MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB

Syllabus of B.Sc with Mathematics and Computer Applications (In-house)

(Effective for 2020-2021 Admission Session)

Choice Based Credit System

140 Credit (3-Year UG) MAKAUT Framework

w.e.f 2020-21

Program Objective

- ✓ To cultivate a mathematical attitude and nurture the interest,
- ✓ To motivate for research in mathematical and statistical sciences,
- ✓ To train computational scientists who can work on real life challenging problems

Program Outcome

PO1- Science Knowledge: To promote and apply mathematical and computational knowledge for finding sustainable solution to solve the issues pertaining to the society/Industry.

PO2- Problem analysis: Identify, formulate, review research literature, and analyze scientific problems reaching validated conclusions using basic principles of sciences.

PO3- Modern tool use: Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modelling to complex scientific activities with an understanding of the limitations

PO4-Lifelong learning: Cultivate unparallel comprehension of fundamental concepts relevant to basic sciences leading to an individual progress and career advancement at the national and Global levels.

PO5-Communication: To communicate effectively their views and ideas orally/written in English and in other related languages.

PO6-The science and society: Design computing algorithms for complex mathematical problems and design system components or processes that meets the specific needs with appropriate consideration for public health and safety, cultural, societal and environmental conditions.

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Course Structure

Semester-I

S.No.	Category	Subject Name	Subject Code	Contact Hours/ Week			Credit
				L	T	P	
1	Core Course: C1	Differential Calculus and Integral Calculus	BMCA101	5	1	0	6
2	Core Course: C2	Principles and Practices of Object Oriented Programming	BMCA102	4	0	0	4
3	Generic Elective: GE1	Physics-I	BMCA103	4	0	0	4
4	Ability Enhancement Course: AECC1	English	BMCA104	2	0	0	2
Practical							
5	Core Course	Principles and Practices of Object Oriented Programming Lab	BMCA191	0	0	4	2
6	Generic Elective	Physics-I Lab	BMCA192	0	0	4	2
Total Credits							**20**

Semester-II

S.No.	Category	Subject Name	Subject Code	Contact Hours/ Week			Credit
				L	T	P	
1	Core Course: C3	Differential Equations	BMCA201	5	1	0	6
2	Core Course: C4	Data Structure	BMCA202	4	0	0	4
3	Generic Elective: GE2	Physics-II	BMCA203	4	0	0	4
4	Ability Enhancement Course: AECC2	Environmental Science	BMCA204	2	0	0	2
Practical							
5	Core Course	Data Structure Lab	BMCA291	0	0	4	2
6	Generic Elective	Physics-II Lab	BMCA292	0	0	4	2
Total Credits							**20**

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Semester III

S.No.	Category	Subject Name	Subject Code	Contact Hours/Week			Credit
				L	T	P	
1	Core Course: C5	Real and Complex analysis	BMCA301	5	1	0	6
2	Core course: C6	Numerical Analysis	BMCA302	4	0	0	4
3	Core Course: C7	Design and Analysis of Algorithms	BMCA303	4	0	0	4
4	Generic Elective: GE3	**(Choose one)** Chemistry-I	BMCA304A	4	0	0	4
		Statistics-I	BMCA304B	5	1	0	6
		Mathematical Economics	BMCA304C	5	1	0	6
		Data Science	BMCA304D	4	0	0	4
		Soft Computing	BMCA304E	5	1	0	6
5	Skill Enhancement Course: SEC1	**(Choose one)** Analytical Geometry	BMCA305A	2	0	0	2
		Graph Theory	BMCA305B				
Practical							
6	Core Course	Numerical Analysis Practical	BMCA391	0	0	4	2
7	Core Course	Design and Analysis of Algorithms Lab(Python)	BMCA392	0	0	4	2
8	Generic Elective	Chemistry-I Practical	BMCA393A	0	0	4	2
		Data Science Practical	BMCA393B	0	0	4	2
Total Credit							**26**

Semester-IV

S.No.	Category	Subject Name	Subject Code	Contact Hours/Week			Credit
				L	T	P	
1	Core Course: C8	Algebra	BMCA401	5	1	0	6
2	Core course: C9	Discrete Mathematics	BMCA402	5	1	0	6
3	Core course: C10	Optimization Techniques	BMCA403	4	0	0	4
4	Generic Elective: GE4	**Choose one:**					
		Chemistry-II	BMCA404A	4	0	0	4
		Advanced Statistics	BMCA404B	5	1	0	6
		Financial Mathematics	BMCA404C	5	1	0	6
		Machine Learning	BMCA404D	5	1	0	6
5	Skill Enhancement Course: SEC2	**(Choose one)** Vector calculus	BMCA405A	2	0	0	2
		Automata	BMCA405B				
		User interface and Web Development	BMCA405C				
Practical							
6	Core Course	Optimization Techniques Lab	BMCA491	0	0	4	2
7	Generic Elective	Chemistry-II Practical	BMCA492	0	0	4	2
Total Credit							**26**

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Semester V

S.No.	Category	Subject Name	Subject Code	Contact Hours/ Week			Credit
				L	T	P	
1	Core Course: C11	Theory of Probability and Stochastic Process	BMCA501	5	1	0	6
2	Core course: C12	Operating System	BMCA502	4	0	0	4
2	Discipline Specific Elective: DSE1	**(Choose one)** Operations Research	BMCA503A	4	0	0	4
		Data Mining	BMCA503B				
4	Discipline Specific Elective: DSE2	**(Choose one)** Statics and Dynamics	BMCA504A	5	1	0	6
		Software Engineering	BMCA504B				
Practical							
5	Core course	Operating System Lab	BMCA591	0	0	4	2
6	Discipline Specific Elective	Operations Research Lab using R	BMCA592A	0	0	4	2
		Data Mining Lab using R	BMCA592B				
Total Credit							**24**

Semester VI

S.No.	Category	Subject Name	Subject Code	Contact Hours/ Week			Credit
				L	T	P	
1	Core Course: C13	Mathematical Methods	BMCA601	5	1	0	6
2	Core course: C14	Database Management System	BMCA602	4	0	0	4
3	Discipline Specific Elective: DSE3	**(Choose one)** Number theory and Cryptography	BMCA603A	5	1	0	6
		Computer Network	BMCA603B				
4	Discipline Specific Elective: DSE4	Project	BMCA604	6	0	0	6
Practical							
5	Core Course	Database Management System Lab	BMCA691	0	0	4	2
Total Credits							**24**

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Detailed Syllabus:

Semester-I:

Category: C1
Subject Name: Differential Calculus and Integral Calculus
Subject Code: BMCA101

Course Objectives:

1. To provide understating of limit and continuity
2. To provide understanding of existence of n'th order derivative.
3. To find the radius of curvature in Cartesian form and in parametric form.
4. To apply the reduction formula to evaluate definite integral and to develop an understanding of Double and Triple Integrals.

Course description:

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions, Maxima and Minima, Necessary and sufficient condition for maxima and minima.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $sinx, cosx, e^x, log(l+x), (l+x)m,$ Indeterminate forms.

Integration by Partial fractions, integration of rational and irrational functions.Properties ofdefinite integrals. Reduction formulae for integrals of rational, trigonometric, exponential andlogarithmic functions and of their combinations, Beta and Gamma functions.

Areas and lengths of curves in Cartesian and polar coordinates, volumes and surfaces of solids of revolution. Double and Triple integrals.

Books Recommended:

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.
3. Daniel A. Murray, Differential and Integral Calculus, Fb& c Limited, 2018.

Course Outcomes:

Upon successful completion of Calculus students will be able to:

1. Use Leibnitz Theorem to determine the nth derivative of product of functions.
2. Compute radius of curvature for Cartesian curves, parametric curves.
3. Evaluate integral values by appropriate reduction formula.

4. Identify and evaluate the multiple integral techniques.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Differential Calculus and Integral Calculus (BMCA101)						
CO1: Use Leibnitz Theorem to determine the nth derivative of product of functions.	S	S	M	M	M	M
CO2: Compute radius of curvature for Cartesian curves, parametric curves.	S	S	S	M	M	S
CO3: Evaluate integral values by appropriate reduction formula.	S	S	M	M	M	S
CO4: Identify and evaluate the multiple integral techniques.	S	S	M	M	L	M

S- Strong; M-Medium; L-Low

Category: C2
Subject Name: Principles and Practices of Object Oriented Programming
Subject Code: BMCA102

Course description:

Programming Concepts: Algorithm and its characteristics, pseudo code / flow chart, program, identifiers, variables, constants, primitive data types, expressions, structured data types, arrays, compilers and interpreters.

Statements: Assignment statement, if then else statements, switch statement, looping statementswhile, do while, for, break, continue, input/output statements, functions/procedures.

Object Oriented Concepts: Abstraction, encapsulation, objects, classes, methods, constructors, inheritance, polymorphism, static and dynamic binding, overloading.

Program Development: Object oriented analysis, design, unit testing & debugging, system testing & integration, maintenance.

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input using the extraction operator >> and cin, output using the insertion operator << and cout, preprocessor directives, increment (++) and decrement operations (--), creating a C++ program, input/output, relational operators, logical operators and logical expressions, if and if … else statement, switch and break statements.

"for", "while" and "do – while" loops, break and continue statement, nested control statement, value returning functions, void functions, value versus reference parameters, local and global variables, static and automatic variables, enumeration type, one dimensional array, two dimensional array, character array, pointers, structures and unions, File I/O.

Objects, Operator Overloading, Function and Object Polymorphism, Inheritance, Abstraction, Function Pointers.

Books Recommended:

1. Richard Johnson, *An Introduction to Object-Oriented Application Development*, Thomson Learning, 2006
2. BjarneStroupstrup, *The C++ Programming Language*, Addison Wesley, 2004.
3. Brett D. McLaughlin,*Head First Object-Oriented Analysis and Design:A Brain Friendly Guide to OOA&D*, OReilly, 2011.
4. Matt Weisfeld, *The Object Oriented Thought Process*, Addison-Wesley, 2013.

Course Outcomes:

Upon successful completion the students will be able to:

1. Understand several kind of basic statements and loops useful in OOPs.
2. Describe the procedural and Object Oriented Paradigm with concepts of streams, classes, functions, data and objects.
3. Understand dynamic memory management techniques using pointers, constructors, destructors, etc.
4. Describe the concept of function overloading, operator overloading, virtual functions and polymorphism.
5. Classify inheritance with the understanding of early and late binding, usage of exception handling, generic programming.
6. Demonstrate the use of various OOPs concepts with the help of programs.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Principles and Practices of Object Oriented Programming (BMCA102)						
CO1: Understand several kind of basic statements and loops useful in OOPs.	S	M	S	S	M	S
CO2: Describe the procedural and Object Oriented Paradigm with concepts of streams, classes, functions, data and objects.	S	S	S	M	M	S
CO3: Understand dynamic memory management techniques using pointers, constructors, destructors, etc.	M	S	S	M	M	S
CO4: Describe the concept of function overloading, operator overloading, virtual functions and polymorphism.	M	M	S	S	L	M
CO5: Classify inheritance with the understanding of early and late binding, usage of exception handling, generic programming.	S	S	S	M	M	M
CO6: Demonstrate the use of various OOPs concepts with the help of programs.	S	L	S	M	M	L

S- Strong; M-Medium; L-Low

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Category: GE1
Subject Name: Physics –I
Subject Code: BMCA103

Course Objectives:
The objective of this Course is to provide the students with an introductory knowledge in the field of Electronics. This course also facilitate better understanding of, optics including Laser and Quantum Physics.

Lab should be taken concurrently, so, that student can understand laboratory/practical use of the knowledge gained from the course lectures.

Course description:

Module 1 :(10 L) Diode circuits and power Supplies: Junction diode characteristics - Half and full wave rectifiers - Expression for efficiency and ripple factor - Construction of low range power peak using diodes - Bridge rectifier - Filter circuits - Zener Diode - Characteristics - Regulated power supply using Zener diode - Clipper and Clamper using diodes. Differentiator and integrator using resistor and capacitor.

Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications;

Module 2 : (8 L) Transistor circuits: Characteristics of a transistor in CB, CE modes - Relatively merits - Graphical analysis in CE configuration - Transistor as a amplifier - RC coupled Single stage amplifier - Frequency response - Thevenin's and Norton's theorems - h parameters.

Basis logic gates AND, OR, and NOT - Construction of basic logic gates using diodes and transistors.

Module 3 : (12 L) Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.

Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.

Module 4: Quantum Physics (18L) Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

Books Recommended:
1. Principles of Electronics - V.K. Mehta, S. Chand & Co., 4/e, 2001.
2. Basic Electronics - B.L. Theraja, S. Chand & Co., 4/e, 2001.
3. Basic Electronics - B. Grob, McGraw - hill, 6/e, NY, 1989.

4. Elements of Electronics – Bagde & Singh, S. Chand & Co.
5. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker, Wiley
6. Optics, Hecht, Pearson Education
7. Optics, Ghatak, McGraw Hill Education India Private Limited
8. Principles of Lasers, O. Svelto, Springer Science & Business Media, 2010
9. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley.
10. Introduction to Quantum Mechanics, J. Griffiths David, Pearson Education

Course Outcomes:

Students will be familiar with:

1. Know broadly the concepts and functionalities of the electronic devices.
2. Diffraction and it's practical applications, introduced to the principles of lasers, types of lasers and their applications.
3. Some of the basic laws related to quantum mechanics as well as associated quantum mechanics calculations.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Physics –I (BMCA103)						
CO1: Know broadly the concepts and functionalities of the electronic devices.	S	S	M	M	M	M
CO2: diffraction and it's practical applications, introduced to the principles of lasers, types of lasers and their applications.	S	S	S	M	L	M
CO3: Some of the basic laws related to quantum mechanics as well as associated quantum mechanics calculations.	S	S	S	M	L	S

S- Strong; M-Medium; L-Low

Category: AECC1
Subject Name: English
Subject Code: BMCA104

Course Objectives:

1. To enable the learner to communicate effectively and appropriately in a real-life situation
2. To use English effectively for study purposes across the curriculum.
3. The course will enable the learner to develop and demonstrate the speaking skills for group discussions, Viva-voce, Personal interviews etc.
4. To use R, W, L, S and integrate the use of four language skills; Reading, Writing, Listening and Speaking.

Course description:

Vocabulary Building: The concept of Word Formation: Compounding, Backformation, Clipping, Blending; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms, and standard abbreviations: Acronyms.

Basic Writing Skills: Sentence Structures & Types: Simple, Compound, Complex; Use ofphrases and clauses in sentences: Transformation of sentences, active, passive, narration;

Importance of proper punctuation; Creating coherence: Arranging paragraphs & Sentences in logical order; Creating Cohesion: Organizing principles of paragraphs in documents; Techniques for writing precisely.

Identifying Common Errors in Writing: Subject-verb agreement; Noun-pronoun agreement Misplaced modifiers; Articles; Prepositions; Redundancies; Clichés.

Nature and Style of sensible Writing: Describing; Defining; Classifying; Providing examples or evidence; Writing introduction and conclusion.

Writing Practices: Comprehension; Précis Writing; Essay Writing; Business Letter, Cover Letter & CV; E-mail.

Books Recommended:

1) Kulbushan Kumar, R S Salaria,Effective Communication Skills, Khanna Publishing House, Delhi.
2) Practical English Usage. Michael Swan. OUP. 1995.
3) Remedial English Grammar. F.T. Wood. Macmillan.2007
4) On Writing Well. William Zinsser. Harper Resource Book. 2001
5) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
7) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
8) Universal English Prof. Prasad Kataria Publications, 2019.
9) "Communication Skills for Professionals"-NiraKonar, Prentice Hall of India 2nd edition, New Delhi, 2011.
10) Gajendra Singh Chauhan, SmitaKashiramka and L. Thimmesha. Functional English. Cengage, 2019.

Course Outcomes:

Upon successful completion the students will be able to

1. Apply English grammar correctly to make an error-free communication.
2. Compose impressive Business Correspondence to set a positive impression for them.
3. Choose perfect words from their vocabulary to use them effectively and appropriately.
4. Discuss confidently in a group discussion or Personal interviews.
5. Develop various types of presentations to enhance their performance.
6. Interpret a text and apprehend the same.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
English (BMCA104)						
CO1: Apply English grammar correctly to make an error-free communication.	L	M	S	S	S	M
CO2: Compose impressive Business Correspondence to set a positive impression for them.	L	M	M	S	S	M
CO3: Choose perfect words from their vocabulary to use them effectively and appropriately.	L	L	M	M	S	M
CO4: Discuss confidently in a group discussion or Personal interviews.	M	M	M	S	S	M
CO5: Develop various types of presentations to enhance their performance.	M	M	M	S	S	M
CO6: Interpret a text and apprehend the same.	L	M	M	S	S	L

S- Strong; M-Medium; L-Low

Category: Core Course
Subject Name: Principles and Practices of Object Oriented Programming Lab
Subject Code: BMCA191

Course Objectives:

The course should enable the students to:

1. Gain knowledge about basic Java language syntax and semantics to write Java programs and use concepts such as variables, conditional and iterative execution methods etc.
2. Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, invoking methods etc. and exception handling mechanisms.
3. Understand the principles of inheritance, packages and interfaces.

Course description:

List of practical problems/ experiments:

1. Develop minimum 2 programs using constants, variables, arithmetic expression, operators, exhibiting data type conversion.
2. Develop a program to implement decision making statements (If-else, switch).
3. Develop a program to demonstrate control structures (for, while, do-while).
4. Develop a program to implement I-dimension array.
5. Develop a program to perform matrix operations using multi-dimensional array.
6. Develop programs that implements a class and use it with objects.
7. Develop programs that implements a class and create array of objects.
8. Write a program to implement friend function.
9. Write a program to implement inline function.
10. Write a program to implement all types of constructors (constructor overloading) with destructor.

Books Recommended:

1. Herbert Schildt, "Java the Complete Reference", TMH. 8th edition.
2. Kathy Sierra & Bert Bates, "Head First Java", O'Reilly, 2nd Edition.
3. E Balagurusamy, "Programming with Java A Primer", TMH, 4th edition.
4. Patrick Naughton, "Java Handbook", Osborne McGraw-Hill.

Course Outcomes:

Students who complete the course will have demonstrated the ability to do the following:

1. Identify classes, objects, members of a class and relationships among them needed for a specific problem.
2. Write Java application programs using OOP principles and proper program structuring.
3. Demonstrate the concepts of polymorphism and inheritance.
4. Write Java programs to implement error handling techniques using exception handling.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Principles and Practices of Object Oriented Programming Lab (BMCA191)						
CO1: Identify classes, objects, members of a class and relationships among them needed for a specific problem.	L	S	L	S	L	L
CO2: Write Java application programs using OOP principles and proper program structuring.	L	S	L	S	L	L
CO3: Demonstrate the concepts of polymorphism and inheritance.	M	S	M	S	M	S
CO4: Write Java programs to implement error handling techniques using exception handling.	S	S	M	M	S	S

S- Strong; M-Medium; L-Low

Category: Generic Elective
Subject Name: Physics-I Lab
Subject Code: BMCA192

Course Objectives:

The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments. **At least eight experiments to be completed by each student taking at least two from each unit.**

Course description:

Experiments in Solid State Physics.

1. Characteristics of Zener diode
2. Characteristics of Thermistor

3. Fabrication of a regulated +5 v Power supply using 7805.
4. Zener diode as voltage regulator

Experiments in Optics:

1. Determination of resolving power of a prism.
2. Determination of dispersive power of the material of a prism.
3. Determination of wavelength of a monochromatic Laser light by Newton's ring
4. Determination of refractive index of a liquid by Newton's ring
5. Determination of wavelength of the given laser source by diffraction method
6. Determination of refractive index of a liquid by Newton's ring
7. Determination of Divergence and spot size of a Laser beam.

Experiments in Quantum Physics.

1. Determination of Planck constant using photocell.
2. Study of Photoelectric effect.
3. Franck – Hertz Experiment to study quantization of energy states in atom.
4. Abbes' Experiment: to study the variation of refractive index with (a) temperature of the Liquid sample (b) wavelength of the light source.

Course Outcomes:

On completion of the course students are able to:

1. Develop skill to impart practical knowledge in real time solution. Understand working principle, applications, measurement techniques and comparison of obtained results with theoretically calculated value.
2. Gain knowledge of new concept in the solution of practical
3. Understand measurement techniques, usage of new instruments and real time applications in Science and Technology.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Physics-I Lab (BMCA192)						
CO1: Develop skill to impart practical knowledge in real time solution. Understand working principle, applications, measurement techniques and comparison of obtained results with theoretically calculated value.	S	S	S	M	M	S
CO2: Gain knowledge of new concept in the solution of practical	M	S	S	M	L	S
CO3: Understand measurement techniques, usage of new instruments and real time applications in Science and Technology.	M	S	S	S	M	M

S- Strong; M-Medium; L-Low

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Semester-II:

Category: C3
Subject Name: Differential Equations
Subject Code: BMCA201

Course objectives:

1. To use the method of integrating factors to solve linear, first-order DEs.
2. To find the complete solution of a non-homogeneous differential equation.
3. To solve the first order differential equations using variable separable method.
4. To introduce and solve linear Partial Differential with different methods.

Course description:

Ordinary Differential Equation (ODE): Existence and uniqueness of solutions of ODE, First order exact differential equations, Integrating factors, rules to find an integrating factor.

First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties.

Solving a differential equation by reducing its order.

Linear homogenous equations with constant coefficients, Linear non-homogenous equations,

The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Partial Differential Equations (PDE): Formation of PDEs, Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Lagrange method for solution of first order quasilinear PDE, Charpit's method for first order nonlinear PDE.

Books Recommended:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition,1967.
3. An Elementary Course in Partial Differential Equations-T. Amarnath.

Course Outcomes:

Upon successful completion students will be able to

1. Evaluate and solve Separable, Homogeneous, Exact, and Linear first order differential equations.
2. Analyse and solve first order and higher order differential equations using various methods.
3. Formulate the separation of variables and solve simultaneous equations and analyze the behaviour of solutions.
4. Formulate P.D.E by eliminating arbitrary constants and variables and solve its standard types.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Differential Equations (BMCA201)						
CO1: Evaluate and solve Separable, Homogeneous, Exact, and Linear first order differential equations.	S	S	S	M	M	M
CO2: Analyse and solve first order and higher order differential equations using various methods.	S	S	S	S	M	M
CO3: Formulate the separation of variables and solve simultaneous equations and analyze the behaviour of solutions.	S	S	M	S	M	S
CO4: Formulate P.D.E by eliminating arbitrary constants and variables and solve its standard types.	S	S	M	S	L	S

S- Strong; M-Medium; L-Low

Category: C4
Subject Name: Data Structures
Subject Code: BMCA202

Course description:

Introduction**:** Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off.

Array: Operations, Different representations – row major, column major.

Sparse matrix - its implementation and usage. Array representation of polynomials.

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation–corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Graph: Basic Terminologies and Representations (Operations on linked list and matrix representations of graphs), Graph Connectivity, Graph search and traversal algorithms and complexity analysis.

Sorting, Searching and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Topological Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods,

Searching: Linear Search and Binary Search, Interpolation Search, Binary Tree Search Techniques and their complexity analysis. Hashing: Hashing functions, collision resolution techniques.

Books recommended:

1. "Fundamentals of Data Structures of C" by Ellis Horowitz, SartajSahni, Susan Anderson-freed, Universities Press.
2. "Data Structures in C" by Aaron M. Tenenbaum, YedidyahLangsam, Moshe J. Augenstein, Pearson.
3. "Data Structures with C" by S. Lipschutz, McGraw Hill India.
4. "Data Structures and Algorithm Analysis in C++" Hardcover, by Mark A. Weiss, Jun 2013, Publisher: PHI; 4 edition, ISBN-10: 013284737X ISBN-13: 978-0132847377.
5. "Algorithms in C++: Fundamentals, Data Structures, Sorting, Searching", Parts 1-4, 3rd Edition (Paperback) by Robert Sedgewick, Pearson India, ISBN-10 8131713059, 2009, ISBN-13 9788131713051.

Course Outcomes:

Upon successful completion students will be able to

1. Implement, analyze and determine the time and space complexity for a given problem of Array, Stack, Queue and Linked list.
2. Implement Tree and Graph and use them in solving a problem.
3. Write and implement an algorithm for Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Linear Search, Binary Search and compare their performance in term of Space and Time complexity.
4. Identify appropriate data structure & algorithmic methods in problem solving.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Data Structures (BMCA202)						
CO1: Implement, analyze and determine the time and space complexity for a given problem of Array, Stack, Queue and Linked list.	S	S	M	M	M	S
CO2: Implement Tree and Graph and use them in solving a problem.	S	S	S	M	L	M
CO3: Write and implement an algorithm for Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Linear Search, Binary Search and compare their performance in term of Space and Time complexity.	S	S	S	M	M	M
CO4: Identify appropriate data structure & algorithmic methods in problem solving.	S	S	S	M	L	S

S- Strong; M-Medium; L-Low

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Category: GE2
Subject Name: Physics-II
Subject Code: BMCA203

Course description:

Unit I: Digital Electronics: 8 L
Different number systems – Decimal, binary, Octal, Hexadecimal number systems- Conversion between different number systems- Binary arithmetic - Addition, Subtraction, Subtraction with 2's complement and 1's complement- BCD code, ASCII code, Basic theorems of Boolean algebra de Morgan's theorems, Logic gates - logic symbol and Truth table.

Unit II: Standard forms of Boolean Expressions and Functions of Combinational Logic: 15 L
The SOP and POS forms, Conversion of a general expression to SOP and POS, converting standard SOP to POS and vice versa, Boolean Expressions and Truth Tables, Karnaugh Map (up to 4 variables), Karnaugh Map SOP and POS minimization.

Basic Adders - Half Adder, Full Adder, Parallel Binary Adder, 4 Bit Parallel Adder, Multiplexer, Comparators, decoders, encoders. A/D and D/A converter, Microprocessor (8085) and their applications.

Unit III: Electronic Measurements and Measuring Instruments 10 L
Generalized measurement system, Performance and parameters of instruments, Principle of permanent magnet moving coil meter, Galvanometer as ammeter, voltmeter and ohmmeter, Multimeter, Electronic multimeter, Testing of electronic components. Oscilloscopes

Unit IV: Electromagnetism and Dielectric Magnetic Properties of Materials 10L
Maxwell's equations, Polarization, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation (expression only), applications of dielectrics.
Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

Unit V: Statistical Mechanics 10L
Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Books Recommended:

1. Digital Fundamentals - 10th Edition, Thomas L. Floyd (Pearson Education)
2. Principles of Electronics-VK Mehta
3. Fundamentals of Digital Circuits by A. Anand Kumar, PHI
4. Microprocessor Architecture, Programming and Applications with the 8085, Ramesh S. Gaonkar, Penram International Publishing (INDIA)
5. Introduction to Electronics Engineering - 5th Edition, Dr. K. Gopakumar (Phasor Books)
6. Principles of Physics, 10ed, David Halliday, Robert ResnickJearl Walker, Wiley
7. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
8. Statistical Physics, L.D.Landau, E.M. Lifshitz, Butterworth-Heinemann
9. Digital Principles and Applications - D P Leach and A P Malvino (TMH).
10. Basic Electronics – B L Theraja (S Chand & Co.).

Course outcomes:
Upon successful completion students will be able to

1. Understand the different number systems, arithmetic operations and conversions.
2. Understand the Boolean Expressions, Functions of Combinational Logic and K map simplifications. A to D & D to A converter, Basic idea of microprocessors
3. Understand the basic electronic test and measuring instruments.
4. Be familiar with Maxwell's equations of EM various terms related to properties of materials such as, permeability, polarization, magnetic and dielectric properties of materials, etc.
5. Understand qualitative concepts of Statistical mechanics.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Physics-II (BMCA 203)						
CO1: Understand the different number systems, arithmetic operations and conversions.	S	S	M	S	M	S
CO2: Understand the Boolean Expressions, Functions of Combinational Logic and K map simplifications. A to D & D to A converter, Basic idea of microprocessors	M	S	S	M	M	M
CO3: Understand the basic electronic test and measuring instruments.	M	S	S	M	L	M
CO4: Be familiar with Maxwell's equations of EM various terms related to properties of materials such as, permeability, polarization, magnetic and dielectric properties of materials, etc.	S	S	M	M	L	M
CO5: Understand qualitative concepts of Statistical mechanics.	S	S	S	M	M	M

S- Strong; M-Medium; L-Low

Category: AECC2
Subject Name: Environmental Science
Subject Code: BMCA204

Course description:

Module I: Environment: Meaning & Components, Energy sources & Management, Man and Environment Relation, Environmental Degradation- cause and effects, Environmental Ethics and Awareness Programmes.

Module II: Energy and its Types, Natural Resources- Meaning & Components ; Ecosystem- components and Functions, Biodiversity and its Conservation, Energy Crisis, Land degradation, Soil Erosion, Deforestation, Mining Activities, Depletion of Natural Resources, Energy Conservation and Management.

Module III: Environmental Pollution - Types: - Air pollution, Water pollution, Land pollution, Noise pollution; pollutants, Sources of Pollution, Effects of pollution, Control and Remedial measures.

Module IV: Environmental Protection- Report of the Club of Rome: Sustainable Development, Global Warming and Climate Change- Causes, Effects and Remedial measures, Paris Agreement

(2015), Environmental Movements- Chipko movement; Narmada Bachao movement; Tehri Dam conflict.

Module V: Environmental policies and Legislations: Environmental Regulations; Environmental Protection Act, Environmental Ethics, Environmental Impact Assessment (EIA) – Methods and Tools, Appraisal and Clearance for Industry, Environmental Audit, Stockholm Conference 1972, Rio Declaration 1992, Kyoto Protocol 1997.

Books Recommended:

1. Asthana, D. K. (2006).Text Book of Environmental Studies; S. Chand Publishing. Basu, M., Xavier, S. (2016).
2. Fundamentals of Environmental Studies, Cambridge University Press, India.
3. Basu, R. N., (Ed.) (2000). Environment. University of Calcutta, Kolkata
4. Bharucha, E. (2013). Textbook of Environmental Studies for Undergraduate Courses. Universities Press.
5. De, A.K., (2006).Environmental Chemistry, 6th Edition, New Age International, New Delhi

Course Outcomes:

Upon successful completion students will be able to

1. Gain in-depth knowledge on natural processes that sustain life, and govern economy.
2. Predict the consequences of human actions on the web of life, global economyand quality of human life.
3. Develop critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development.
4. Acquire values and attitudes towards understanding complex environmental-economicsocial challenges, and participating actively in solving current environmental problems and preventing the future ones.
5. Adopt sustainability as a practice in life, society and industry.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Environmental Science (BMCA204)						
CO1: Gain in-depth knowledge on natural processes that sustain life, and govern economy.	M	M	M	S	M	M
CO2: Predict the consequences of human actions on the web of life, global economy and quality of human life.	M	M	S	S	M	M
CO3: Develop critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development.	M	M	M	S	M	M
CO4: Acquire values and attitudes towards understanding complex environmental-economic social challenges, and participating actively in solving current environmental problems and preventing the future ones.	M	M	M	M	M	M
CO5: Adopt sustainability as a practice in life, society and industry.	M	M	S	M	M	M

S- Strong; M-Medium; L-Low

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Category: Core Course
Subject Name: Data Structure Lab
Subject Code: BMCA291

Course Objectives:

The course should enable the students to:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques.
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course description:

List of practical problems/ experiments:

1. Write a program that uses functions to perform the following operations on singly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal.
2. Write a program that uses functions to perform the following operations on doubly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal.
3. Write a program that uses functions to perform the following operations on circular linked List i) Creation ii) Insertion iii) Deletion iv) Traversal.
4. Write a program that implement stack (its operations) using i) Arrays ii) Linked list(Pointers).
5. Write a program that implement Queue (its operations) using i) Arrays ii) Linked list(Pointers).
6. i) Write a program that implement Circular Queue using arrays,
   ii) Write a program that uses both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers: a) Linear search b) Binary search.
7. Write a program that implements the following sorting i) Bubble sort ii) Selection sort iii) Quick sort.
8. Write a program that implements the following i) Insertion sort ii) Merge sort iii)Heap sort.
9. Write a program to implement all the functions of a dictionary (ADT) using Linked List.
10. Write a program to perform the following operations:
    a) Insert an element into a binary search tree,
    b) Delete an element from a binary search tree,
    c) Search for a key element in a binary search tree.

Books Recommended:

1. Data Structure with C, Seymour Lipschutz, TMH
2. Data Structures using C. Reema Tharej , Oxford
3. Data Structures, 2/e, Richard F, Gilberg , Forouzan, Cengage
4. Data structures and algorithm analysis in C
5. Data Structures and Algorithms, 2008, G. A. V. Pai, TMH
6. Classic Data Structures, 2/e, Debasis , Sarnanta,PHI,2009
7. Fundamentals of Data Structure in C, 2le,' Horowitz, Sahni, Anderson Freed, University Prees

Course Outcomes:

Students who complete the course will have demonstrated the ability to do the following:

1. Ability to analyze algorithms and aalgorithm correctness.
2. Ability to summarize searching and sorting techniques.
3. Ability to describe stack,queue and linked list operation.
4. Ability to have knowledge of treeand graphs concepts.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Data Structure Lab (BMCA291)						
CO1: Ability to analyze algorithms and aalgorithm correctness.	L	S	L	S	L	L
CO2: Ability to summarize searching and sorting techniques.	L	S	L	S	L	L
CO3: Ability to describe stack,queue and linked list operation.	M	S	M	S	M	S
CO4: Ability to have knowledge of treeand graphs concepts.	S	S	M	M	S	S

S- Strong; M-Medium; L-Low

Category: Generic Elective
Subject Name: Physics-II Lab
Subject Code: BMCA292

A brief theoretical back ground of each experiment must be given to the students before each cycle of experiments and assess it. Students have to maintain a practical log book regularly signed by the teacher in charge and to be submitted at the time of University Examination. Fair record is not required.

At least 10 experiments have to be performed. Students may refer the diode/transistor/IC data manual to get details of the components in all electronic/Digital electronics experiments.

Course description:

LIST OF EXPERIMENTS:

1. Verification and interpretation of truth table for AND, OR, NOT, gates
2. Verification and interpretation of truth table for NAND, NOR, Ex-OR, Ex-NOR, gates
3. Construction of half and full adder using XOR and NAND gates and verification of its operation
4. To Study and Verify Half and Full Adder
5. To Study and Verify Half and Full Subtractor
6. Realization of logic functions with the help of Universal Gates (NAND, NOR)
7. Construction of a NOR gate latch and verification of its operation
8. Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates
9. Design and Verify the 4-Bit Serial In - Parallel Out Shift Registers
10. Implementation and verification of decoder or de-multiplexer and encoder using logic gates
11. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates
12. Voltage multiplier circuit.
13. Fabrication of a Multi vibrator circuit (astable)

14. Hartley Oscillator
15. Inverting amplifier, Non-inverting amplifier and voltage follower using Op-amp
16. Differentiator and Integrator using Op-amp.
17. Wien Bridge Oscillator using Op-amp.
18. Hall effect experiment:- Determination of charge carrier density of a semiconductor
19. A to D converter
20. D to A Converter.

Books Recommended:

1. Electronics Lab Manual by Dr. K A Navas (Rajath Publishers, Vol. I)
2. Advanced Practical Physics by S P Singh (PragatiPrakashan Meerut, Vol. II)
3. A text book of Advanced Practical Physics by Samir Kumar Ghosh (New Central Book Agency)
4. Core Course Practical Physics by C J Babu& K Vijayalakshmi(Calicut Univ.Central Co-Opt Stores).
5. Link of some Virtual Lab:

Virtual Lab	Link
Virtual lab Elect. & Communicat.(IITKg)	https://www.vlab.co.in/broad-area-electronics-and-commun
Digital Electronics (IITR)	https://de-iitr.vlabs.ac.in/List%20of%20experiments.html
Basic Electronics Virtual Lab.(IITKg)	http://vlabs.iitkgp.ac.in/be/#http://vlabs.iitkgp.ac.in/be/#
Basic Electronics Virtual Lab.(IITKg)	http://vlabs.iitkgp.ac.in/dec/#

Course Outcomes:

Upon successful completion students will be able to

1. Understand logic gates and their uses in digital circuits.
2. Describe and analyze truth tables and hardware part of the logic devices.
3. Able to understand working of some IC based Digital and analog circuits.
4. Get exposure to analog and digital devices for different applications.
5. Able to analyze the semiconductor materials type and carrier concentration from Hall effect experiment.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Physics-II Lab (BMCA292)						
CO1: Understand logic gates and their uses in digital circuits.	S	S	S	M	M	S
CO2: Describe and analyze truth tables and hardware part of the logic devices.	M	S	S	M	L	S
CO3: Able to understand working of some IC based Digital and analog circuits.	M	S	S	S	M	M
CO4: Get exposure to analog and digital devices for different applications.	S	S	S	M	M	S
CO5: Able to Analyze the semiconductor materials type and carrier concentration from Hall effect experiment.	S	S	S	M	M	S

S- Strong; M-Medium; L-Low

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Semester-III:

Category: C5
Subject Name: Real and Complex analysis
Subject Code: BMCA301

Course description:

Real Analysis:

Theory of real Number: - Concepts: Archimedean Principle, Concepts and related theorems, Concept of real number, Rational number, Properties of Sets. Limit points, Compactness, Bolzano-Weierstrass Theorem, Heine-Borel Theorem (Statement only) and its illustration with the help of applications.

Riemann integral: Partition, Riemann integrability, some Riemann integrable function, properties of Riemann integrable function, fundamental theorem, Mean value theorem.

Improper Integral: Different types of improper integral**,** tests for convergence(Practical test, $\mu integral$concept).

Sequence of real numbers: Different types of sequence, Convergent & divergent sequence, limit, Cauchy's theorem on limits.

Series of Real number: Infinite series, tests for convergence, series of arbitrary terms, conditionally convergent series.

Power series: Introduction, determination of Radius of convergence, properties of a power series.

Sequence of functions: pointwise convergence, uniform convergence, consequences of uniform convergence.

Series of functions: pointwise convergence, uniform convergence, consequences of uniform convergence, Abel's test, Dirichlet test.

Complex Analysis:

Complex variables: Introduction to complex variables, Analytic functions, General Cauchy Theorem, Real-Differentiability and the Cauchy-Riemann Equations. Exponential Function. Harmonic Functions.

Books Recommended:

1. Bartle and Sherbert, Introduction to Real Analysis, Third edition, Wiley-India \item Complex Analysis, V.L Ahlfors, McGraw-Hill Inc.
2. "Complex Variables and Applications" by R V Churchill and J W Brown.
3. Principles of Mathematical Analysis, Walter Rudin, 3rd Edition, McGaw Hill
4. Mathematical Analysis, Tom M. Apostol, 2nd Edition, Wiley
5. Mathematical Analysis, SC Malik and Arora, Multi Color Edition, New Age International Publishers 4. Introduction to Real Analysis, Bartle, Sherbert, 4th Edition, Wiley.

Course Outcomes:

Upon successful completion the students will be able to

1. To expose the students to the basics of real analysis and to recognize convergent, divergent, bounded, Cauchy and monotone sequences,
2. To define the real numbers, least upper bounds, and the triangle inequality, define functions between sets; equivalent sets; finite, countable and uncountable sets,
3. To apply the concept of convergent and divergent series in different application-oriented fields,
4. To analyse with functions (polynomials, reciprocals, exponential, trigonometric, hyperbolic) of single real/complex variable and its synthesis and describe mappings in the complex plane.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Real and Complex Analysis (BMCA301)						
CO1: To expose the students to the basics of real analysis and to recognize convergent, divergent, bounded, Cauchy and monotone sequences,	S	S	S	S	M	S
CO2: To define the real numbers, least upper bounds, and the triangle inequality, define functions between sets; equivalent sets; finite, countable and uncountable sets,	S	S	S	M	M	S
CO3: To apply the concept of convergent and divergent series in different application-oriented fields,	S	S	M	S	M	S
CO4: To analyse with functions (polynomials, reciprocals, exponential, trigonometric, hyperbolic) of single real/complex variable and its synthesis and describe mappings in the complex plane.	S	S	S	S	L	S

S- Strong; M-Medium; L-Low

Category: C6
Subject Name: Numerical Analysis
Subject Code: BMCA302

Course Objectives:

1. To use several methods of solving algebraic and transcendental equations of one variable.
2. To approximate functions by polynomials.
3. To approximate differentiation & integration.
4. To solve IVP numerically.
5. To solve linear systems of equation.
6. To use iterative techniques to solve linear systems.

Course description:

Solution to Transcendental and Polynomial Equations: Iterative methods, bisection method, secant method, Newton-Raphson method, fixed point iteration, methods for finding complex roots.

Matrices and Linear System of Equations: LU decomposition method for solving systems of equations, Symmetric positive definite matrices and least square approximation, iterative algorithms for linear equations.

Interpolation: Polynomial interpolation, Newton-Gregory, Stirling's, Bessel's and Lagrange's interpolation formula, Newton's divided differences interpolation formulae.

Curve fitting: Spline and Approximation: Fitting linear and non-linear curves, weighted least square approximation, method of least square for continuous functions.

Numerical Differentiation and Integration: Numerical differentiation and errors in numerical differentiation, Newton-Cotes formulae, trapezoidal rule, Simpson's rule, Gaussian integration.

Numerical Solutions of Ordinary Differential Equations: Picard's and Taylor's series, Euler's and Runge-Kutta (RK) methods.

Finite Element Method: Boundary value problems, Rayleigh and Galerkin methods of approximation, applications.

Books Recommended:

1. K.E. Atkinson, W. Han, Elementary Numerical Analysis, 3rd Ed., Wiley, 2003.
2. C. Xavier, S.S. Iyengar, Introduction to Parallel Algorithms, Wiley-Interscience, 1998.
3. A. Kharab, R.B. Guenther, An Introduction to Numerical Methods: A MATLAB Approach, 1st Ed., Chapman and Hall/CRC, 2001.
4. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, 2007.
5. S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer, 2005.
6. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Ed., New Age International Publishers, 2007.

Course Outcomes:

Upon successful completion students will be able

1. To understand the potential pitfalls of numerical computations.
2. To determine the roots of nonlinear equations and solve system of linear equations.
3. To evaluate integrals numerically.
4. To do function approximation and interpolation using polynomials.
5. To get the numerical solutions of Initial and boundary value problem.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Numerical Analysis (BMCA302)						
CO1: To understand the potential pitfalls of numerical computations.	S	S	S	S	M	S
CO2: To determine the roots of nonlinear equations and solve system of	S	S	S	S	M	S

linear equations.						
CO3: To evaluate integrals numerically.	S	S	S	M	M	M
CO4: To do function approximation and interpolation using polynomials.	S	S	S	M	M	S
CO5: To get the numerical solutions of Initial and boundary value problem.	S	S	S	S	M	S

S- Strong; M-Medium; L-Low

Category: C7
Subject Name: Design and Analysis of Algorithms
Subject Code: BMCA303

Course description:

Introduction: RAM model, O(log n) bit model. Review of data structures: Balanced trees, Mergeable sets. Algorithm Design Techniques: Iterative techniques, Divide and conquer, dynamic programming, greedy algorithms.

Searching and Sorting Techniques: Review of elementary sorting techniques-selection sort, bubble sort, insertion sort, more sorting techniques-quick sort, heap sort, merge sort, shell sort, external sorting.

Lower bounding techniques: Decision Trees, Adversaries. String Processing: KMP, BoyreMoore, Robin Karp algorithms.

Introduction to randomized algorithms: Random numbers, randomized Qsort, randomly Built BST Number Theoretic Algorithms: GCD, Addition and Multiplication of two large numbers, polynomial arithmetic, Fast-Fourier Transforms.

Graphs: Analysis of Graph algorithms Depth-First Search and its applications, minimum Spanning Trees and Shortest Paths. Introduction to Complexity Theory: Class P, NP, NP-Hard, NP Completeness. Introduction to Approximation Algorithms.

Books Recommended:

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, PrenticeHall of India, 2006.
2. J. Kleinberg and E. Tardos, Algorithms Design, Pearson Education, 2006.
3. S. Baase, Computer Algorithms: Introduction to Design and Analysis, Addison Wesley, 1999.
4. A.V. Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 2006.

Course Outcomes:

Upon successful completion students will be able to

1. Analyze the worst-case running times of algorithms based on asymptotic analysis.

2. Model a problem and develop the appropriate algorithm from divide and conquer, greedy, dynamic programming and other paradigms.
3. Classify problems in appropriate complexity classes and apply approximation and randomized algorithms in solving computationally hard real life problems.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Design and Analysis of Algorithms (BMCA303)						
CO1: Analyze the worst-case running times of algorithms based on asymptotic analysis.	S	M	S	M	M	S
CO2: Model a problem and develop the appropriate algorithm from divide and conquer, greedy, dynamic programming and other paradigms.	S	S	S	M	M	S
CO3: Classify problems in appropriate complexity classes and apply approximation and randomized algorithms in solving computationally hard real life problems.	S	S	S	M	L	S

S- Strong; M-Medium; L-Low

Category: GE 3
Subject Name: Chemistry-I
Subject Code: BMCA304A

Course description:

i) Atomic structure and Chemical Periodicity (6 Lectures)

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states.

ii) Chemical Bonding and of molecular structure (10 Lectures)

Introduction to the electronic theory of binding, Ionic character of bonds, Bond energy, Molecular orbitalsof diatomic molecules (e.g.H_2). Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene andbenzene and aromaticity.Crystal field theory and the energy level diagrams for transition metal ions.Co-ordination numbers and geometries.

iii) Thermodynamics and Electrochemistry (10 Lectures)

First and second laws of thermodynamics and thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Conductance of ions in solution, Free energy and emf. Cell potentials, the Nernst equation and applications. Use of free energy consideration sinmetallurgy through Ellingham diagrams, Corrosion.

iv) Chemical kinetics and Quantum Chemistry (10 Lectures)

Introduction of reaction rate in terms of extent of reaction; rate constants, order and molecularity of reactions. Reactions of zero order, first order, second order and fractional order. Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate.). Schrodinger equation. Particle in one dimensional box solution and their applications.

v) Ionic Equilibrium (8 Lectures)

General principle of equilibrium,the equilibrium constant,acid base and redox equilibrium, hydrolysis of salts, pH and pOHscale,buffersolution,Hendersonequation,acid base and redox indicator. solubility and solubility product, common ion effect,application of the concept in qualitative analysis.

vi) Surface Chemistry (4 Lectures)

Adsorption, Adsorption isotherm, Surface catalysis, Colloids, lyophobic and lyophilic colloids, Properties of colloids, Stability of colloids, Schulze Hardy rule.

Books Recommended:

1. Physical Chemistry by P.C.Rakshit
2. Physical Chemistry by G.W. Castellan
3. Inorganic chemistry by R.L.Dutta
4. Inorganic chemistry by Cotton and Wilkinson
5. Organic Chemistry by I.L.Finar
6. Molecular Spectroscopy by C.M. Banwell.
7. Experimental Physical Chemistry by V.D. Athawale and ParulMathur.

Course Outcomes:

Upon successful completion students will be able to

1. Gain complete knowledge about all fundamental aspects of all the elements of chemistry
2. Gather attention about the physical aspects of atomic structure and appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
3. Gather knowledge about the bonding in molecules and various aspects of co-ordination chemistry along with an explanation of the Quantum mechanical treatment of chemical bonding
4. Understand the fundamentals of thermodynamic system and surroundings along with entropy of different processes through thermodynamics
5. Appreciate the importance of electrochemistry along with its laws and also gaining a deep insight about electrochemical cell & various redox reactions.
6. Gather knowledge about rate laws of chemical transformations, experimental methods of determining the rate of a reaction.
7. Understand the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt followed by determination of pH of buffer solutions.
8. Gain an insight on surface and interfacial phenomena along with understanding the interactions between colloidal particles and explain colloidal stability and instability.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Chemistry-I (BMCA304A)						
CO1: Gain complete knowledge about all fundamental aspects of all the elements of chemistry	M	S	S	S	M	M
CO2: Gather attention about the physical aspects of atomic structure and appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.	S	S	M	M	L	M
CO3: Gather knowledge about the bonding in molecules and various aspects of co-ordination chemistry along with an explanation of the Quantum mechanical treatment of chemical bonding	S	S	M	M	L	M
CO4: Understand the fundamentals of thermodynamic system and surroundings along with entropy of different processes through thermodynamics	M	S	S	M	M	M
CO5: Appreciate the importance of electrochemistry along with its laws and also gaining a deep insight about electrochemical cell & various redox reactions.	M	S	M	M	L	M
CO6: Gather knowledge about rate laws of chemical transformations, experimental methods of determining the rate of a reaction.	M	M	S	S	M	M
CO7: Understand the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt followed by determination of pH of buffer solutions.	M	S	M	M	L	M
CO8: Gain an insight on surface and interfacial phenomena along with understanding the interactions between colloidal particles and explain colloidal stability and instability	M	S	M	M	L	M

S- Strong; M-Medium; L-Low

Category: GE3
Subject Name: Statistics-I
Subject Code: BMCA304B

Course description:

Probability: Random Experiments and Random Events, Statistical regularity and meaning of Probability, Classical and Axiomatic definitions of Probability (discrete sample space only), Conditional Probability, Independence of Events, Principal Theorems including union and intersection of events and Bayes Theorem.

Random Variable and its Probability Distribution, Cumulative Distribution Function, Probability Mass Function and Probability Density Function, Mathematical Expectation, Variance and Moments.

Joint Distribution of two random variables, Marginal and Conditional distributions, Covariance and Correlation, Simple Theorems including theorems on expectation and variance of a sum of random variables and expectation of product of random variables.

Chebychev's Inequality, Weak Law of Large Numbers, Bernoulli's Theorem.

Descriptive Statistics: Types of statistical data, Compilation, Classification, Tabulation and Diagrammatic representation of data, Frequency Distribution, Cumulative Distribution and their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive.

Analysis of Univariate Quantitative Data – concepts of central tendency, dispersion, relative dispersion, skewness and kurtosis and their measures based on quantiles and moments. Fitting of Binomial, Poisson and Normal distributions.

Analysis of Bivariate Quantitative Data – Scatter Diagram, Product Moment Correlation Coefficient and its properties, Correlation Ratio, Regression Analysis, Fitting of Linear and Polynomial equations by the principle of Least Squares, Correlation Index, Spearman's Rank Correlation Coefficients.

Analysis of Multivariate Quantitative Data – Multiple Regression, Multiple Correlation and Partial Correlation in three variables, their measures and related results.

Analysis of Categorical Data – Independence and Association of Attributes, Measures of association for two-way classified data.

Standard Univariate Discrete Distributions and their properties – Discrete Uniform, Binomial, Poisson and Hypergeometric distributions.

Standard Univariate Continuous Distributions – Uniform, Normal, Exponential, Bivariate Normal distribution and statement of its general properties.

Books Recommended:

1. J.E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, 2009.
2. A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamentals of Statistics, Vol. I, 8th Ed., World Press, Kolkatta, 2005.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand and Sons, 2007.
4. R.V. Hogg, A.T. Craig and J.W. Mckean, Introduction to Mathematical Statistics, 6th Ed., Pearson Education, 2005.
5. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw Hill Publication, 2007.

Course Outcomes:

Upon successful completion students will be able to

1. Explain the various fundamental concepts and different attributes of theory of probability.
2. Apply basic concepts of statistics to analyse a real life problem
3. Analyze and appreciate variety of performance measures for various data related assignment

Relationship of CO with PO mapping:

CO	PO					
	1	2	3	4	5	6
Statistics-I (BMCA304B)						
CO1: Explain the various fundamental concepts and different attributes of theory of probability	M	S	S	S	M	M
CO2: Apply basic concepts of statistics to analyse a real life problem.	M	M	S	M	M	M
CO3: Analyze and appreciate variety of performance measures for various data related assignment.	S	S	S	M	L	M

S- Strong; M-Medium; L-Low

Category: GE3
Subject Name: Mathematical Economics
Subject Code: BMCA304C

Course objectives:

1. Build models by expressing words in symbols, numbers and equations.
2. Explore techniques to solve complex problems.
3. Measure the effect of change and discover techniques to improve your decision-making process.
4. Explore Economic dynamics.

Course description:

Number Systems, Set Theory and Functions; Economic Models.

Utility and Partial Equilibrium Market Model, Matrix Algebra; Application of Matrix in Market Model and National Income Model.

Input-Output Analysis; Differentiation; Linear Programming; Duality in Linear programming**;** Integration and its Applications.

Difference Equations; Applications of Difference Equations and differential equations in Economics.

Computational Economics.

Course Outcomes:

Upon successful completion students will be able to

1. Build economic models by using numbers and equations in real life situations.
2. Measure the effect of change and discover techniques to improve your decision-making process
3. Implement economic dynamics and solve problems through adjustments with time.

4. Apply scientific, logical and critical thinking to solve personal, professional and social decision making problems.

Books Recommended:

1. Chiang, Alpha C., Fundamental Methods of Mathematical Economics, McGraw Hill
2. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group

Relationship of CO with PO mapping:

CO	PO					
	1	2	3	4	5	6
Mathematical Economics (BMCA304C)						
CO1: Build economic models by using numbers and equations in real life situations.	M	S	S	S	M	M
CO2: Measure the effect of change and discover techniques to improve your decision-making process	S	S	M	M	M	S
CO3: Implement economic dynamics and solve problems through adjustments with time.	M	S	M	S	M	M
CO4: Apply scientific, logical and critical thinking to solve personal, professional and social decision making problems.	M	S	S	M	M	M

S- Strong; M-Medium; L-Low

Category: GE3
Subject Name: Data Science
Subject Code: BMCA304D

Course Objectives:

1. Provide Insights About the Roles of a Data Scientist
2. Enable You to Analyze of Big Data.
3. Learn Techniques and Tools for Transformation of Data
4. Make You Understand Data Mining
5. Make You Figure Out Machine Learning Algorithms
6. Learn Data Visualization and Optimization

Course description:

Data Scientist's Tool Box: Turning data into actionable knowledge, introduction to the tools that will be used in building data analysis software: version control, markdown, git, GitHub, R, and RStudio.

R Programming Basics: Overview of R, R data types and objects, reading and writing data, Control structures, functions, scoping rules, dates and times, Loop functions, debugging tools, Simulation, code profiling.

Getting and Cleaning Data: Obtaining data from the web, from APIs, from databases and from colleagues in various formats. basics of data cleaning and making data ―tidy‖.

Exploratory Data Analysis: Essential exploratory techniques for summarizing data, applied before formal modelling commences, eliminating or sharpening potential hypotheses about the world that can be addressed by the data, common multivariate statistical techniques used to 45 visualize high-dimensional data.

Reproducible Research: Concepts and tools behind reporting modern data analyses in a reproducible manner. To write a document using R markdown, integrate live R code into a literate statistical program, compile R markdown documents using knitr and related tools, and organize a data analysis so that it is reproducible and accessible to others.

Course outcomes:

Upon successful completion students will be able to

1. Demonstrate proficiency with statistical techniques for data analysis.
2. Develop the ability to build and assess data-based models.
3. Execute statistical analyses with professional statistical software.
4. Demonstrate skill in data management.

Books Recommended:

1. Rachel Schutt, Cathy O'Neil, "Doing Data Science: Straight Talk from the Frontiline" by Schroff/O'Reilly, 2013.
2. Foster Provost, Tom Fawcett, "Data Science for Business" What You Need to Know About Data Mining and Data-Analytic Thinking" by O'Reilly, 2013.
3. John W. Foreman, "Data Smart: Using data Science to Transform Information into Insight" by John Wiley & Sons, 2013.
4. Ian Ayres, "Super Crunchers: Why Thinking-by-Numbers Is the New Way to Be Smart" Ist Edition by Bantam, 2007.
5. Eric Seigel, "Predictive Analytics: The Power to Predict who Will Click, Buy, Lie, or Die", 1st Edition, by Wiley, 2013.
6. Matthew A. Russel, "Mining the Social Web: Data mining Facebook, Twitter, Linkedln, Goole+, GitHub, and More", Second Edition, by O'Reilly Media, 2013.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Data Science (BMCA304D)						
CO1: Demonstrate proficiency with statistical techniques for data analysis.	S	S	S	M	M	S
CO2: Develop the ability to build and assess data-based models.	S	S	M	M	L	S
CO3: Execute statistical analyses with professional statistical software.	S	M	S	S	M	S
CO4: Demonstrate skill in data management.	M	M	S	M	M	M

S- Strong; M-Medium; L-Low

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB
Syllabus of B.Sc with Mathematics and Computer Applications (In-house)
(Effective for 2020-2021 Admission Session)
Choice Based Credit System
140 Credit (3-Year UG) MAKAUT Framework
w.e.f 2020-21

Category: GE3
Subject Name: Soft Computing
Subject Code: BMCA304E

Course objectives:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
2. To implement soft computing based solutions for real-world problems.
3. To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
4. To provide studentan hand-on experience on MATLAB to implement various strategies.

Course description:

Introduction to Soft Computing, Evolution of Computing, Soft Computing Constituents, From Conventional Artificial Intelligence to Computational Intelligence - Machine Learning Basics.

Neural Networks, Biological Neuron, Artificial Neuron, Artificial Neural Network, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feed forward network, Back propagation,Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications.

Heuristic and Meta-heuristic Search, Genetic Algorithm (GA), different operators of Genetic Algorithm, Analysis of selection operations, Hypothesis of building Blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Tabu Search, Swarm Intelligence, Particle Swarm Optimization, Applications.

Fuzzy sets and Fuzzy logic, Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, Fuzzy Decision Making, Applications.

Hybrid Systems, Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Books Recommended:

1. Mitchell Melanie, “An Introduction to Genetic Algorithm”, Prentice Hall, 1998.
2. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison Wesley, 1997.
3. S. Haykin, “Neural Networks”, Pearson Education, 2ed, 2001.
4. S. Rajasekaran& G. A. V. Pai, Neural Networks, Fuzzy logic, and Genetic Algorithms, PHI.
5. Fuzzy Sets and Fuzzy Logic, Klir& Yuan, PHI, 1997.
6. Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran and G. A. V. Pai, PHI.
7. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.

Course Outcomes:

Upon successful completion students will be able to

1. Apply basics of Fuzzy logic and neural networks to deal with human uncertainties.
2. Relate with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
3. Describe with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations.
4. Develop some familiarity with real life example.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Soft Computing (BMCA304E)						
CO1: Apply basics of Fuzzy logic and neural networks to deal with human uncertainties.	S	S	S	M	M	S
CO2: Relate with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.	S	M	S	M	M	S
CO3: Describe with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations.	S	M	S	M	M	S
CO4: Develop some familiarity with real life example.	M	M	M	M	M	M

S- Strong; M-Medium; L-Low

Category: SEC1
Subject Name: Analytical geometry
Subject Code: BMCA305A

Course objectives:

1. To introduce the geometry of lines and conics in the Euclidean plane.
2. To develop geometry with a degree of confidence.
3. To gain fluency in the basics of Euclidean geometry.

Course description:

Techniques for sketching parabola, ellipse and hyperbola.

Reflection properties of parabola, ellipse and hyperbola.

Classification of quadratic equations representing lines, parabola, ellipse and hyperbola.

Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Books Recommended:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) Pvt. Ltd. 2002.
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.

Course Outcomes:

Upon successful completion the students will be able to

1. Define conics and draw the graph of conics.
2. Understand the properties of planes, lines, spheres and cones.
3. Express the real life problems geometrically and then get the solution.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Analytical geometry (BMCA305A)						
CO1: Define conics and draw the graph of conics.	S	S	S	S	M	S
CO2: Understand the properties of planes, lines, spheres and cones.	S	S	S	S	M	S
CO3: Express the real life problems geometrically and then get the solution.	M	S	M	M	M	M

S- Strong; M-Medium; L-Low

Category: SEC1
Subject Name: Graph Theory
Subject Code: BMCA305B

Course description:

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite 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.

Graph Coloring, Coloring maps and planar graphs; Coloring vertices, Coloring Edges, List Coloring.

Books Recommended:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Course Outcomes:

Upon successful completion the students will be able to

1. To understand and apply the fundamental concepts in graph theory,
2. To analyze network problems using the concepts of graph theory,
3. To introduce the basics of graphs and combinatory required for VLSI design and Optimization.
4. To understand the various types of graph Algorithms and graph theory properties,

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Graph Theory (BMCA305B)						
CO1: To understand and apply the fundamental concepts in graph theory,	S	S	S	S	M	S
CO2: To analyze network problems using the concepts of graph theory,	M	S	S	M	M	M
CO3: To introduce the basics of graphs and combinatory required for VLSI design and Optimization.	S	M	S	M	M	S
CO4: To understand the various types of graph Algorithms and graph theory properties,	S	S	M	M	L	S

S- Strong; M-Medium; L-Low

Category: Core Course
Subject Name: Numerical Analysis Practical
Subject Code: BMCA391

Course Objectives:

The Objectives of this course are

1. To gain the basic knowledge of any one programming language of FORTRAN/ C/ C++/ Python/ MATLAB.
2. To co-relate with the theoretical and practical studies relate to Numerical Analysis.
3. To understand the limitations, advantages and disadvantages of different numerical method.
4. To introduce the numerical techniques of solving algebraic and transcendental equations, solving system of linear equations and ordinary differential equations.
5. To acquaint the knowledge of various techniques of interpolation and numerical integration.

Note: At least ten experiments to be completed by each student.

Course description:

List of practical problems (using FORTRAN/ C/ C++/ Python/ MATLAB):

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ….+ 1/ N.
2. Enter 100 integers into an array and sort them in an ascending order.

3. Solution of transcendental and algebraic equations by
    a. Bisection method
    b. Newton Raphson method.
    c. Secant method.
    d. Regula Falsi method.
4. Solution of system of linear equations
    a. LU decomposition method
    b. Gaussian elimination method
    c. Any one iterative method
5. Interpolation
    a. Newton Interpolation
    b. Lagrange Interpolation
6. Numerical Integration
    a. Trapezoidal Rule
    b. Simpson's rule
7. Solution of ordinary differential equations
    a. Euler method
    b. Modified Euler method
    c. Runge Kutta method.

Examination Scheme for Practical Sessional examination:

Internal Examination:	
Continuous evaluation	: 40
External Examination:	
Examiner-Signed Lab Assignments	: 10
On Spot Experiment	: 40
Viva voce	: 10
Total	**: 100**

Books Recommended:

7. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Ed., New Age International Publishers, 2007.
8. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
9. Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
10. Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
11. Yashavant Kanetkar, Let Us C, BPB Publications.

Course outcomes:

Upon successful completion of the course students are able to:

1. Implement the knowledge of any one programming language of FORTRAN/ C/ C++/ Python/ MATLAB.
2. Determine the roots of nonlinear equations and solution of system of linear equations.

3. Introduce the numerical techniques of interpolation in various intervals.
4. Find the integral value using different numerical integration methods.
5. Understand to solve ordinary differential equations by various numerical techniques.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Numerical Analysis Practical (BMCA391)						
CO1: Implement the knowledge of any one programming language of FORTRAN/ C/ C++/ Python/ MATLAB.	S	S	S	S	S	S
CO2: Determine the roots of nonlinear equations and solution of system of linear equations.	S	M	S	S	S	M
CO3: Introduce the numerical techniques of interpolation in various intervals.	S	M	S	S	S	M
CO4: Find the integral value using different numerical integration methods.	S	M	M	S	M	M
CO5: Understand to solve ordinary differential equations by various numerical techniques.	S	S	S	S	S	S

S- Strong; M-Medium; L-Low

Category: Core Course
Subject Name: Design and Analysis of Algorithms Lab (Python)
Subject Code: BMCA392

Course objectives:

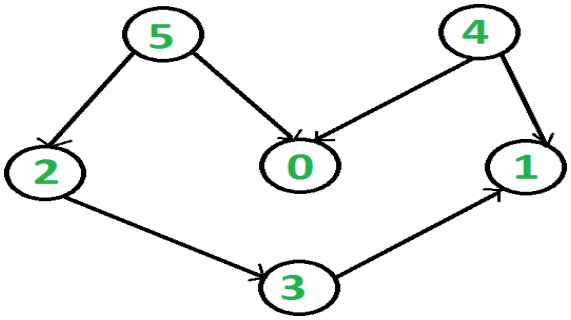
The course should enable the students to:

1. Learn how to analyze a problem and design the solution for the problem.
2. Design and implement efficient algorithms for a specified application.
3. Strengthen the ability to identify and apply the suitable algorithm for the given real world problem.

Course description:

1. QUICK SORT - Sort a given set of elements using the quick sort method and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the 1st to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
2. MERGE SORT - Implement merge sort algorithm to sort a given set of elements and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
3. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

4. a. Obtain the Topological ordering of vertices in a given digraph.



b. Compute the transitive closure of a given directed graph using Warshall's algorithm.

5. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.
6. Print all the nodes reachable from a given starting node in a digraph using BFS method.
7. Implement any scheme to find the optimal solution for the Traveling Sales Person problem and then solve the same problem instance using any approximation algorithm and determine the error in the approximation.

Books Recommended:

1. Levitin A, "Introduction to the Design And Analysis of Algorithms", Pearson Education, 2008.
2. Goodrich M.T.,R Tomassia, "Algorithm Design foundations Analysis and Internet Examples", John Wiley and Sons, 2006.
3. Base Sara, Allen Van Gelder ," Computer Algorithms Introduction to Design and Analysis", Pearson, 3rd Edition, 1999.

Course outcomes:

Students who complete the course will have demonstrated the ability to do the following:

1. Argue the correctness of algorithms using inductive proofs and invariants.
2. Analyze worst-case running times of algorithms using asymptotic analysis.
3. Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.
4. Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic-programming algorithms, and analyze them.
5. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize greedy algorithms, and analyze them.
6. Explain the major graph algorithms and their analyses. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Design and Analysis of Algorithms Lab (Python) (BMCA392)						
CO1: Argue the correctness of algorithms using inductive proofs and invariants.	L	S	L	S	L	L
CO2: Analyze worst-case running times of algorithms using asymptotic analysis.	L	S	L	S	L	L
CO3: Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.	M	S	M	S	M	S
CO4: Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic-programming algorithms, and analyze them.	S	S	M	M	S	S
CO5: Describe the greedy paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize greedy algorithms, and analyze them.	S	S	M	M	L	M
CO6: Explain the major graph algorithms and their analyses. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them.	S	S	M	M	L	M

S- Strong; M-Medium; L-Low

Category: Generic Elective
Subject Name: Chemistry-I Practical
Subject Code: BMCA393A

Course description:

Practical (Any five):

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
3. Determination of dissolved oxygen present in a given water sample.
4. Determination of surface tension and viscosity.
5. Ion exchange column for removal of hardness of water.
6. Determination of the rate constant of a reaction.
7. Adsorption of acetic acid by charcoal.
8. Chemical analysis of a salt.
9. Determination of the partition coefficient of a substance between two immiscible liquids.

Books Recommended:

1. Physical Chemistry by P.C.Rakshit
2. Physical Chemistry by G.W. Castellan
3. Inorganic chemistry by R.L.Dutta
4. Inorganic chemistry by Cotton and Wilkinson
5. Organic Chemistry by I.L.Finar
6. Molecular Spectroscopy by C.M. Banwell.
7. Experimental Physical Chemistry by V.D. Athawale and ParulMathur.

Course Outcomes:

Upon successful completion students will be able to

1. Gain complete knowledge about all fundamental aspects of all the elements of chemistry
2. Gather attention about the physical aspects of atomic structure and appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
3. Gather knowledge about the bonding in molecules and various aspects of co-ordination chemistry along with an explanation of the Quantum mechanical treatment of chemical bonding
4. Understand the fundamentals of thermodynamic system and surroundings along with entropy of different processes through thermodynamics
5. Appreciate the importance of electrochemistry along with its laws and also gaining a deep insight about electrochemical cell & various redox reactions.
6. Gather knowledge about rate laws of chemical transformations, experimental methods of determining the rate of a reaction.
7. Understand the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt followed by determination of pH of buffer solutions.
8. Gain an insight on surface and interfacial phenomena along with understanding the interactions between colloidal particles and explain colloidal stability and instability.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Chemistry-I Practical (BMCA393A)						
CO1: Gain complete knowledge about all fundamental aspects of all the elements of chemistry	M	S	S	S	M	M
CO2: Gather attention about the physical aspects of atomic structure and appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.	S	S	M	M	L	M
CO3: Gather knowledge about the bonding in molecules and various aspects of co-ordination chemistry along with an explanation of the Quantum mechanical treatment of chemical bonding	S	S	M	M	L	M
CO4: Understand the fundamentals of thermodynamic system and	M	S	S	M	M	M

surroundings along with entropy of different processes through thermodynamics						
CO5: Appreciate the importance of electrochemistry along with its laws and also gaining a deep insight about electrochemical cell & various redox reactions.	M	S	M	M	L	M
CO6: Gather knowledge about rate laws of chemical transformations, experimental methods of determining the rate of a reaction.	M	M	S	S	M	M
CO7: Understand the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt followed by determination of pH of buffer solutions.	M	S	M	M	L	M
CO8: Gain an insight on surface and interfacial phenomena along with understanding the interactions between colloidal particles and explain colloidal stability and instability	M	S	M	M	L	M

S- Strong; M-Medium; L-Low

Category: Generic Elective
Subject Name: Data Science Practical
Subject Code: BMCA393B

Course description:

Practical (Using R)

1. Write a program that prints “Hello World” to the screen.
2. Write a program that asks the user for a number n and prints the sum of the numbers 1 to n
3. Write a program that prints a multiplication table for numbers up to 12.
4. Write a function that returns the largest element in a list.
5. Write a function that computes the running total of a list.
6. Write a function that tests whether a string is a palindrome.
7. Implement linear search.
8. Implement binary search.
9. Implement matrices addition , subtraction and Multiplication
10. Fifteen students were enrolled in a course. There ages were: 20 20 20 20 20 21 21 21 22 22 22 22 22 23 23 23.
    i) Find the median age of all students.
    ii) Find the mean age of all students
    iii) Find the modal age for all students
    iv) Two more students enter the class. The age of both students is 23. What is now mean, mode and median?
11. Obtain probability distribution of, where X is number of spots showing when a six-sided symmetric die (i.e. all six faces of the die are equally likely) is rolled. Simulate random samples of sizes 40, 70 and 100 respectively and verify the frequency interpretation of probability.

12. Make visual representations of data using the base, lattice, and ggplot2 plotting systems in R, apply basic principles of data graphics to create rich analytic graphics from available datasets.
13. Use Git / Github software to create Github account. Also, create a repo using Github.

Books Recommended:

1. Rachel Schutt, Cathy O'Neil, "Doing Data Science: Straight Talk from the Frontiline" by Schroff/O'Reilly, 2013.
2. Foster Provost, Tom Fawcett, "Data Science for Business" What You Need to Know About Data Mining and Data-Analytic Thinking" by O'Reilly, 2013.
3. John W. Foreman, "Data Smart: Using data Science to Transform Information into Insight" by John Wiley & Sons, 2013.
4. Ian Ayres, "Super Crunchers: Why Thinking-by-Numbers Is the New Way to Be Smart" Ist Edition by Bantam, 2007.
5. Eric Seigel, "Predictive Analytics: The Power to Predict who Will Click, Buy, Lie, or Die", 1st Edition, by Wiley, 2013.
6. Matthew A. Russel, "Mining the Social Web: Data mining Facebook, Twitter, Linkedln, Goole+, GitHub, and More", Second Edition, by O'Reilly Media, 2013.

Course outcomes:

Upon successful completion students will be able to

1. Demonstrate proficiency with statistical techniques for data analysis.
2. Develop the ability to build and assess data-based models.
3. Execute statistical analyses with professional statistical software.
4. Demonstrate skill in data management.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Data Science Practical (BMCA393B)						
CO1: Demonstrate proficiency with statistical techniques for data analysis.	S	S	S	M	M	S
CO2: Develop the ability to build and assess data-based models.	S	S	M	M	L	S
CO3: Execute statistical analyses with professional statistical software.	S	M	S	S	M	S
CO4: Demonstrate skill in data management.	M	M	S	M	M	M

S- Strong; M-Medium; L-Low

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Semester-IV:

Category: C8
Subject Name: Algebra
Subject Code: BMCA401

Course description:

Matrices, Vectors and Systems of linear equations: Introduction to Matrix and Determinant, Systems of Linear Equations, Consistency, Elementary Row-operations, Row-equivalent matrices, Row-reduced Echelon Matrices and its application to Solution of Linear system of equations, Elementary Matrices.

Vector spaces, basis, dimension : Vector spaces, Subspaces, Bases and dimension, Spanning set, Basis from spanning set, a Linear independence , Linear span, Linear transformations and matrices, Relation between rank & nullity, Coordinate change w.r.to Linear transformations, Linear Functionals, the Cayley-Hamilton Theorem its applications, Eigen Values & Eigen vectors of a matrix and there properties, similarity transformation, diagonalisability .

An introduction to Abstract Algebra: History of abstract algebra, review of set theory, the notion of a group, Examples of groups, Modular arithmetic and symmetry groups, Generator of a group Cyclic groups, Classification of cyclic groups, Cyclic subgroups, Multiplicative group modulo *n*. abelian groups, Order of element in a group, Dihedral groups, Cyclic decomposition, Subgroups. Lagrange's theorem,

Ring**:** Quadratic integer rings. Polynomial rings. Matrix rings.
Fields: Skew-fields, Zero-divisors, Units, Integral domains, Unit group, Unit groups of quadratic integer rings.

Books Recommended:

1. Loehr, Nicholas, Advanced Linear Algebra, Taylor & Francis Inc, ISBN13: 9781466559011.
2. IulianaIatan, Advanced Lectures on Linear Algebra with Applications, LAP Lambert Academic Publishing, ISBN13: 9783844324105.
3. Sohail A. Dianat, Eli Saber, Advanced Linear Algebra for Engineers with MATLAB, Taylor Francis Inc, ISBN13: 9781420095234.
4. K.Hoffman and R.Kunze, Linear Algebra, 2nd Edition, Prentice- Hall of India, 2005. 2.
5. M.Artin,Algebra,Prentice-Hall of India, 2005.

Course Outcomes:

Upon successful completion the students will be able to

1. Recognize the concepts of the terms span, linear independence, basis, and dimension, and apply these concepts to various vector spaces and subspaces.
2. Use matrix algebra and the related matrices to linear transformations.
3. Find the eigenvalues and eigenvectors of a square matrix using the characteristic polynomial and use it to diagonalize a matrix.
4. Familiarization with group, ring and field.

Relationship of CO with PO mapping:

CO	PO					
	1	2	3	4	5	6
Algebra (BMCA401)						
CO1: Recognize the concepts of the terms span, linear independence, basis, and dimension, and apply these concepts to various vector spaces and subspaces.	S	S	M	S	S	S
CO2: Use matrix algebra and the related matrices to linear transformations.	S	M	S	S	S	S
CO3: Find the eigenvalues and eigenvectors of a square matrix using the characteristic polynomial and use it to diagonalize a matrix.	S	S	M	M	S	S
CO4: Familiarization with group, ring and field.	S	S	S	S	M	S

S- Strong; M-Medium; L-Low

Category: C9
Subject Name: Discrete Mathematics
Subject Code: BMCA402

Course description:

Partial Ordering Relation, Equivalence Relation, Lattice.

Principles of Mathematical Induction: The Well Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

Basic counting techniques: inclusion and exclusion, pigeon-hole principle, permutation and combination, Recurrence relation, Generating function.

Propositional Logic: Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers. Proof Techniques: Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

Boolean algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form.

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles.

Books Recommended:

1. J.K. Sharma, Discrete Mathematics, Macmillan.
2. Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PEARSON.

Course Outcomes:

Upon successful completion students will be able to

1. Understand the basic principles of sets and operations in sets.
2. Apply counting principles to determine probabilities.
3. Formulate computational problems using trees and graphs.
4. Write an argument using logical notation and determine the validity of an argument.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Discrete Mathematics (BMCA402)						
CO1: Understand the basic principles of sets and operations in sets.	S	M	M	S	M	S
CO2: Apply counting principles to determine probabilities.	S	S	S	M	S	S
CO3: Formulate computational problems using trees and graphs.	S	M	S	M	M	S
CO4: Write an argument using logical notation and determine the validity of an argument.	M	M	S	L	M	S

S- Strong; M-Medium; L-Low

Category: C10
Subject Name: Optimization Techniques
Subject Code: BMCA403

Course description:

Module-1: Concept of optimization, classification of optimization problems.

Module-2: Examples of linear programming problems, formulation simplex methods variable with upper bounds, principle duality, dual simplex method, sensitivity analysis, revised simplex procedure, solution of the transportation problem, assignment, network minimization, shortest route problem , maximal two problem, L.P. representation of networks.

Module-3: Queuing Model, poison and exponential distributions -Queues with combined arrivals and departures-random and series queues.

Module-4: Maximization and minimization of convex functions, Necessary and sufficient conditions for local minima – speed and order of convergence, steepest and desent methods, conjugate gradient method. Necessary and sufficient condition, equality constraints, inequality constraints, kuhu- tucker conditions, gradient projection method, penalty function methods, cutting plane methods.

Module-5: Review on Genetic Algorithm (GA), Artificial Neural Networks and Particle swarm optimization.

Books Recommended:

1. H. A. Taha. "Operations Research, An Introduction", PHI, India, 2002.
2. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons (2009). • Kwang Y. Lee,
3. D. Gross and C. M. Harris, Fundamentals of Queueing Theory, Wiley, 2018
4. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
5. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
6. Genetic Algorithms in Search, Optimization and Machine Learning, David E. Goldberg, Pearson Education, 2002.
7. HarndyA.Tahh. "operations Research, An Introduction", Macmillan Publishers Co. New York, 1982.

Course Outcomes:

Upon successful completion students will be able to

1. Explain the various fundamental concepts of the optimization theory.
2. Use concepts of mathematical properties to formulate an optimization problem
3. Analyze and appreciate variety of performance measures for various optimization problems

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Optimization Techniques (BMCA403)						
CO1: Explain the various fundamental concepts of the optimization theory.	S	S	S	M	S	M
CO2: Use concepts of mathematical properties to formulate an optimization problem.	S	M	S	S	L	S
CO3: Analyze and appreciate variety of performance measures for various optimization problems.	S	S	M	S	S	S

S- Strong; M-Medium; L-Low

Category: GE 4
Subject Name: Chemistry-II
Subject Code: BMCA404A

Course description:

i. Solid state (8 lectures)

Crystal systems, concept of unit cell, lattice, Miller indices, symmetry elements in crystals, X-ray diffraction, Bragg's law, structure of metal crystals, metallic bonds, band theory, defects in crystals , superconductivity in solids, semiconductor (n-type, p-type).

ii. Solutions and Phase Equilibrium (10 lectures)

Henry's law, Raoult's law, colligative properties (osmotic pressure, lowering of vapour pressure, elevation of boiling point, depression of freezing point,) Phase rule and its applications to one component and simple two component systems, Nernst distribution law.

iii. Coordination Chemistry (10 lectures)

Werner's theory, primary and secondary valency, ligands (monodentate and polydentate), structure of coordination compounds from orbital hybridization of central atoms, isomerism, stability of complex ions in solution, chelate effect.

iv. Spectroscopy (8 lectures)

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications. Vibrational and rotational spectroscopy of diatomic molecules. Raman spectroscopy, Applications. Nuclear magnetic resonance and magnetic resonance imaging

v. Stereochemistry (8 lectures)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

vi. **Organic reactions and synthesis of a drug molecule (4 lectures)**

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Books Recommended:

1. Physical Chemistry by P.C.Rakshit
2. Physical Chemistry by G.W. Castellan
3. Inorganic chemistry by R.L.Dutta
4. Inorganic chemistry by Cotton and Wilkinson
5. Organic Chemistry by I.L.Finar
6. Molecular Spectroscopy by C.M. Banwell.
7. Experimental Physical Chemistry by V.D. Athawale and ParulMathur.

Course Outcomes:

Upon successful completion students will be able to

1. Understand, solve and explain the major concepts in different disciplines of chemistry.
2. Gain knowledge about various theoretical and experimental approach to give fundamental insights into solid state followed by knowledge of characteristic physical properties of different categories of solid materials, with an emphasis on the crystalline state.
3. Learn the importance of Phase Diagrams in the field of materials science and engineering.
4. Use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds, to recognize the types of isomers in coordination compounds and also to be able to name coordination compounds and to be able to draw the structure based on it's name.

5. Analyze data obtained from sophisticated equipments (FT-NMR, FT-IR, UV -Vis, GC, GC-MS, Spectrofluorimeter etc.) for structure elucidation and chemical analysis.
6. Do identification of stereogenic centres in organic molecules and also able to distinguish between different types of isomers, including enantiomers and diastereomers.
7. Gather thorough knowledge about various chemical reactions followed by classification of the drugs with examples and structure, structural activity relation of some important class of drugs followed by gaining proper knowledge of mechanism of action of the drugs.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Chemistry-II (BMCA404A)						
CO1: Understand, solve and explain the major concepts in different disciplines of chemistry.	S	S	S	M	S	S
CO2: Gain knowledge about various theoretical and experimental approach to give fundamental insights into solid state followed by knowledge of characteristic physical properties of different categories of solid materials, with an emphasis on the crystalline state.	S	S	M	S	M	S
CO3: Learn the importance of Phase Diagrams in the field of materials science and engineering.	S	S	S	M	S	S
CO4: Use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds, to recognize the types of isomers in coordination compounds and also to be able to name coordination compounds and to be able to draw the structure based on it's name.	S	S	M	S	S	S
CO5: Analyze data obtained from sophisticated equipments (FT-NMR, FT-IR, UV -Vis, GC, GC-MS, Spectrofluorimeter etc.) for structure elucidation and chemical analysis.	S	S	S	S	M	S
CO6: Do identification of stereogenic centres in organic molecules and also able to distinguish between different types of isomers, including enantiomers and diastereomers.	S	S	M	S	L	S
CO7: Gather thorough knowledge about various chemical reactions followed by classification of the drugs with examples and structure, structural activity relation of some important class of drugs followed by gaining proper knowledge of mechanism of action of the drugs.	S	S	M	S	L	S

S- Strong; M-Medium; L-Low

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Category: GE4
Subject Name: Advanced Statistics
Subject Code: BMCA404B

Course Objectives:

1. Concepts of statistical population and sample, variables and attributes.
2. Measures of central tendency, Dispersion, Skewness and Kurtosis.
3. Moments and their use in studying various characteristics of data.
4. Important theorems on probability and their use in solving problem.
5. Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation coefficient and Multiple correlation coefficient.

Course description:

Sampling Distributions: Population and Sample, Random Sampling and Sampling Distributions of Statistics, sampling distribution of sum of independent Binomial and Poisson variables, $\chi 2$, t and F distributions (derivations excluded), sampling distribution of mean and variance of independent Normal variables.

Statistical Inference: Point Estimation of a population parameter – concepts of Bias and Standard Error of an estimator, concepts of Unbiasedness, Minimum Variance, Consistency and Efficiency of an estimator, Method of Moments and Maximum Likelihood Method of estimation, point estimators of the parameters of Binomial, Poisson, and univariate Normal distributions.

Statistical tests of Hypotheses – Null and Alternative hypotheses, Types of Errors, Critical Region, Level of Significance, Power and p-values, Exact tests of hypotheses under Normal set-up for a single mean, the equality of two means, a single variance and the equality of two variances, Test of Significance of sample correlation coefficient (null case) Interval Estimation – Confidence Interval and Confidence Coefficient, Exact confidence interval under Normal set-up for a single mean, single variance, the difference of two means and the ratio of two variances.

Large Sample Tests and related Interval Estimates of a single mean and a single proportion and difference of two means & two proportions, Fisher's z transformation and its uses, Pearsonian $\chi 2$ tests for goodness of fit & for homogeneity and independence in a contingency table. (6L) 5 Sample Survey: Concepts of Population and sample, Need for sampling, Stages in the design and conduct of sample surveys.

Concept of probability sampling, Random Number tables. Simple random sampling with and without replacement, Stratified random sampling – associated unbiased estimators of population mean, total and proportion, their variances and Unbiased variance estimators.

Design & Analysis of Experiments: Analysis of Variance in one-way classified data and two-way classified data with equal number of observations in each cell. (6L) Basic principles of design – Randomization, Replication and Local Control, Completely Randomized design, Randomized Block design and Latin Square design, applications of the technique of Analysis of Variance for the analysis

of data collected under these designs. (8L) Economic Statistics: Index Number –construction and use of price index numbers and tests in connection with them, Consumer and Wholesale price index numbers, their uses and major steps in their construction. Ideas of National Income.

Time Series Analysis: Different components of a times series, determination of Trend by method of simple moving-averages and by fitting mathematical curves by least squares principle, determination of seasonal indices by methods of trend ratios and ratios to moving averages.

Statistical Quality Control: Advantages of statistical quality control, construction and use of Control Charts for mean, R, number of defectives d, p and number of defects c.

Books Recommended:

1. Moore, David S. (1991), Statistics: concepts and controversies, 3rd ed., New York: W.H. Freeman and Company.
2. Muenchen, Robert A. (2011), R for SAS and SPSS Users, 2nd ed., New York et al.: Springer.
3. Qian, Song S. (2010), Environmental an ecological statistics with R, New York: Taylor & Francis Group.
4. Ross, Sheldon M. (2004), Introduction to probability and statistics for engineers and scientists, 3rd ed., Amsterdam et al.: Elsevier Academic Press.

Course Outcomes:

Upon successful completion students will be able

1. Demonstrate knowledge of probability and the standard statistical distributions.
2. Demonstrate knowledge of fixed-sample and large-sample statistical properties of point and interval estimators.
3. Demonstrate the ability to perform complex data management and analysis.
4. Demonstrate the ability to apply linear, nonlinear and generalized linear models.
5. Demonstrate knowledge of classical and repeated measures multivariate methods and computational techniques.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Advanced Statistics (BMCA 404B)						
CO1: Demonstrate knowledge of probability and the standard statistical distributions.	S	S	M	S	S	S
CO2: Demonstrate knowledge of fixed-sample and large-sample statistical properties of point and interval estimators.	S	S	S	S	S	S
CO3: Demonstrate the ability to perform complex data management and analysis.	S	S	M	S	S	S
CO4: Demonstrate the ability to apply linear, nonlinear and generalized linear models.	S	S	S	S	S	M
CO5: Demonstrate knowledge of classical and repeated measures multivariate methods and computational techniques.	S	S	M	S	L	S

S- Strong; M-Medium; L-Low

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Category: GE4
Subject Name: Financial Mathematics
Subject Code: BMCA404C

Course description:

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

Books Recommended:

1. David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
2. John C. Hull, Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
3. Sheldon Ross, An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.

Course Outcomes:

Upon successful completion the students will be able to

1. Describe, interpret and discuss the theories on interest rates.
2. Demonstrate the capability to deploy established approaches accurately to solve problems of interest rate theories and using models to value cash flows.
3. Demonstrate a basic appreciation of recent developments in financial mathematics and their practical application.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Financial Mathematics (BMCA404C)						
CO1: Describe, interpret and discuss the theories on interest rates.	S	S	S	S	S	S
CO2: Demonstrate the capability to deploy established approaches accurately to solve problems of interest rate theories and using models to value cash flows.	S	M	S	S	S	M
CO3: Demonstrate a basic appreciation of recent developments in financial mathematics and their practical application.	S	S	S	S	S	S

S- Strong; M-Medium; L-Low

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Category: GE4
Subject Name: Machine Learning
Subject Code: BMCA404D

Course description:

Supervised Learning (Regression/ Classification) Basic methods:

1. Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes.
2. Linear models: Linear Regression, Logistic Regression, Generalized Linear Models.
3. Support Vector Machines, Nonlinearity and Kernel Methods.
4. Beyond Binary Classification: Multi-class/Structured Outputs, Ranking.

Unsupervised Learning Clustering:

1. K-means/Kernel K-means.
2. Dimensionality Reduction: PCA and kernel PCA.
3. Matrix Factorization and Matrix Completion.
4. Generative Models (mixture models and latent factor models)

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests).

Sparse Modelling and Estimation, Modelling Sequence/ Time-Series Data, Deep Learning and Feature Representation Learning.

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Recent trends in various learning techniques of machine learning and classification methods.

Books Recommended:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online).
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018.

Course Outcomes:

Upon successful completion the students will be able to

1. Extract features that can be used for a particular machine learning approach in various real life applications.
2. To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
3. Study recent state of the art research.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Machine Learning (BMCA404D)						
CO1: Extract features that can be used for a particular machine learning approach in various real life applications.	L	S	S	S	S	M
CO2: To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.	L	S	S	S	M	S
CO3: Study recent state of the art research.	S	M	S	M	S	S

S- Strong; M-Medium; L-Low

Category: SEC2
Subject Name: Vector calculus
Subject Code: BMCA405A

Course description:

Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence and curl.

Books Recommended:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.

Course Outcomes:

Upon successful completion the students will be able to

1. Memorize definition of directional derivative and gradient and illustrate geometric meanings with the aid of sketches.
2. Apply gradient to solve problems involving normal vectors to level surfaces.

Explain the concept of a vector integration a plane and in space.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Vector Calculus (BMCA405A)						
CO1: Memorize definition of directional derivative and gradient and illustrate geometric meanings with the aid of sketches.	S	S	S	S	S	S
CO2: Apply gradient to solve problems involving normal vectors to level surfaces.	S	M	S	S	S	S
CO3: Explain the concept of a vector integration a plane and in space.	S	S	S	S	L	M

S- Strong; M-Medium; L-Low

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Category: SEC2
Subject Name: Automata
Subject Code: BMCA405B

Course description:

Module 1: Basics of Strings and Alphabets
Module 2: Finite Automata – DFA, transition graphs, regular languages, non-deterministic FA, equivalence of DFA and NDFA
Module 3: Regular grammars, regular expressions, equivalence between regular languages, properties of regular languages, pumping lemma.
Module 4: Context Free Languages – Leftmost and rightmost derivation, parsing and ambiguity, ambiguity in grammar and languages, normal forms
Module 5: Pushdown Automata – NDPDA, DPDA, context free languages and PDA, comparison of deterministic and non-deterministic versions, closure properties, pumping lemma for CFL
Module 6: Turing Machines, variations, halting problem, PCP
Module 7: Chomsky Hierarchy

Books Recommended:

1. An Introduction to Formal Languages and Automata, by Peter Linz, Third Edition, Narosa Publishers (1998).

Course Outcomes:

Upon successful completion the students will be able to

1. Write a formal notation for strings, languages and machines. Design finite automata to accept a set of strings of a language.
2. Design context free grammars to generate strings of context free language.
3. Determine equivalence of languages accepted by Push Down Automata and languages generated by context free grammars.
4. Distinguish between computability and non-computability and Decidability and undecidability.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Automata (BMCA405B)						
CO1: Write a formal notation for strings, languages and machines. Design finite automata to accept a set of strings of a language.	S	S	S	M	S	S
CO2: Design context free grammars to generate strings of context free language.	S	M	S	S	S	S
CO3: Determine equivalence of languages accepted by Push Down Automata and languages generated by context free grammars.	S	S	S	S	S	M
CO4: Distinguish between computability and non-computability and Decidability and undecidability.	S	S	M	L	S	S

S- Strong; M-Medium; L-Low

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Category: SEC2
Subject Name: User interface and Web Development
Subject Code: BMCA405C

Course description:

Module 1:

Web Design Principles: Basic principles involved in developing a web site, Planning process, Five Golden rules of web designing, Designing navigation bar, Page design, Home Page Layout, Design Concept.

Basics in Web Design: Brief History of Internet, What is World Wide Web, Why create a web site, Web Standards, Audience requirement.

Introduction to HTML: What is HTML, HTML Documents, Basic structure of an HTML document, creating an HTML document, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags.

Module 2:

Elements of HTML: Introduction to elements of HTML, Working with Text, Working with Lists, Tables and Frames, Working with Hyperlinks, Images and Multimedia, Working with Forms and controls.

Introduction to Cascading Style Sheets: Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling(Background, Text Format, Controlling Fonts), Working with block elements and objects, Working with Lists and Tables, CSS Id and Class, Box Model(Introduction, Border properties, Padding Properties, Margin properties), CSS Advanced(Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector), CSS Color, Creating page Layout and Site Designs.

Module 3:

Introduction to Web Publishing or Hosting: Creating the Web Site, Saving the site, Working on the web site, Creating web site structure, Creating Titles for web pages, Themes-Publishing web sites.

Human Computer Interface: Monitors, Traditional Monitors, Alternative Monitors, Criteria for Monitors, Graphic Adapter-Its Criteria, Graphic Standard-Anatomy of Graphic Adapter.

Books Recommended:

1. Kogent Learning Solutions Inc. HTML 5 in simple steps Dreamtech Press
2. A beginner's guide to HTML NCSA,14th May,2003,
3. Murray,Tom/Lynchburg Creating a Web Page and Web Site College,2002
4. Murray,Tom/Lynchburg Creating a Web Page and Web Site College,2002,
5. Steven M. Schafer HTML, XHTML, and CSS Bible, 5ed Wiley India,
6. John Duckett Beginning HTML, XHTML, CSS, and JavaScript Wiley India,
7. Ian Pouncey, Richard York Beginning CSS: Cascading Style Sheets for Web Design Wiley India,
8. Kogent Learning Web Technologies: HTML, Javascript Wiley India.

Course Outcomes:

Upon successful completion the students will be able to

1. Understand the major areas and challenges of web programming.
2. Distinguish web-related technologies.
3. Use advanced topics in HTML5, CSS3, Java Script.
4. Use a server-side scripting language
5. Use a relational DBMS, MySQL.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
User interface and Web Development (BMCA405C)						
CO1: Understand the major areas and challenges of web programming.	S	S	S	S	S	M
CO2: Distinguish web-related technologies.	M	S	S	M	S	S
CO3: Use advanced topics in HTML5, CSS3, JavaScript.	L	S	S	S	S	M
CO4: Use a server-side scripting language	M	S	S	L	S	S
CO5: Use a relational DBMS, MySQL.	M	S	M	M	S	S

S- Strong; M-Medium; L-Low

Category: Core Course
Subject Name: Optimization Techniques Lab
Subject Code: BMCA491

Course description:

List of practical problems:

1. Optimization technique through different type software and programming language.
2. Applications on queuing theory in real life problem.
3. Solution of LPP, Transportation problem, Assignment problem and NLPP by using MATLAB, Mathematica, Lingo and CPlex Software.
4. Use of Genetic Algorithm (GA), Artificial Neural Networks and Particle swarm optimization techniques for real life problem solving.

Books Recommended:

1. H. A. Taha. "Operations Research, An Introduction", PHI, India, 2002.
2. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons (2009). Kwang Y. Lee,
3. D. Gross and C. M. Harris, Fundamentals of Queueing Theory, Wiley, 2018
4. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
5. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.

6. Genetic Algorithms in Search, Optimization and Machine Learning, David E. Goldberg, Pearson Education, 2002.

Course Outcomes:

7. Upon successful completion students will be able to
8. 1. Learn efficient computational procedures to solve optimization problems.
9. 2. Use different software to implement important optimization methods.
10. 3. Use of different soft computing techniques for real life problem solving.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Optimization Techniques Lab (BMCA491)						
CO1: Learn efficient computational procedures to solve optimization problems.	L	S	L	S	L	L
CO2: Use different software to implement important optimization methods.	L	S	L	S	L	L
CO3: Use of different soft computing techniques for real life problem solving.	M	S	M	S	M	S

S- Strong; M-Medium; L-Low

Category: Generic Elective
Subject Name: Chemistry-II Practical
Subject Code: BMCA492

Course description:

Practical (Any five):

1. Thin layer chromatography
2. Ion exchange column for removal of hardness of water
3. Determination of the rate constant of a reaction
4. Determination of cell constant and conductance of solutions
5. Potentiometry - determination of redox potentials and emfs
6. Saponification/acid value of oil
7. Identification of a Pure Organic Compound by chemical test
8. Method of preparation of standard solutions of titrants
9. Based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, etc., of components of a binary solid mixture; purification of any one of the separated components by crystallization and determination of its melting point.

Books recomended:

1. Physical Chemistry by P.C.Rakshit
2. Physical Chemistry by G.W. Castellan
3. Inorganic chemistry by R.L.Dutta
4. Inorganic chemistry by Cotton and Wilkinson
5. Organic Chemistry by I.L.Finar
6. Molecular Spectroscopy by C.M. Banwell.
7. Experimental Physical Chemistry by V.D. Athawale and Parul Mathur.

Course Outcomes:

Upon successful completion students will be able to

1. Understand, solve and explain the major concepts in different disciplines of chemistry.
2. Gain knowledge about various theoretical and experimental approach to give fundamental insights into solid state followed by knowledge of characteristic physical properties of different categories of solid materials, with an emphasis on the crystalline state.
3. Learn the importance of Phase Diagrams in the field of materials science and engineering.
4. Use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds, to recognize the types of isomers in coordination compounds and also to be able to name coordination compounds and to be able to draw the structure based on it's name.
5. Analyze data obtained from sophisticated equipments (FT-NMR, FT-IR, UV -Vis, GC, GC-MS, Spectrofluorimeter etc.) for structure elucidation and chemical analysis.
6. Do identification of stereogenic centres in organic molecules and also able to distinguish between different types of isomers, including enantiomers and diastereomers.
7. Gather thorough knowledge about various chemical reactions followed by classification of the drugs with examples and structure, structural activity relation of some important class of drugs followed by gaining proper knowledge of mechanism of action of the drugs.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Chemistry-II Practical (BMCA492)						
CO1: Understand, solve and explain the major concepts in different disciplines of chemistry.	S	S	S	M	S	S
CO2: Gain knowledge about various theoretical and experimental approach to give fundamental insights into solid state followed by knowledge of characteristic physical properties of different categories of solid materials, with an emphasis on the crystalline state.	S	S	M	S	M	S
CO3: Learn the importance of Phase Diagrams in the field of materials science and engineering.	S	S	S	M	S	S
CO4: Use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds, to recognize the types of isomers in coordination compounds and also to be able to name	S	S	M	S	S	S

coordination compounds and to be able to draw the structure based on it's name.						
CO5: Analyze data obtained from sophisticated equipments (FT-NMR, FT-IR, UV -Vis, GC, GC-MS, Spectrofluorimeter etc.) for structure elucidation and chemical analysis.	S	S	S	S	M	S
CO6: Do identification of stereogenic centres in organic molecules and also able to distinguish between different types of isomers, including enantiomers and diastereomers.	S	S	M	S	L	S
CO7: Gather thorough knowledge about various chemical reactions followed by classification of the drugs with examples and structure, structural activity relation of some important class of drugs followed by gaining proper knowledge of mechanism of action of the drugs.	S	S	M	S	L	S

S- Strong; M-Medium; L-Low

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Semester V:

Category: C11
Subject Name: Theory of Probability and Stochastic Process
Subject Code: BMCA501

Course description:

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables. 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,

Stochastic Process.

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.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

Course Outcomes:

Upon successful completion students will be able to

1. Understand probability distributions in the study of the joint behaviour of two random variables.
2. Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
3. Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve.
4. Understand real life applications of Markov Chains, Chapman-Kolmogorov equations.

Relationship of CO with PO mapping:

CO	PO					
	1	2	3	4	5	6
Theory of Probability and Stochastic Process (BMCA501)						
CO1: Understand probability distributions in the study of the joint behaviour of two random variables.	S	S	S	S	S	S
CO2: Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.	S	S	M	S	S	M
CO3: Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve.	S	S	S	S	S	S
CO4: Understand real life applications of Markov Chains, Chapman-Kolmogorov equations.	S	S	S	M	M	S

S- Strong; M-Medium; L-Low

Category: C12
Subject Name: Operating System
Subject Code: BMCA502

Course description:

Importance of OS, Basic concepts and terminology, Types of OS, Different views, Journey of a command execution, Design and implementation of OS

Concept and views, OS view of processes, OS services for process management, Scheduling algorithms, Performance evaluation; Inter-process communication and synchronisation, Mutual exclusion, Semaphores, Hardware support for mutual exclusion, Queuing implementation of semaphores, Classical problem of concurrent programming, Critical region and conditional critical region, Monitors, Messages, Deadlocks

Memory management, File management, Processor management, Device management

Security and protection, Authentication, Protection and access control, Formal models of protection, Worms and viruses

Multiprocessor system, Classification and types, OS functions and requirements, Introduction to parallel computing, Multiprocessor interconnection synchronization

Introduction to UNIX OS/DOS

Books Recommended:

1. Operating Systems, Galvin, John Wiley
2. Operating Systems ,Milankovic, TMH
3. An Introduction to Operating System, Bhatt,PHI
4. Modern Operating System, Tannenbaum,PHI
5. Guide to Operating Systems, Palmer, VIKAS
6. Operating Systems, Prasad, Scitech.

Course Outcomes:

Upon successful completion students will be able to

1. Create processes and threads and analyse the concepts of processes and threads in operating system and illustrate the scheduling of processor for a given problem instance.
2. For a given specification of memory organization, develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.
3. Identify and handle deadlock related issues.
4. Understand the implement file systems and directories along with the interfacing of IO devices with the operating system and disk management.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Operating System (BMCA502)						
CO1: Create processes and threads and analyse the concepts of processes and threads in operating system and illustrate the scheduling of processor for a given problem instance.	S	S	M	S	M	S
CO2: For a given specification of memory organization, develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.	M	S	S	M	S	S
CO3: Identify and handle deadlock related issues.	S	M	S	M	S	S
CO4: Understand the implement file systems and directories along with the interfacing of IO devices with the operating system and disk management.	S	S	M	L	S	M

S- Strong; M-Medium; L-Low

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Category: DSE1
Subject Name: Operations Research
Subject Code: BMCA503A

Course description:

Module-1: Basics of Operational Research: Origin & Development of Operational Research, Definition and Meaning of Operational Research, Different Phases of an Operational Research Study, Scope and Limitations of Operational Research, Mathematical Modelling of Real Life Problems.

Module-2: Transportation problem (TP) and its formulation. Finding basic feasible solution of TP using North-West Corner Rule, Least Cost and Vogel's Approximation Method, MODI method for finding optimal solution for TP, Assignment problem and its formulation, Hungarian method for solving Assignment problem, Transhipment and Travelling salesmen problem.

Module-3: Introduction to linear integer programming, Branch and Bound Technique, Gomory's Cutting Plane Algorithm for pure and mixed linear integer programming problem, E-Bala's Algorithm for 0-1 programming problem, Real life applications of linear Integer Programming Problem.

Module-4: Convex functions and their properties. Unconstrained and constrained optimization problems. Fritz-John and Karush-Kuhn-Tucker optimality conditions. Quadratic Programming: Wolfe's and Beale's method. Applications of Quadratic programming. Dorn's Duality for Quadratic programming problem.

Quadratic Programming Complementary Pivoting Algorithms. Steepest Ascent and Descent Method. Feasible Direction Method. Separable Programming. Linear Fractional Programming.

Module-5: Introduction to inventory systems, inventory classification and its use in controlling inventory. Deterministic inventory models: Economic order quantity (EOQ) model, EOQ with finite supply, EOQ with backorders, EOQ with constraints, All-units quantity discounts model. Single period probabilistic inventory models with discrete and continuous demand, determination of reorder point for deterministic and probabilistic Inventory System. Introduction to Production Planning and Scheduling, Aggregate production plan, Formulation of lot size production problem: Wagner and Whitin algorithm. Basic concepts of Just-in-Time (JIT) and Material Requirement Planning (MRP).

Course Outcomes:
Upon successful completion the students will be able to

1. Give an appreciation of strategic importance of operations and supply chain management in a global business environment.
2. Develop a working knowledge of concepts and methods related to designing and managing operations and supply chains.
3. Develop a skill set for quality and process improvement.
4. Develops how to manage and control the resource allocation.

Books Recommended:

1. David G. Luerbeggan, "Introduction to Linear and Non Linear Programming", Addison Wesley Publishing Co. 1973.
2. Hadley G. "Nonlinear and – dynamic programming" Addison Wesley Publishing Co. 1964.
3. Cordan C.C. Beveridge and Robert S. Schedther, "Optimization, Theory and Practice" McGraw Hill Co.1970.
4. HarndyA.Tahh. "operations Research, An Introduction", Macmillan Publishers Co. New York, 1982.
5. Beightferand S. others, "Foundations of Optimization Pill", New Delhi, 1979.
6. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons (2009).

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Operations Research (BMCA503A)						
CO1: Give an appreciation of strategic importance of operations and supply chain management in a global business environment.	S	S	M	S	M	S
CO2: Develop a working knowledge of concepts and methods related to designing and managing operations and supply chains.	S	M	S	S	L	S
CO3: Develop a skill set for quality and process improvement.	S	S	S	M	S	S
CO4: Develops how to manage and control the resource allocation.	M	S	S	S	S	S

S- Strong; M-Medium; L-Low

Category: DSE1
Subject Name: Data Mining
Subject Code: BMCA503B

Course description:

Introduction: Introduction to data mining and knowledge discovery from databases. Scalability issues of data mining algorithms**.**
Introduction to Data warehousing: General principles, modelling, design, implementation, and optimization.
Data preparation: Pre-processing, sub-sampling, feature selection. Associations, dependence analysis, correlation, rule generation- a priori algorithm, FP Trees etc. and evaluation.
Cluster analysis and Outlier Detection, Temporal and spatial data mining: Mining complex types of data. Advanced topics: High performance computing for data mining, distributed data mining.

Course Outcomes:
Upon successful completion students will be able to

1. Design a data mart or data warehouse for any organization.
2. Develop skills to write queries using DMQL.

3. Extract knowledge using data mining techniques.

Books Recommended:

1. M. J. Zaki and W. Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014
2. E. Frank, I. H. Witten and M. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2017.
3. J. Han, M.Kamber and J. Pie, Data Mining: Concepts and Techniques, Elsevier, 2012

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Data Mining (BMCA503B)						
CO1: Design a data mart or data warehouse for any organization.	S	S	S	M	S	M
CO2: Develop skills to write queries using DMQL.	M	M	S	S	M	S
CO3: Extract knowledge using data mining techniques.	S	S	S	M	S	S

S- Strong; M-Medium; L-Low

Category: DSE 2
Subject Name: Statics and Dynamics
Subject Code: BMCA504A

Course description:

Principles of statics: Introduction to vector approach-free body diagrams-forces in plane-forces in space-concurrent forces - resolution of forces-equilibrium of particle.

Statics of rigid bodies in two dimensions and three dimensions: Moment of a force about a point-moment of a force about an axis-moment of a couple – equivalent force couple system – rigid body equilibrium – support reactions.

Applications of statics: Friction – contact friction problems. Analysis of trusses –method of joints – method of sections.

Properties of surfaces and solids - Centroid, Moment of inertia, Polar moment ofinertia, Mass moment of inertia, Product of inertia and Principal moment of inertia.

Dynamics: Rectangular and cylindrical coordinate system - Combined motion of rotation and translation - Newton's second law in rectilinear translation - D'Alembert'sprinciple - Mechanical vibration - free and forced vibrations, resonance and its effects; Degree of freedom; Frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems.

Books Recommended:

1. Hibbeler, R. C., "Engineering Mechanics', 12/e, Pearson Education Pvt. Ltd., 2007.
2. Meriam, J. L., "Dynamics", 5/e, John Wiley & sons, 2003.
3. K. L. Kumar, "Engineering Mechanics", 3/e, Tata McGraw Hill, 2003.

Course Outcomes:

Upon successful completion the students will be able to

1. Develop equilibrium relationships for non-accelerating particles and rigid bodies acted on by forces.
2. Estimate external loads and find the internal forces in frames, trusses, beams and other structures while evaluating their structural safety.
3. Obtain system information (position, velocity, etc.) at a given location or time knowing the system information at a different location or time.
4. Find the loads and accelerations for rigid bodies under planar motion.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Statics and Dynamics (BMCA504A)						
CO1: Develop equilibrium relationships for non-accelerating particles and rigid bodies acted on by forces.	S	S	S	S	S	S
CO2: Estimate external loads and find the internal forces in frames, trusses, beams and other structures while evaluating their structural safety.	S	S	S	S	S	M
CO3: Obtain system information (position, velocity, etc.) at a given location or time knowing the system information at a different location or time.	S	S	S	M	S	M
CO4: Find the loads and accelerations for rigid bodies under planar motion.	S	S	S	M	L	S

S- Strong; M-Medium; L-Low

Category: DSE2
Subject Name: Software Engineering
Subject Code: BMCA504B

Course description:

Introduction: Software Processes & Characteristics, Software life cycle Models - Waterfall, Prototype, Evolutionary and Spiral Models Software Requirements analysis & specifications: Requirement engineering, requirement, elicitation techniques like FAST, QFD, requirements analysis using DFD, Data dictionaries, ER Diagrams, Requirements documentation, Nature of SRS, Characteristics & organization of SRS.

Introduction to Software Engineering: Definitions, Size Factors, Quality and Productivity Factors, Managerial Issues, Planning a Software Project: Defining the Problem, Goals and Requirements,

Solution Strategy, Planning the Development Process: Various Models, Planning an Organizational Structure, Planning Activities.

Software Cost Estimation: Introduction - Software Cost Factors - Software Cost Estimation Techniques - Stating Level estimation - Estimating Software Maintenance Costs Software Requirements Definition - Software Requirements Specification - Specification Techniques - Languages and Processors for Requirements.

Software Design: Design concepts, Modules and Modularization Criteria, Design Notations, Design Techniques, Design Considerations, Real Time and Distributed System Design, Test Plans, Milestones, Walkthroughs and Inspections. Design Guidelines Implementation Issues: Structure Loading Techniques, Coding Style, Standards and Guidelines, Documentation Guidelines.

Modern programming Language Features: Type Checking, Separate Compilation, User Defined Data Types, Data Abstraction, Scoping Rules, Exception Handling, Currency Mechanism Verification and Validation Techniques, Quality Assurance, States Analysis, Symbolic Excretion.

Testing and Debugging: System Testing, Formal Verification Software Maintenance, Maintainability, Managerial Aspect of Software Maintenance, Configuration Management, Source Code Metrics, Other Maintenance Tools and Techniques.

Books Recommended:

1. Software Engineering Concepts 1997 Edition Author: RICHARD FAIRLEY Publishers: TATA Mc GRAW-Hill Edition.
2. Software Engineering VI Edition, Author: ROGER S . PRESSMAN Publishers TATA McGRAW - HILL International Edition.
3. Software Engineering Programs Documentation Operating procedures
4. Author : K.K. AGGARWAL & YOGESH SINGH Publishers : NEW AGE INTERNATIONAL PUBLISHERS.

Course Outcomes:

Upon successful completion the students will be able to

1. Apply software engineering principles and techniques.
2. Develop, maintain and evaluate large-scale software systems.
3. Produce efficient, reliable, robust and cost-effective software solutions.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Software Engineering (BMCA504B)						
CO1: Apply software engineering principles and techniques.	**S**	**S**	**S**	**M**	**S**	**S**
CO2: Develop, maintain and evaluate large-scale software systems.	**S**	**S**	**S**	**S**	**M**	**S**
CO3: Produce efficient, reliable, robust and cost-effective software solutions.	**M**	**S**	**M**	**S**	**L**	**S**

S- Strong; M-Medium; L-Low

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Category: Core course
Subject Name: Operating System Lab
Subject Code: BMCA591

Course description:

Practical

List of Experiments:

1. Basics of UNIX commands
2. Write programs using the following system calls of UNIX operating system fork, exec, getpid, exit, wait, close, stat, opendir, readdir
3. Write C programs to simulate UNIX commands like cp, ls, grep, etc.
4. Shell Programming
5. Write C programs to implement the various CPU Scheduling Algorithms
6. Implementation of Semaphores
7. Implementation of Shared memory and IPC
8. Bankers Algorithm for Deadlock Avoidance
9. Implementation of Deadlock Detection Algorithm
10. Write C program to implement Threading & Synchronization Applications
11. Implementation of the following Memory Allocation Methods for fixed partition
    a) First Fit b) Worst Fit c) Best Fit
12. Implementation of Paging Technique of Memory Management
13. Implementation of the following Page Replacement Algorithms
    a) FIFO b) LRU c) LFU
14. Implementation of the various File Organization Techniques
15. Implementation of the following File Allocation Strategies

Books Recommended:

1. Operating Systems, Galvin, John Wiley
2. Operating Systems ,Milankovic, TMH
3. An Introduction to Operating System, Bhatt,PHI
4. Modern Operating System, Tannenbaum,PHI
5. Guide to Operating Systems, Palmer, VIKAS
6. Operating Systems, Prasad, Scitech

Course Outcomes:

Upon successful completion students will be able to

1. Create processes and threads and analyse the concepts of processes and threads in operating system and illustrate the scheduling of processor for a given problem instance.
2. For a given specification of memory organization, develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.
3. Identify and handle deadlock related issues.
4. Understand the implement file systems and directories along with the interfacing of IO devices with the operating system and disk management.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Operating System Lab (BMCA591)						
CO1: Create processes and threads and analyse the concepts of processes and threads in operating system and illustrate the scheduling of processor for a given problem instance.	S	S	M	S	M	S
CO2: For a given specification of memory organization, develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.	M	S	S	M	S	S
CO3: Identify and handle deadlock related issues.	S	M	S	M	S	S
CO4: Understand the implement file systems and directories along with the interfacing of IO devices with the operating system and disk management.	S	S	M	L	S	M

S- Strong; M-Medium; L-Low

Category: Discipline Specific Elective
Subject Name: Operations Research Lab using R
Subject Code: BMCA592A

Course Objectives:

The Objectives of this course are

1. To gain the basic knowledge of R.
2. To co-relate with the theoretical and practical studies relate to Operations Research in R.
3. To introduce the knowledge of the R package 'lpSolve'.
4. To understand implementation of different R package 'lpSolve' to solve LPP, IPP, Transportation Problem, Assignment Problem.
5. To acquaint the knowledge to solve the inventory control problem using R package.

Note: At least ten experiments to be completed by each student.

Course description:

List of practical problems:

1. R as Calculator Application
   a. Using with and without R objects on console
   b. Using mathematical functions on console
   c. Write an R script, to create R objects for calculator application and save in a specified location in disk.
2. Descriptive Statistics in R
   a. Write an R script to find basic descriptive statistics using summary, str, quartile function on mtcars & cars datasets.

b. Write an R script to find subset of dataset by using subset (), aggregate () functions on iris dataset.

3. Data Import and Export
   a. Save and Load R Data
   b. Import/ Reading and Export/ Writing Different Types of Datasets
      i. Reading different types of data sets (.txt, .csv) from Web and disk and writing in file in specific disk location.
      ii. Read and Write Excel data sheet in R.
      iii. Read and Write XML dataset in R.
4. Data Exploration and Visualization
   a. Find the data distributions using box and scatter plot.
   b. Find the outliers using plot.
   c. Plot the histogram, bar chart and pie chart on sample data.
5. Write a program to perform basic operations on matrices.
6. Write a menu driven program for list operations: search, sort, max, and min for string arrays using different functions.
7. Package 'lpSolve' in R.
8. Write a program to find the solution of LPP.
9. Write a program to find the solution of Transportation Problem.
10. Write a program to find the solution of Assignment Problem.
11. Write a program to find the solution of Travelling Salesman Problem.
12. Write a program to find the solution of IPP using Branch and Bound method.
13. Write a program to find the EOQ with and without shortages.

Examination Scheme for Practical Sessional examination:

Internal Examination:	
Continuous evaluation	: 40
External Examination:	
Examiner-Signed Lab Assignments	: 10
On Spot Experiment	: 40
Viva voce	: 10
Total	**: 100**

Books Recommended:

1. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons (2009). • Kwang Y. Lee.
2. John C. Nash, Nonlinear Parameter Optimization Using R Tools, Wiley, 2014.
3. David G.Luerbeggan, "Introduction to Linear and Non Linear Programming", Addison Wesley Publishing Co. 1973.
4. Cordan C.C. Beveridge and Robert S. Schedther, "Optimization, Theory and Practice" McGraw Hill Co.1970.
5. Harndy A.Tahh. "operations Research, An Introduction", Macmillan Publishers Co.NewYork, 1982.

Course outcomes:

Upon successful completion of the course students are able to:

1. Use R as a calculator, import and export data in R.
2. Exploration and Visualization data in R.
3. Understand the knowledge of the R package 'lpSolve'.
4. Implement of different R package 'lpSolve' to solve LPP, IPP, Transportation Problem, Assignment Problem.
5. Solve the inventory control problem using R package.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Operations Research Lab using R (BMCA592A)						
CO1: Use R as a calculator, import and export data in R.	S	S	S	S	S	S
CO2: Exploration and Visualization data in R.	S	M	S	S	S	M
CO3: Understand the knowledge of the R package 'lpSolve'.	S	M	S	S	S	M
CO4: Implement of different R package 'lpSolve' to solve LPP, IPP, Transportation Problem, Assignment Problem.	S	M	M	S	M	M
CO5: Solve the inventory control problem using R package.	S	M	S	S	S	M

S- Strong; M-Medium; L-Low

Category: Discipline Specific Elective
Subject Name: Data Mining Lab using R
Subject Code: BMCA592B

Course description:

Practical:

List of experiments:

- Creation of a Data Warehouse.
- Apriori Algorithm.
- FP-Growth Algorithm.
- K-means clustering.
- One Hierarchical clustering algorithm.
- Bayesian Classification.
- Decision Tree.
- Support Vector Machines.
- Applications of classification for web mining.
- Case Study on Text Mining or any commercial application.

Books Recommended:

1. M. J. Zaki and W. Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014
2. E. Frank, I. H. Witten and M. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2017.
3. J. Han, M.Kamber and J. Pie, Data Mining: Concepts and Techniques, Elsevier, 2012

Course Outcomes:

Upon successful completion students will be able to

1. Design a data mart or data warehouse for any organization.
2. Develop skills to write queries using DMQL.
3. Extract knowledge using data mining techniques.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Data Mining Lab using R (BMCA592B)						
CO1: Design a data mart or data warehouse for any organization.	S	S	S	M	S	M
CO2: Develop skills to write queries using DMQL.	M	M	S	S	M	S
CO3: Extract knowledge using data mining techniques.	S	S	S	M	S	S

S- Strong; M-Medium; L-Low

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Semester VI:

Category: C13
Subject Name: Mathematical Methods
Subject Code: BMCA601

Course description:

Module 1:
Fourier transform, Laplace transform, Solution of differential equations by Laplace and Fourier transform methods, Applications of Laplace and Fourier transforms to Boundary value problems.

Hankel transform, Applications.

Solutions of Laplace, Wave and Heat Conduction Equations.

Basic ideas of Discrete Fourier transform (DFT) and Finite Fourier transform (FFT), Z-transform, and Applications.

Module 2:
Ordinary Differential Equations: Power series and Frobenius methods, Hermite functions, Bessel functions, Modified Bessel functions, Applications. Legendre polynomials, Associated Legendre polynomials, Rodrigues formula, Orthogonality of Legendre polynomials, Hermite functions and Bessel functions, Sturm-Liouville problem.

Module 3:
Concept and calculation of Green's function, Approximate Green's function, Green's function method for differential equations.

Books Recommended:

1. G. S. Rao and K. K. Reddy, Mathematical Methods, I.K.InternationalPvt. Ltd., 2009.
2. O. Scherzer (Ed.), Handbook of Mathematical Methods in Imaging, Springer, 2011.
3. G. N. Watson, A Treatise on the Theory of Bessel Functions, Cambridge University Press, 1944.
4. G. F. Roach, Green's Functions, Cambridge University Press, 1995.
5. A. D. Poularikas, The Transforms and Applications Handbook, CRC Press, 1996.

Course outcomes:
Upon successful completion the students will be able to

1. Understand the theory and applications of integral transforms.
2. Explain how integral transforms can be used to solve a variety of differential equations.
3. Solve integro-differential equations of Fredholm and Volterra type.
4. Understand the properties of various kinds of integral equations.

Relationship of CO with PO mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
Mathematical Methods (BMCA601)						
CO1: Understand the theory and applications of integral transforms.	S	S	S	M	S	S
CO2: Explain how integral transforms can be used to solve a variety of differential equations.	S	S	S	S	L	M
CO3: Solve integro-differential equations of Fredholm and Volterra type.	M	S	S	S	M	M
CO4: Understand the properties of various kinds of integral equations.	S	S	S	S	S	S

S- Strong; M-Medium; L-Low

Category: C14
Subject Name: Database Management System
Subject Code: BMCA602

Course description:

Introduction
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.
Entity-Relationship Model
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended
E-R features.
Relational Model
Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations,
Views, Modifications Of the Database.
SQL and Integrity Constraints
Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints,Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application developmentusing SQL, Stored procedures and triggers.
Relational Database Design
Functional Dependency, Different anamolies in designing a Database., Normalization using funtionaldependencies,Decomposition, Boyce-Codd Normal Form, 3NF, Nomalization using multi-valued depedencies, 4NF, 5NF
Internals of RDBMS
Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transactionprocessing, Concurrency control and Recovery Management: transaction model properties, state serializability, lockbase protocols, two phase locking.
File Organization & Index Structures

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index(primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .

Books Recommended:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc. Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, "Transaction Processing: Concepts and Techniques", Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
7. Ullman JD., "Principles of Database Systems", Galgottia Publication.
8. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
9. "Fundamentals of Database Systems", Ramez Elmasri, Shamkant B. Navathe, Addison Wesley Publishing Edition.
10. "Database Management Systems", Arun K. Majumdar, Pritimay Bhattacharya, Tata McGraw Hill.

Course Outcomes:

Upon successful completion the students will be able to

1. Design the databases using E-R diagram method and convert it into Relational Database.
2. Write relational algebra and Relational Calculus expressions for a given query and optimize the developed expressions.
3. Construct the SQL queries for Open source and Commercial DBMS for a given specification.
4. Optimize its execution using Query optimization algorithms for a given query.
5. Understand and implement transaction processing, concurrency control and Recovery system.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Database Management System (BMCA602)						
CO1: Design the databases using E-R diagram method and convert it into Relational Database.	S	S	S	S	M	M
CO2: Write relational algebra and Relational Calculus expressions for a given query and optimize the developed expressions.	S	S	S	S	S	S
CO3: Construct the SQL queries for Open source and Commercial DBMS for a given specification.	M	M	S	M	S	S
CO4: Optimize its execution using Query optimization algorithms for a given query.	M	M	S	S	S	L
CO5: Understand and implement transaction processing, concurrency control and Recovery system.	S	S	S	S	M	M

S- Strong; M-Medium; L-Low

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Category: DSE3
Subject Name: Number theory and Cryptography
Subject Code: BMCA603A

Course description:

Elementary number theory: Prime numbers, Fermat's and Euler's theorems, Testing for primality, Chinese remainder theorem, discrete logarithms. Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form GF(p), Polynomial Arithmetic, Finite fields of the form GF(2).

Data Encryption Techniques: Algorithms for block and stream ciphers, private key encrypton – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems. Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.

Book Recommended:

1. W. Stallings, Cryptography and Network Security Principles and Practices, 4th Ed., PrenticeHall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, Security in Computing, 3rd Ed., Prentice-Hall of India, 2007.
3. M.Y. Rhee, Network Security, John Wiley and Sons, NY, 2002

Course Outcomes:

Upon successful completion the students will be able to

1. Understand fundamental number-theoretic algorithms such as the Euclidean algorithm, the Chinese Remainder algorithm, binary powering, and algorithms for integer arithmetic.
2. Understand fundamental algorithms for symmetric key and public-key cryptography.
3. Understand the number-theoretic foundations of modern cryptography and the principles behind their security.
4. Implement and analyze cryptographic and number-theoretic algorithms in real life problems.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Number theory and Cryptography (BMCA603A)						
CO1: Understand fundamental number-theoretic algorithms such as the Euclidean algorithm, the Chinese Remainder algorithm, binary powering, and algorithms for integer arithmetic.	S	S	S	S	M	M
CO2: Understand fundamental algorithms for symmetric key and public-key cryptography.	S	S	M	S	M	S
CO3: Understand the number-theoretic foundations of modern cryptography and the principles behind their security.	S	S	L	S	S	S
CO4: Implement and analyze cryptographic and number-theoretic algorithms in real life problems.	M	S	S	S	S	S

S- Strong; M-Medium; L-Low

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Category: DSE3
Subject Name: Computer Network
Subject Code: BMCA603B

Course description:

Basic Concepts: Components of data communication, distributed processing, Line configuration, topology, transmission mode, and categories of networks. OSI and TCP/IP Models: Layers and their functions, comparison of models. Digital Transmission: Interfaces and Modems: DTE-DCE Interface, modems, cable modems. Transmission Media: Guided and unguided, Attenuation, distortion, noise, throughput, propagation speed and time, wavelength, Shannon Capacity.

Telephony: Multiplexing, error detection and correction, Many to one, one to many, WDM, TDM, FDM, circuit switching, packet switching and message switching. Data Link control protocols: Line discipline, flow control, error control, synchronous and asynchronous protocols overview. ISDN: Services, historical outline, subscriber's access, ISDN, Layers, and broadband ISDN.

Devices: Repeaters, bridges, gateways, routers, The Network Layer, Design Issues, Network Layer Addressing and Routing concepts (Forwarding Function, Filtering Function);Routing Methods (Static and dynamic routing, Distributed routing, Hierarchical Routing);Distance Vector Protocol, Link State protocol.

Transport and upper layers in OSI Model: Transport layer functions, connection management, Functions of session layers, Presentation layer, and Application layer.

Books Recommended:

1. A.S. Tenanbaum, Computer Networks, 4th Ed., Pearson Education Asia, 2003.
2. Behrouz A. Forouzan, Data Communication and Networking, 2nd Ed., Tata McGraw Hill.
3. D. E. Comer, Internetworking with TCP/IP, Pearson Education Asia, 2001.
4. William Stallings, Data and Computer Communications, 7th Ed., Pearson education Asia, 2002.

Course Outcomes:

Upon successful completion the students will be able to

1. Explain the functions of the different layer of the OSI Model.
2. Understand the functionality of each layer of TCP/IP protocol suite and developed the network programming for a given problem.
3. Familarization with DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Computer Network (BMCA603B)						
CO1: Explain the functions of the different layer of the OSI Model.	M	S	M	S	S	M
CO2: Understand the functionality of each layer of TCP/IP protocol suite	S	S	S	S	M	S

and developed the network programming for a given problem.						
CO3: Familarization with DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.	M	S	S	L	S	M

S- Strong; M-Medium; L-Low

Category: Core Course
Subject Name: Database Management System Lab
Subject Code: BMCA691

Course description:

Practical

1. Structured Query Language, Creating Database : Creating a Database, Creating a Table, Specifying Relational Data Types, Specifying Constraints, Creating Indexes
2. Table and Record Handling: INSERT statement, Using SELECT and INSERT together, DELETE, UPDATE, TRUNCATE statements, DROP, ALTER statements
3. Retrieving Data from a Database : The SELECT statement, Using the WHERE clause, Using Logical Operators in the WHERE clause, Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING
4. Clause : Using Aggregate Functions, Combining Tables Using JOINS, Subqueries
5. Database Management : Creating Views, Creating Column Aliases, Creating Database Users, Using GRANT and REVOKE, Cursors in Oracle PL / SQL

Books Recommended:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.Graw Hill.
2. ElmasriRamez and NovatheShamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, “Transaction Processing : Concepts and Techniques”, Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., “Introduction to Database Management”, Vol. I, II, III, Addison Wesley.
7. Ullman JD., “Principles of Database Systems”, Galgottia Publication.
8. James Martin, “Principles of Database Management Systems”, 1985, Prentice Hall of India, New Delhi
9. “Fundamentals of Database Systems”, RamezElmasri, ShamkantB.Navathe, Addison Wesley PublishingEdition.
10. “Database Management Systems”, ArunK.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill.

Course Outcomes:

Upon successful completion the students will be able to

1. Design the databases using E-R diagram method and convert it into Relational Database.
2. Write relational algebra and Relational Calculus expressions for a given query and optimize the developed expressions.
3. Construct the SQL queries for Open source and Commercial DBMS for a given specification.
4. Optimize its execution using Query optimization algorithms for a given query.
5. Understand and implement transaction processing, concurrency control and Recovery system.

Relationship of CO with PO mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
Database Management System Lab (BMCA691)						
CO1: Design the databases using E-R diagram method and convert it into Relational Database.	S	S	S	S	M	M
CO2: Write relational algebra and Relational Calculus expressions for a given query and optimize the developed expressions.	S	S	S	S	S	S
CO3: Construct the SQL queries for Open source and Commercial DBMS for a given specification.	M	M	S	M	S	S
CO4: Optimize its execution using Query optimization algorithms for a given query.	M	M	S	S	S	L
CO5: Understand and implement transaction processing, concurrency control and Recovery system.	S	S	S	S	M	M

S- Strong; M-Medium; L-Low