
4	BMA-328	Probability Theory(DSE 2)	5-1-0	6
5	PD-392	PDP/Interpersonal Skills	2-0-0	2
		Total		**26**

Semester – VI				
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**
1	BMA-329	Metric space and Complex analysis	5-1-0	6
2	BMA-330	Ring Theory and Linear algebra II	5-1-0	6
3	BMA-331	Linear Programming (DSE 3)	5-1-0	6
4	BMA-332	Mechanics (DSE 4)	5-1-0	6
5	BMA-333	Minor project/seminar	4-0-0	4
		Total		**28**

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**Total**
Load	**22**	**22**	**28**	**30**	**26**	**28**	**156**

SYLLABUS

Semester I

Code	Name	Credit(6)
BMA-111	Calculus	5-1-0

Course Objectives:
1. Understand the major problems of differential and integral calculus. 2. Appreciate how calculus allows us to solve important practical problems in an optimal way.

Unit-I Limit & Continuity: The real line and its geometrical representation; *e-δ* treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions.

Unit-II: Differentiability: Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms.

Unit-III: Applications of Differentiation Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementry curves, tangent and normal in parametric form; Polar Coordinates.

Unit-IV: Partial Differentiation: Limits and continuity of functions of two variables; Partial derivatives; Taylor's theorem and Maclaurin's Theorem for function of two variable; Maxima and minima for function of two variable.

Unit-V: Double and triple integrals; Change of order in double integrals. Application of Integration: length of a curve; Arc length as a parameter; Evoute & Envelope; Volumes and surface areas of solids of revolution.

Reference Books:

1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
2. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
3. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.
4. Shanti Narayan, Elements of Real Analysis, S. Chand & Company, New Delhi.
5Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
6. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
7. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
8. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd.,Singapore, 2002.

Course outcomes:
1. Interpret a function from an algebraic, numerical, graphical and verbal perspective and extract information relevant to the phenomenon modeled by the function. 2. Calculate the limit of a function at a point numerically and algebraically using appropriate techniques including L'Hospital's rule.

Code	Name	Credit(6)
BMA-117	**Algebra**	**5-1-0**

Course Objectives:
1) Students should be helped to make connections and build relationships between algebra and arithmetic, geometry, and probability and statistics. 2) The course will enhance research, inquiry and analytical thinking abilities of students.

Unit-I: Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Unit-II: Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit-III: Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Unit -IV: Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.

Unit V: Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix, special matrices.

Books Recommended

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**
3. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

Course outcomes:
1. Students will learn to transform between bases, including the creation, geometric connections, and the application of orthogonal and orthonormal bases. 2. Students will learn Fundamental Theorem of Arithmetic

Code	Name	Credit(4)
BMA-116	OBJECT ORIENTED PROGRAMMING IN C++	**4-0-0**

Course Objective:

To develop programming skills of students, using object oriented programming concepts, learn the concept of class and object using C++ and develop classes for simple applications.

Unit-I: OOP Paradigm: Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++,Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers. Enumeration, Arrays and Pointer.

Unit-II: Implementing oops concepts in C++ Objects, Classes, Functions, Passing Data to Functions, Scope and Visibility of variables in Functions, Structures in C++, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables with Functions.

Unit-III: Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers – private, Public and protected.

Unit-IV: Implementing Class Functions within Class declaration or outside the Class declaration. Instantiation of objects, Scope resolution operator, Working with Friend Functions, Using Static Class members.

Unit-V: Understanding Compile Time Polymorphism function overloading
Rules of Operator Overloading (Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators, Overloading Output/Input,Prefix/ Postfix Increment and decrement Operators, Overloading comparison operators, Assignment, subscript and function call Operator , concepts of namespaces.
Practical to be performed in lab.

Books Recommended

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, M*astering C++*, TMH, 1997.
2. S. B. Lippman and J. Lajoie, *C++ Primer,* 3rd Ed., Addison Wesley, 2000.
3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall.
4. D. Parasons, *Object Oriented Programming with C++*, BPB Publication.

Course outcome:
Program using objects and data abstraction, class, and methods in function abstraction. Analyze, write, debug, and test basic C++ codes using the approaches introduced in the course. Analyze problems and implement simple C++ applications using an object-oriented software engineering approach.

Code	**Name**	**Credit(4)**
BMA-166	OBJECT ORIENTED PROGRAMMING IN C++ Lab	**4-0-0**

Course Objective:
Introduces object-oriented programming concepts using the C++ language, Introduces the principles of data abstraction, inheritance and polymorphism, Introduces exception handling

1. Write a C++ Program to display Names, Roll No., and grades of 3 students who have appeared in the examination. Declare the class of name, Roll No. and grade. Create an array of class objects. Read and display the contents of the array.

2. Write a C++ program to declare Struct. Initialize and display contents of member variables.

3. Write a C++ program to declare a class. Declare pointer to class. Initialize and display the contents of the class member.
4. Write a program to find the largest, smallest & second largest of three numbers. (use inline function MAX and MIN to find largest & smallest of 2 numbers).
5. Write a program to calculate the volume of different geometric shapes like cube, cylinder and sphere and hence implement the concept of Function Overloading.
6. Write a C++ program to allocate memory using new operator.
7. . Write a C++ program to create an array of pointers. Invoke functions using array objects.
8. Write a C++ program to use pointer for both base and derived classes and call the member function. Use Virtual keyword.
9. Write a C++ program Program to test arithmetic operators.
10. Write a C++ program Print the month name using switch statement.
11. Write a C++ program To check whether a given number is palindrome or not.

Reference Books:

1. The C++ Programming Language, 3rd Edition, B. Stroutstrup, Pearson Education. C++ Programming Lab Manual / II-I SEM / 2019-20 Page 9
2. OOP in C++, 3rd Edition, T. Gaddis, J. Walters and G. Muganda, Wiley Dream Tech Press.
3. Object Oriented Programming in C++, 3rd Edition, R. Lafore, Galigotia Publications Pvt Ltd.

Course outcome:
Ability to develop applications for a range of problems using object-oriented programming techniques

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Semester II

Code	Name	Credit (6)
BMA-113	**Ordinary Differential Equations**	**5-1-0**

Course Objectives:
1) Identify essential characteristics of ordinary differential equations.
2) Develop essential methods of obtaining closed form solutions.

Unit-I: Geometrical meaning of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for x,y,p Lagrange's equations, Clairaut's equations.

Unit-II: Orthogonal trajectories: in Cartesian coordinates and polar coordinates. Self orthogonal family of curves.. Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous .

Unit-III: Method of variations of parameters. Method of undetermined coefficients. Reduction of order of a differential equation. Linear differential equations of second order: Reduction to normal form.

Unit-IV: Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations.

Unit-V: Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators x (d/dx) or t (d/dt) etc. Simultaneous equation of the form dx/P = dy/Q = dz/R. Total differential equations. Condition for Pdx + Qdy +Rdz = 0 to be exact. General method of solving Pdx + Qdy + Rdz = 0 by taking one variable constant. Method of auxiliary equations. The existence and uniqueness of solutions. The method of successive approximations, Picards theorem, Systems, The second order linear equations.

Reference Books:

1. B.Rai & D.P. Chaudhary : Ordinary Differential Equations; Narosa, Publishing House Pvt. Ltd.
2. D.A. Murray : Introductory Course in Differential Equations. Orient Longaman (India)

Course outcomes:
1. Distinguish between initial value problems and boundary value problems. 2. Solve standard constant coefficient nonhomogeneous ordinary differential equations by the methods of undetermined coefficients.

Code	Name	Credit (6)
BMA-114	**Real Analysis**	5-1-0

Course Objectives:
1. To describe fundamental properties of the real numbers that lead to the formal development of real analysis. 2. To comprehend rigorous arguments developing the theory underpinning real analysis

Unit-I Algebraic and Order Properties of R, d-neighborhood of a point in R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals.

Unit-II- Limit points of a set, Isolated points,Derived sets, Examples of derived sets, Bolzano-Weierstrass theorem, Illustrations of Bolzano-Weierstrass theorem for sets. Idea of countable sets, uncountable sets and uncountability of R .Weierstrass Approximation Theorem, Generalised Stone-Weierstrass Theorem, Baire Category Theorem and its Applications, Contraction Mapping.

Unit-III- Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria.

Unit-IV- Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Unit-V – Infinite series, convergence and divergence of infinite series, Cauchy Criterion,Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Books Recommended

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), 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, Second Edition, 2010.

Course outcomes:

1. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
2. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration

Code	Name	Credit (6)
BMA-115	ECONOMETRICS& STATISTICS	5-1-0

Course Objectives:

1. To understanding the tools of econometrics and applying them in practice.
2. To provide you with the skills helpful in filling the gap between being "a student of economics" and being "a practicing economist.

Unit-I: Basic Statistics: Statistical Concepts, Partition Values, Quartiles, deciles, percentiles, Measures of variation, Range, IQR, quartile deviation.

Unit-II: Correlation Analysis: Correlation coefficient, Assumption of Correlation analysis coefficient of determination and correlation, Measurement of correlation, Karl person's method, spearman's rank correlation, Concurrent deviation of the correlation coefficient.

Unit-III: Distribution & Estimation of parameter: Random variable, Normal distribution; chi-square, t and F-distributions; estimation of parameters; properties of estimators.

Unit-IV: Hypothesis Testing: Testing of hypotheses: defining statistical hypotheses; distributions of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples.

Unit V: Regression Analysis: Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting, Multiple Linear Regression Model Estimation of parameters.

Bo**oks Recommended**

1. Jay L. Devore, *Probability and Statistics for Engineers*, Cengage Learning, 2010.
2. John E. Freund, *Mathematical Statistics*, Prentice Hall, 1992.
3. Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and its Applications,* Prentice Hall, 2011.
4. D. N. Gujarati and D.C. Porter, *Essentials of Econometrics*, McGraw Hill, 4th Ed., International Edition, 2009.

Course outcomes:

1. Able to critique reported regression results in applied academic papers and interpret the results for someone who is not trained as an economist.
2. Able to use a statistics to estimate an econometric model

Semester III

Code	Name	Credit (6)
BMA-220	**Group Theory I**	**5-1-0**

Course Objectives:
1) Students will be able to understand the concept of group theory. 2) Understand the properties of homomorphism and isomorphism.

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

Unit-II: Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.

Unit-III: Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit-IV: External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit-V: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra,* 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, *An Introduction to the Theory of Groups,* 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

Course outcomes:
1. Explain the concept of group homomorphism and the application of these concepts 2. Be able to produce examples and counter examples illustrating the mathematical concepts presented in the course.

Code	Name	Credit (6)
BMA-221	**Theory of Real Functions**	**5-1-0**

Course Objectives:
1) Students will be able to describe fundamental properties of continuous functions that lead to the formal development of real analysis. 2) Appreciate how abstract ideas and regions methods in mathematical analysis can be applied to important practical problems.

Unit-I: Limits of functions ($\epsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions.

Unit-II: Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Unit-III: Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem.

Unit-IV: Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities.Cauchy's mean value theorem.

Unit-V: Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1 + x)$, $1/ax+b$ and $(1 +x)^n$

Books Recommended

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.
2. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis,* Springer, 2006.

Course outcomes:

1. Demonstrate an understanding of limits ad how that are used in sequences, series and differentiation.
2. Construct rigorous mathematical proofs of basic results in real analysis.

Code	Name	Credit (6)
BMA-222	**PDE and Systems of ODE**	**5-1-0**

Course Objectives:
1.Introduce students to partial differential equations 2.Introduce students to how to solve linear Partial Differential with different methods

Unit-I: Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations.

Unit-II: Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Derivation of Heat equation, Wave equation and Laplace equation. Solve linear second order PDEs using canonical variables for initial-value problems, Separation of Variables and Fourier series for boundary value problems.

Unit-III: Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

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.

Unit-V: Homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method.

Books Recommended

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers,* 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, *Differential equations,* 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA,* 3rd Ed.,Elsevier Academic Press, 2004.

Course outcomes:

1. Classify partial differential equations and transform into canonical form.
2. Solve linear partial differential equations of both first and second order.

Code	Name	Credit (6)
BMA-224	**INFORMATION SECURITY**	**5-1-0**

Course Objectives:
1. To give basic understanding about system security. **2.** To understand the salient facets of information security basics and the basics of risk management.

Unit-I: Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book.

Unit-II: Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer overflow; system threats- intruders; communication threats- tapping and piracy.

Unit-III: Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

Unit-IV: Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.

Unit-V: Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

Books Recommended

1. W. Stallings, *Cryptography and Network Security Principles and Practices,* 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing ,* 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security,* Springer-Verlag Berlin, 2003.
5. J.M. Kizza, *Computer Network Security*, Springer, 2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices,* PearsonEducation, 2006.

Course Outcomes:
• To appreciate the difficulties that arise when valuable information needs to be shared • To identify the five leading-edge resources that have up-to-date information on information security.

Code	Name	Credit (4)
BMA-223	**Logic and Sets**	4-0-0

Course Objectives:
1.) Students will be able to explain the concepts of sets, relations and functions with a counter example. 2.) To understand the difference between tautology and contradiction

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

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

Unit-III: Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finiteand infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standardset operations. Classes of sets. Power set of a set.

Unit-IV: Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.

Unit-V:Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, nary relations.

Books Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education,1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

Course outcomes:

1. Students can formalise first-order properties with formulas of predicate logic.
2. Students can prove simple first-order properties about sets, relations and functions using calculation style reasoning

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Semester IV

BMA-229	NUMERICAL METHODS	L-T-P	Credits
		4-0 -0	4

Course Objectives:
1) Derive appropriate numerical methods to solve algebraic and transcendental equations 2) Develop appropriate numerical methods to approximate a function

UNIT-1 ERRORS AND APPROXIMATIONS, SOLUTION OF NONLINEAR EQUATIONS : Introduction to numbers and their accuracy; absolute, relative and percentage errors. Bisection method; Regular falsi method; secant method; fixed point iteration method; Newton- Raphson method; convergence criteria of methods.

UNIT-2 SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS : Gauss elimination method; Gauss-Jordan method; UV factorization method; Jacobi's iteration method; Gauss-Seidal iteration method; .

UNIT-3 INTERPOLATION AND CURVE FITTING: Introduction to interpolation; Newton's forward and backward interpolation formulae; Gauss's forward and backward interpolation formulae; Stirling formula; Lagrange interpolation; Newton's divided difference formula; Principle of least squares; curve fitting.

UNIT-4 NUMERICAL DIFFERENTIATION AND INTEGRATION: Numerical differentiation formulae: differentiation by using forward interpolation formula; backward interpolation formula; Stirling formula; Newton-Cotes formula for numerical integration: Trapezoidal rule; Simpson's rules; Boole's rule and Weddle's rule; Romberg' method.

UNIT-5 NUMERICAL SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATION : ,Taylor series method; Euler method; Euler modified method; Runge kutta method; Milne's predictor -corrector method; Adams-Bashforth method for finding solution of differential equation.

BOOKS Recommended:

1) Grewal, B. S., “Numerical methods in Engineering and Science”.

2) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007

3) Sastry, S.S.,” “ Introductory Methods of Numerical Analysis”.

4) Curtis F “Applied Numerical Analysis”.**Books Recommended**

5) Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

Course outcomes:
1. Solve an algebraic or transcendental equation using an appropriate numerical method 2. Approximate a function using an appropriate numerical method

Code	Name	Credits(2)
BMA-279	**Numerical Methods Lab**	0-0-2

List of Practicals (Using any software)

(1) Bisection Method.

(2) Newton Raphson Method.

(3) Secant Method.

(4) Regulai Falsi Method.

(5) LU decomposition Method.

(6) Gauss-Jacobi Method.

(7) Gauss-Siedel Method.

(8) Lagrange Interpolation or Newton Interpolation.

(9) Simpson's rule.

(10) Trapezoidal Rule

Code	Name	Credits(6)
BMA-225	**Riemann Integration and Series of Functions**	5-1-0

Course Objectives:
1) To describe a regular partition of an interval, a Riemann sum for a function on a given interval (including the specific cases of left, right, and mid-point Riemann sums), and how they can be used to approximate area. 2) Compute specific Riemann sums for a function on a given interval.

Unit 1: Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions;

Unit 2: Riemann integrability of monotone and continuous functions, Properties of theRiemann integral; definition and integrability of piecewise continuous and monotone functions.

Unit 3: Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. Improper integrals; Convergence of Beta and Gamma functions.Pointwise and uniform convergence of sequence of functions.

Unit 4: Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions;Theorems on the continuity and derivability of the sum function of a series of functions; Cauchycriterion for uniform convergence and Weierstrass M-Test.

Unit 5: Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Books Recommended

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.

Course outcomes:
1. Read and interpret an expression in sigma notation as the sum of a series of numbers. 2. Express Riemann sums for a function f(x) on a given interval using sigma notation, and identify a function and an interval which give rise to a given Riemann sum in sigma notation.

Code	Name	Credits(6)
BMA-226	**Ring Theory and Linear Algebra I**	5-1-0p

Course Objectives:
1. Students will have the capacity to work with the classes of rings and fields appearing in the course, particularly specific calculations around finite fields and polynomials. 2. Be able to produce examples and counter examples illustrating the mathematical concepts presented in the course**.**

Unit 1:Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring.

Unit 2: Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Unit 3: Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

Unit 4: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Unit 5: Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., PrenticeHall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
7. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
8. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

9. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

Course outcomes:
1. Will be able to write the statements and proofs of important theorems and be able to explain the key steps in proofs, sometimes with variation 2. Facility with the ring homomorphisms and presentations, and the application of these in order to describe aspects of the intrinsic structure of rings ,both abstractly and in specific examples

Code	Name	Credits(4)
BMA-227	**Graph Theory**	4-0-0

Course Objectives:
1) It has a aim to know about different types of graph. 2) To understand Shortest Path.

Unit1: Definition, examples and basic properties of graphs, pseudo graphs, complete graphs Adjacency and incidence matrices,.

Unit 2: Bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits Paths, walks, cycles, components, cut-edges, cut-vertices..

Unit-3: Hamiltonian cycles, the adjacency matrix, weighted graph,.

Unit4: Tree, Spanning trees, radius and diameter, Minimum spanning trees (Kruskal's algorithm) ,travelling salesman's problem,shortest path.

Unit 5: Network flow problems, flows and source/sink cuts, Ford-Fulkerson algorithm, Max-flow min-cut theorem. Vertex colorings, bounds on chromatic numbers, Dijkstra's algorithm,Floyd-Warshall algorithm.

Books Recommended :

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Course outcomes:
1. Students will able to learn applications of matrix in graph. 2. It will help to understand Networking.

Code	Name	Credit (6)
BMA-228	**Application of Algebra**	5-1-0

Course Objectives:
1. To recognize technical terms and appreciate some of the uses of algebra. 2. Multiply out brackets.

Unit 1: Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

Unit 2: Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

Unit 3: Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs.

Unit 4: Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of a positive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization.

Unit 5: Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an m×n matrix, solving a matrix equation using its normal equation, finding functions that approximate data.

Books Recommended:

1. I. N. Herstein and D. J. Winter, Primer on Linear Algebra, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S. K. Jain, Topics in Applied Abstract Algebra, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with Maple, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, Linear Algebra and its Applications. 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

Course Outcomes:
1. To recognize technical terms and appreciate some of the uses of algebra. 2. To collect like terms and simplify expressions term by term.

Semester V

Code	Name	Credit (6)
BMA-325	**Multivariate Calculus**	5-1-0

Course Objectives:
The goal of this chapter is to see that many quantities in various scientific fields depend on more than one variable: the strength of the gravitational force between two bodies depend on their masses and their distance apart. The understand how the value of a multivariable function changes as one of its independent variables is allowed to vary with all other variables fixed at constants

Unit 1: Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability.

Unit 2: Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained voptimization problems, Definition of vector field, divergence and curl

Unit 3: Double integration over rectangular region, double integration over non-rectangular region,Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped andsolid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.

Unit 4: Change of variables in double integrals and triple integrals. Line integrals, Applications of lineintegrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields,independence of path.

Unit 5: Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.

4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

Course outcomes:
1. Handle vectors fluently in solving problems involving the geometry of lines, curves, planes, and surfaces in space. 2. Visualize and draw graphs of surfaces in space

Code	Name	Credit (6)
BMA-326	**Group Theory II**	5-1-0

Course Objectives:
This lecture course unit aims to introduce students to some more sophisticated concepts and results of group theory as an essential part of general mathematical culture and as a basis for further study of more advanced mathematics. Provide knowledge of some fundamental results and techniques from the theory of finite groups

Unit 1: Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups.

Unit 2: Characteristic subgroups, Commutator subgroup and its properties.
Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

Unit 3: Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.

Unit 4: Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn,

Unit 5:*p*-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for n $\geq$ 5,non-simplicity tests.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra,* 4th Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

Course outcomes:
1. Verify group properties in particular examples 2. Understand and use the concept of conjugacy

Code	Name	Credit (6)
BMA-327	**Analytical Geometry**	5-1-0

Course Objectives:
Model spatial problems with vectors, lines, planes, curves and surfaces in space. The use of differentiation for vector-valued functions to compute tangent lines and also differentiation for multivariate functions to find extrema and rates of change. This course is use iterated integrals to measure areas, compute volumes and find centers of mass

Unit 1: Transformation of axes in two dimensions: Shifting of origin, rotation of axes, invariants.

Unit 2: Pair of Straight Lines : Joint equation of pair of straight lines and angle between them, Condition of parallelism and perpendicularity, Joint equation of the angle bisectors, Joint equation of lines joining origin to the intersection of a line and a curve. Skew lines and shortest distance between skew lines

Unit 3: Circle : General equation of circle, Circle through intersection of two lines, tangents, normals, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, angle of intersection and orthogonality, power of a point w.r.t. circle, radical axis, co-axial family of circles, limiting points.

Unit 4: Conic : General equation of a conic, tangents, normals, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, diameter.

Unit 5: Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola. Indentification of conic in general second degree equations. Equation of a sphere in different forms, plane section of a sphere, Equation of a circle. Sphere through a given circle. Intersection of a sphere and a line. Equation of tangent plane to standard sphere and general sphere.

Books Recommended

1. S. L. Loney : The Elements of Coordinate Geometry, Macmillan and Company, London, 2 nd Edition 2007.
2. P.K. Jain and Khalil Ahmad : A Text Book of Analytical Geometry of Two Dimensions, Wiley Eastern Ltd., 1999.
3. Erwin Kreyszig : Advanced Engineering Mathematics, John Wiley & Sons,1999.
4. Gorakh Prasad and H.C. Gupta : Text Book on Coordinate Geometry, Pothishala Pvt. Ltd., Allahabad, 1955.

Course outcomes:
1. Construct and apply symbolic and graphical representations of functions 2. Model real-life problems mathematically 3. Use technology appropriately to analyze mathematical problems

Code	Name	Credit (6)
BMA-328	**Probability Theory**	5-1-0

Course Objectives:
We will study about the Basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables. Provide the knowledge about discrete time Markov chain .

Unit 1: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments Mathematical Expectations: Definition, Expected value of random variable, expected value of function of a random variable, properties of expectations.

Unit 2: Moment generating function, characteristic function, discrete distributions: uniform, binomial,Poisson, geometric, negative binomial.

Unit 3: Continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions.

Unit 4: Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, joint moment generating function (jmgf) and calculation of covariance(from jmgf).

Unit 5: Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.

Course outcomes:
1. How to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions 2. Discrete time Markov chains and methods of finding the equilibrium probability distributions 3. How to translate real-world problems into probability models

Semester VI

Code	Name	Credit (6)
BMA-329	**Metric Spaces and Complex Analysis**	5-1-0

Course Objectives:
Students will have been introduced to point-set topology and will know the central importance of complex variables in analysis. Students will have grasped a deeper understanding of differentiation and integration in this setting and will know the tools and results of complex analysis including Cauchy's Theorem, Cauchy's integral formula, Liouville's Theorem, Laurent's expansion and the theory of residues

Unit 1: Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighborhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable space, closure of a subset of a metric spaces.

Unit 2: Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach fixed point Theorem. Connectedness, connected subsets of R.

Unit 3: Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions.

Unit 4: Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem,Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra.

Unit 5: Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.

Books Recommended

1. Satish Shirali and Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag, London, 2006.

2. S. Kumaresan, *Topology of Metric Spaces*, 2nd Ed., Narosa Publishing House, 2011.

3. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill, 2004.

4. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.

5. Joseph Bak and Donald J. Newman, *Complex Analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

Course outcomes:
1. Explain the fundamental concepts of real analysis and their role in modern mathematics and applied contexts 2. Demonstrate accurate and efficient use of complex analysis techniques

Code	Name	Credit (6)
BMA-330	**Ring Theory and Linear Algebra II**	**5-1-0**

Course Objectives:
Demonstrate understanding of the idea of a group, a ring and an integral domain, and be aware of examples of these structures in mathematics. Appreciate the significance of unique factorization in rings and integral domains. To learn the basic terminology and results concerning abstract algebra

Unit 1: Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests.

Unit 2: Eisenstein criterion, unique factorization in Z[x]**.** Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains.

Unit 3: Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.

Unit 4: Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal Complements.

Unit 5: Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
5. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.
6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
5. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999.
6. Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra,* 2nd Ed., Prentice-Hall of India Pvt.Ltd., 1971.

Course outcomes:
1. Students completing this course will be able to find the null space of a matrix and represent it 2. Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty.

Code	Name	Credit (6)
BMA-331	**Linear Programming**	5-1-0

Course Objectives:
1. Evaluate the computational performance of search, satisfaction, optimization and learning algorithms. 2. Apply search, satisfaction, optimization and learning algorithms to real world problems

Unit 1: Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, Interior point methods.

Unit 2: Introduction to artificial variables, two-phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Unit 3: Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem.

Unit 4: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem .Network flow problems.

Unit 5: Game theory: formulation of two person zero sum games, solving two person zero sum games,games with mixed strategies, graphical solution procedure, linear programming solution of games. Algebraic and graphical methods

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

Course outcomes:
1. Describe at an intuitive level the process of artificial intelligence and operations research: a real-time cycle of problem understanding, formulation, solution and implementation 2. Formulate simple reasoning, learning and optimization problems, in terms of the representations and methods presented.

Code	Name	Credit (6)
BMA-332	**Mechanice**	5-1-0

Course Objectives:
Develop within the student an understanding of the scientific processes and theories designed to provide answers to the questioning mind. Apply calculus techniques in solving problems.

Unit 1: Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium, two point equivalent loading, problems arising from structures, static indeterminacy.

Unit 2: Laws of Coulomb friction, application to simple and complex surface contact friction problems,transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers.

Unit 3 : Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes.

Unit 4: Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass, moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies.

Unit 5: Chasles' theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references.

Books Recommended

1. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics,* (4thEd.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.

2. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics,* 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

Course outcomes:	
1.	Determine the resultant of a system of forces
2.	Students will learn Law of Coulomba