**Annexure 4**

# SYLLABUS STRUCTURE
**(Effective from academic session 2023-24)**

**FOR THE DEGREE**

**OF**

**Bachelor of Computer Applications**
**(BCA)**
**Specialization - Data Science**

**Six-Semester Full Time**
**Programme**

**SCHOOL OF BASIC SCIENCES**

MANIPAL UNIVERSITY
JAIPUR

**ELIGIBILITY OF THE CANDIDATES:**

The candidate must have passed 10+2 or A level or IB examination in any discipline with at least 50% marks in aggregate.

**Program specific outcomes for Bachelor of Computer applications (BCA) program:**

**[PSO.1.]** Prepare professionally trained in the areas of programming, databases, software engineering, web- designing and networking and other completer application areas to acquire knowledge in various domain-based prospects

**[PSO.2.]** Encourage to communicate effectively and to improve their competency skills to solve real time problems

**[PSO.3.]** Clarity on both conceptual and application-oriented skills of Computer Applications in Business context.

| YEAR | FIRST SEMESTER | | | | | | SECOND SEMESTER | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Course Code | Course Name | L | T | P | C | Course Code | Course Name | L | T | P | C |
| I | MA1107 | Fundamentals of Mathematics | 3 | 1 | 0 | 4 | MA1208 | Basic Statistics and Probability | 3 | 1 | 0 | 4 |
| | LN1108 | Technical Communication | 2 | 0 | 0 | 2 | CA1201 | Data Structures | 3 | 1 | 0 | 4 |
| | CA1103 | C Programming | 3 | 1 | 0 | 4 | CA1202 | Database Management System | 3 | 1 | 0 | 4 |
| | CA1104 | Fundamentals of Computers & Digital Systems | 3 | 1 | 0 | 4 | CA1203 | Principle of Programming Languages | 3 | 1 | 0 | 4 |
| | CA1105 | Introduction to Web Programming | 3 | 1 | 0 | 4 | CA1204 | Object-Oriented Programming usingC++ | 3 | 1 | 0 | 4 |
| | CA1130 | C Programming Lab | 0 | 0 | 2 | 1 | CA1231 | Database Management System Lab | 0 | 0 | 2 | 1 |
| | CA1132 | Web Programming Lab | 0 | 0 | 2 | 1 | CA1232 | Data Structures using C++ Lab | 0 | 0 | 2 | 1 |
| | CY1003 | Environmental Science | 2 | 0 | 0 | 2 | | | | | | |
| | | | 16 | 4 | 4 | 22 | | | 15 | 5 | 4 | 22 |
| | Total Contact Hours (L + T + P) | | 24 | | | | Total Contact Hours (L + T + P) | | 24 | | | |

| YEAR | THIRD SEMESTER | | | | | | FOURTH SEMESTER | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Course Code | Subject Name | L | T | P | C | Course Code | Subject Name | L | T | P | C |
| II | CA2101 | Computer Organization and Architecture | 3 | 1 | 0 | 4 | CA2202 | Python Programming | 3 | 1 | 0 | 4 |
| | CA2104 | Data Communication & Protocols | 3 | 1 | 0 | 4 | CA2203 | Software Engineering | 3 | 1 | 0 | 4 |
| | CA2105 | Java Programming | 3 | 1 | 0 | 4 | CA2204 | Data Mining & Visualization | 3 | 1 | 0 | 4 |
| | CA2106 | Operating Systems | 3 | 1 | 0 | 4 | CA2206 | Intelligent Systems | 3 | 1 | 0 | 4 |
| | CA2109 | Introduction to Data Science | 3 | 1 | 0 | 4 | XXXXXX | Open Elective / MOOC | 3 | 0 | 0 | 3 |
| | CA2132 | Java Programming Lab | 0 | 0 | 2 | 1 | CA2231 | Python Programming Lab | 0 | 0 | 2 | 1 |
| | CA2133 | Operating System Lab | 0 | 0 | 2 | 1 | CA2232 | Data Mining and Visualization Lab | 0 | 0 | 2 | 1 |
| | | | 15 | 5 | 4 | 22 | | | 15 | 4 | 4 | 21 |
| | Total Contact Hours (L+T+P) | | 24 | | | | Total Contact Hours (L+T+P) + OE | | 23 | | | |
| YEAR | FIFTH SEMESTER | | | | | | SIXTH SEMESTER | | | | | |
| | Course Code | Subject Name | L | T | P | C | Course Code | Subject Name | L | T | P | C |
| III | CA3102 | Mobile Application Development | 3 | 1 | 0 | 4 | CA3204 | Wireless Communication | 3 | 1 | 0 | 4 |
| | CA3106 | Machine Learning | 3 | 1 | 0 | 4 | CA3205 | Unix and Shell Programming | 3 | 1 | 0 | 4 |
| | CA3108 | Business Data Analytics | 3 | 1 | 0 | 4 | CA3208 | Deep Learning | 3 | 1 | 0 | 4 |
| | CA31XX | Program Elective-I | 3 | 0 | 0 | 3 | CA32XX | Program Elective-II | 3 | 0 | 0 | 3 |
| | CA3131 | Mobile Application Development Lab | 0 | 0 | 2 | 1 | CA3231 | Deep Learning Lab | 0 | 0 | 2 | 1 |
| | CA3132 | Machine Learning Lab | 0 | 0 | 2 | 1 | CA3270 | Major Project | 0 | 0 | 4 | 2 |
| | CA3170 | Minor Project | 0 | 0 | 2 | 1 | | | | | | |
| | CA3110 | Aptitude and Technical Development | 1 | 0 | 0 | 1 | | | | | | |
| | | | 13 | 3 | 6 | 19 | | | 12 | 3 | 6 | 18 |
| | Total Contact Hours (L+T+P) | | 22 | | | | Total Contact Hours (L+T+P) | | 21 | | | |
| Total Credit= 124 (including first year) | | | | | | | | | | | | |

## Program Elective - I

**CA3143 INTERNET OF THINGS**

**CA3148 NATURAL LANGUAGE PROCESSING**

**CA3149 COMPUTER VISION**

## Program Elective – II

**CA3246 ROBOTICS & AI**

**CAP3247 EMBEDDED SYSTEMS**

**CAP3248 STATISTICAL INFERENCE**

## FIRST SEMESTER

**MA1107: FUNDAMENTALS OF MATHEMATICS [3 1 0 4]**

Function: Definition, domain and range of function, types of functions (into, onto, one to one), composite function. Limit: Definition, first principle, properties, and simple problems related to limit. Some standard limits. Continuity: Definition, continuity of sum, product, difference and quotient of two continuous functions, simple problems. Special Functions: Trigonometric functions and their properties, exponential functions, logarithmic functions, hyperbolic functions, inverse circular functions and related properties, simple problems. Rational functions, partial fraction and simple problems. Differentiation: Definition, differentiation of simple functions using first principle, differentiation of trigonometric functions and inverse circular functions, method of substitution, differentiation of product and quotient of functions, maxima and minima of a function of single variable. Integration: Definition, integration of simple functions using substitution, integration of trigonometric and inverse circular functions and related problems, integration by parts, integration of rational functions. Definite integral and their properties, simple problems. Reduction formula and simple problems.

**References**:


1. Narayan, Differential Calculus, S. Chand & Co, Delhi, 2012.
2. S. Narayan, Integral Calculus, S. Chand & Co, Delhi, 2012.
3. M.D. Raisinghania, Differential Calculus, Delhi, 2010.
4. D. Mukherjee, Integral Calculus, U.N. Dhur, 1977.
5. N. Piskunov, Differential and Integral Calculus, Vol I & Vol II, CBS, 2000.


**LN1108: TECHNICAL COMMUNICATION [2 0 0 2]**

Introduction to communication: Types of communication, Process of communication, Principles of communication, Channels of communication, Verbal and non-verbal communication, Formal and informal communication, Barriers to communication. Vocabulary: Word formation, Affixes, Compound words, Synonyms, Antonyms, Homophones and Homonyms, Misspelt words. Grammar: Punctuations, Parts of speech, Active and passive voice, Direct and indirect speech, Concord, Common errors. Techniques of effective sentence constructions, Précis writing. Structure and format of letter writing: Letter of Enquiry, Quotations, Orders, Tenders, Complaint/adjustment letters, Job application letter, Resume, Group discussion. Art of Public Speaking: Tips for effective presentations.

**References**:


1. A. Koneru, Professional Communication, (1e), Tata McGraw Hill, 2008.
2. L. C. Bovee, J. V. Thill, B. E. Schatzman, Business Communication Today, (7e), Pearson Education, 2004.
3. L. Sen, Communication Skills, (2e), Prentice Hall, 2007.
4. M. Raman, S. Sharma, Technical Communication: Principles and Practice, (2e), Oxford University Press, 2013.


**CA1103: C PROGRAMMING [3 1 0 4]**

C Fundamentals: C program structure, Simple I/O operations, Operators and Expressions: Operator precedence and associativity, bitwise operators, arithmetic expressions, evaluation of expressions, Flow of Control: Statements and blocks, switch case statement, looping constructs. Arrays: arrays- Declaration and Initialization, sorting. Strings: String – operations on strings, built-in string handling functions, programs on strings. Functions: Modular programming, function declaration, definition and function call, Types of functions, function returning more values, function with operators, function and decision statements, function and loop operators, function with Arrays.

**Reference**:


1. E. Balaguruswamy, Programming in ANSI C, (5e) Tata McGraw Hill, 2012.
2. E. Balaguruswamy, Computing Fundamentals & C Programming, (2e), TataMcGraw Hill, 2017.
3. R. Thareja, Computer Fundamentals and Programming in C, (1e), Oxford University Press, 2016.
4. B. A. Forouzan, R. F. Gilberg, Computer Science: A structured programming Approach using C, (3e), Cole Publishing Company-Cengage, 2007.

**CA1104: FUNDAMENTALS OF COMPUTERS & DIGITAL SYSTEMS [3 1 0 4]**

Introduction: Digital and Analog signals, Block diagram of a computer hardware, Generation of Computers, Types of Computers, memory, Storage Devices, Input Devices, Output Devices, Number system, Boolean algebra, De-Morgan's law, simplification of Boolean algebra, Logic Gates: basic and universal gates, simplification method: K-map and tabulation method. Combination circuit: introduction to combinational circuit, half adder circuit, full adder circuit, half subtracted, full subtracted, binary parallel adder, carry propagation, magnitude comparator, decoder, encoder, multiplexer, demultiplexer circuit, design of code converter Sequential circuit: Introduction to Latches &flip flop. Types of flip flop S-R, D, J-K, T flip flop. Counter: Synchronous counters, asynchronous counter, and shift register.

**References**:


1. S.K. Basanadra, Computers Today, Galgotia Publications, (1e) 2010.
2. P.K. Sinha, P. Sinha, Computer Fundamentals, (6e), BPB Publications, 2007.
3. A. Leo, M. Leon, Introduction to Computers, (1e), Vikas Publishing House, 2009.
4. M. Mano, Digital Logic and Computer Design, (1e), Pearson Education India, 2017.
5. R. P. Jain, Modern Digital Electronics, (3e), Tata McGraw-Hill Education, 2003.
6. R.L. Tokheim, Digital Electronics: Principles and Applications, (6e), Tata McGraw Hill, 2007.


**CA1105: INTRODUCTION TO WEB PROGRAMMING [3 1 0 4]**

Introduction: HTML, features, uses & versions Using various HTML syntax, Head & Body Sections, Inserting texts, Text alignment, Using images in pages, Hyperlinks – text and images, bookmarks, Backgrounds and Color controls, creating and using Tables in HTML, and presentation, Use of font size & Attributes, List types and its tags. Cascading Style sheets – defining and using simple CSS. Use of Frames and Forms in web pages, Image editors, Issues in Web site creations & Maintenance. Web Designing: Introduction to WYSIWYG Design tools, Introduction to Dreamweaver, Website Creation and maintenance, Web Hosting and Publishing Concepts; Client-Side Programming: The JavaScript Language, History and Versions; Introduction to JavaScript in Perspective: Syntax, Variables and Data Types, Statements, Operators, Literals, Functions, Objects, Arrays, Built-in Objects, JavaScript Debuggers; Representing Web Data: XML-Documents and Vocabularies Versions and Declaration-Namespaces, Displaying XML Documents in Browsers; Server-Side Programming: Java Servlets- Architecture , Overview- Servlet, Generating Dynamic Content, Life Cycle, Parameter Data, Sessions, Cookies; Electronic commerce: E – Business model, E – Marketing, Online payments and security. Database and Connectivity: ADO.Net. Distributed Application in C#, Visual programming interface with C#. Web controls, Web Forms.

**References**:


1. S. Powers, Dynamic Web Publishing, (2e), Sams, 1997.
2. K. Jamsa, K. King, HTML & Web Design, (1e), McGraw-Hill, 2002.
3. M. Michaelis, Essential C# 3.0: For .NET Framework, (2e), Pearson, 2010.
4. S. Johnson, Using Active Server Pages, (1e) Que, 2000.1. M. Mano, Digital Logic and Computer Design, (1e), Pearson Education India, 2017.


**CA1130: C PROGRAMMING LAB [0 0 2 1]**

Introduction to MS-Office, Excel & PowerPoint, Simple C Programs (expression-oriented operations). Programs to illustrate various operators in C. Programs using branching constructs (if, if-else-if, switch case). Programs using looping constructs (for, while, do-while continue, break). Programs on 1D Arrays, Programs on 2D Arrays. Programs on strings. Programs using functions (with and without recursion), passing parameters by value and reference.

**Reference**:


1. E. Balaguruswamy, Programming in ANSI C, (5e), Tata McGraw Hill, 2012.
2. E. Balaguruswamy, Computing Fundamentals & C Programming, (2e), TataMcGraw Hill, 2017.
3. R. Thareja, Computer Fundamentals and Programming in C, (1e), Oxford University Press, 2017.
4. B. A. Forouzan, R. F. Gilberg, Computer Science: A structured programming Approach Using C, (3e), Cole Publishing Company-Cengage, 2007.

**CA1132: WEB PROGRAMMING LAB [0 0 2 1]**

Simple HTML document using basic elements like: <HTML>, <body>, <head>, <title>, <br>, <hr>. Text formatting tag: center, sup, em, ins, sub, font, h1 to h6, computer output tag: code, kbd, samp, tt, var, pre. Programing based on HTML, HTML with CSS, DHTML with JavaScript, Servlet, JSP and Database Connectivity Web pages. Classes and Objects, Display records by using database, Data list link control & Data binding using dropdown list control, Inserting record into a database & Deleting record into a database, Data binding using data list control & Data list control templates, Data binding using data grid & Data grid control template, Data grid hyperlink & Data grid button column, Creating own table format using data grid, Web Form application.

R**eferences**:


1. M. Michaelis, Essential C# 3.0: For .NET Framework, (2e), Pearson, 2010.
2. S. Johnson, Using Active Server Pages, (1e) Que, 2000.


**CY1003: ENVIRONMENTAL SCIENCE [2 0 0 2]**

Introduction: Multidisciplinary nature, scope and importance, sustainability and sustainable development. Ecosystems: Concept, structure and function, energy flow, food chain, food webs and ecological succession, examples. Natural Resources (Renewable and Non-renewable Resources): Land resources and land use change, Land degradation, soil erosion and desertification, deforestation. Water: Use and over-exploitation, floods, droughts, conflicts. Energy resources: Renewable and non- renewable energy sources, alternate energy sources, growing energy needs, case studies. Biodiversity and Conservation: Levels, biogeographic zones, biodiversity patterns and hot spots, India as a mega-biodiversity nation; Endangered and endemic species, threats, conservation, biodiversity services. Environmental Pollution: Type, causes, effects, and controls of Air, Water, Soil and Noise pollution, nuclear hazards and human health risks, fireworks, solid waste management, case studies. Environmental Policies and Practices: Climate change, global warming, ozone layer depletion, acid rain, environment laws, environmental protection acts, international agreements, nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human Communities and the Environment: Human population growth, human health and welfare, resettlement and rehabilitation, case studies, disaster management, environmental ethics, environmental communication and public awareness, case studies. Field Work and visit.

**References:**


1. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2016.
2. A. K. De, Environmental Studies, New Age International Publishers, New Delhi, 2007.
3. E. Bharucha, Textbook of Environmental Studies for undergraduate courses, Universities Press, Hyderabad, 2013.
4. R. Carson, Silent Spring, Houghton Mifflin Harcourt, 2002.
5. M. Gadgil & R. Guha, This Fissured Land: An Ecological History of India, University of California Press, 1993.
6. M. J. Groom, K. Meffe Gary and C. R. Carroll, Principles of Conservation Biology, OUP, USA, 2005.


## SECOND SEMESTER

**MA1208: BASIC STATISTICS AND PROBABILITY [3 1 0 4]**

Basic Statistics: Population, sample and data condensation, definition and scope of statistics, concept of population and simple with illustration, raw data, attributes and variables, classification, frequency distribution, cumulative frequency distribution. Measures of Central Tendency: Concept of central tendency, requirements of a good measure of central tendency, arithmetic mean, median, mode, harmonic mean, geometric mean for grouped and ungrouped data. Measures of Dispersion: Concept of dispersion, absolute and relative measure of dispersion, range variance, standard deviation, coefficient of variation. Permutations and Combinations: Permutations of 'n' dissimilar objects taken 'r' at a time (with or without repetitions), nPr = n!/(n-r) !(without proof). Combinations of 'r' objects taken from 'n' objects, nCr = n!/(r!(n-r)!) (Without proof). Simple examples, applications. Probability: Sample space, events and probability, experiments and random experiments, ideas of deterministic and non-deterministic experiments, definition of sample space, discrete sample space, events, types of events, union and intersections of two or more events, mutually exclusive events, complementary event, exhaustive event, simple examples. Classical definition of probability, addition & multiplication theorems of probability without proof (up to three events are expected). Definition of conditional probability. Definition of independence of two events, total probability theorem and Baye's theorem, simple numerical problems. Multiple correlation and regression (for the three variables only).

**References**:


1. S. C. Gupta, Fundamentals of statistics, (7e), Himalaya Publishing House, 2016.
2. A. M. Gun, M. K. Gupta, D. Gupta, Fundamentals of statistics, (1e), World Press, 2016.
3. V. K. Rohtagi, An Introduction to Probability and Mathematical Statistics, (1e), Wiley, 1976.
4. S.P. Gupta, Statistical Methods, (1e), S. Chand, 2012.


**CA1201: DATA STRUCTURES [3 1 0 4]**

Introduction: Definitions, Concept of Data Structures, Overview of Data Structures. Arrays: Definitions, terminologies, 1D Array: Memory allocation, Operations on array, Application of Arrays, 2D and 3D Array representation, Linked Lists: Definition, Single Linked List: Representation in memory, operations (insertion, deletion, modify etc.), Circular Linked List, Double Linked List. Stacks: Definition, Array and linked-list representation of stack, Operations on Stack: Push, Pop, application of stack: infix to postfix, evaluation of arithmetic expression, tower of Hanoi. Queues: Definition, Array and linked-list representation of Queue. Operations on Queue: Insertion, Deletion. Various Queue Structure: Circular Queue, Priority Queue. Insertion, Deletion operations on a Circular Queue and Priority Queue, Sorting and Searching: Insertion Sort, Selection Sort, Merge Sort, Linear Search, Binary Search. Tree: Definitions and Concepts, Representation of binary tree, Binary tree traversal (Inorder, postorder, preorder), Threaded binary tree, insertion and deletion, Binary search trees, Applications of Trees- Some balanced tree mechanism, e.g., AVL trees, 2-3 trees, Height Balanced, Weight Balance, B Tree, B+ Tree, Graph-Matrix Representation of Graphs, Elementary Graph operations.

**References**:


1. A. M. Tenenbaum, Data Structures Using C, (1e), Pearson Education, 2008.
2. R. Thareja, Data Structures Using C, (2e), Oxford University Press, 2014.


**CA1202: DATABASE MANAGEMENT SYSTEM [3 1 0 4]**

Introduction: Introduction to Database management system, some examples, characteristics of the database approach, Relational Model. ER Models: Database modeling using the entity-relationship model, entity types, entity sets attributes and keys, relationships. Database Design: Functional dependencies and normalization for relational databases. SQL the Relational Database Standard: Data definition, constraints, Basic Queries in SQL, More complex SQL queries, Insert, Update and Delete Statements in SQL. Transaction Processing: Transaction processing concepts: Introduction to transaction processing, transaction and system concepts, desirable properties of transactions, schedules and recoverability. Introduction to Cursors and Triggers.

**References**:


1. R. Ehmasri, S. Navathe, Fundamentals of Database Systems, (6e), Addison-Wesley, 2011.
2. A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, (6e), McGraw-Hill, 2013.
3. C.J. Date, Introduction to Database Systems, (8e), Pearson Education, 2003.


**CA1203: PRINCIPLES OF PROGRAMMING LANGUAGES [3 1 0 4]**

Introduction: Programming language – design, spectrum and the study motivation, Compilation and interpretation. Programming environments. Names, Scope, and Bindings: Concept of binding time, Object lifetime and storage management, Scope rules and implementing scope, the binding of reference environments, Binding within a scope, Separate compilation; Control Flow: Expression evaluation, Structured and unstructured flow, Sequencing, Selection, Iteration, Recursion, Non-determinacy. Data Types: Type systems and checking, Records and variants, Arrays, Strings, Sets, Pointers and recursive types, Lists, Files and Input/Output, Equality testing and assignment. Subroutines and Control Abstraction: Stack layout, calling sequences, Parameter passing, Generic subroutines and modules, Exception handling, Co-routines. Data Abstraction, Object Orientation: Object oriented programming, Encapsulation and Inheritance, Dynamic method binding. Functional Languages: Origins, Concepts, Scheme, Evaluation order, Higher-order functions, Functional programming in perspective; Logic Languages: Concepts, Prolog, Logic programming in perspective; Scripting Languages: Common characteristics.

**References**:


1. M.L. Scott, Programming Language Pragmatics, (4e), Elsevier, 2009.
2. J. C. Mitchell, Concepts in programming languages, (1e), Cambridge University Press, 2002.
3. R. Sethi, Programming languages Concepts and Constructs, (2e), Pearson Education, 1996.
4. R Sebesta, Concepts of Programming Languages, (8e), Pearson Education, 2008.
5. A. Tucker, R. Noonan, Programming languages, (2e), Tata McGraw-Hill, 2007.

**CA1204: OBJECT-ORIENTED PROGRAMMING USING C++ [3 1 0 4]**

Object Oriented Programming Concepts: Evolution of object-oriented programming, OOPs characteristics, Difference between C and C++. Program Basic: keywords, identifiers, data types, variables declaration and definition, constants, operators, C++ program structure, control and conditional statement, type casting, pointers, dynamic memory allocation, memory deallocation, array & its types. Class & Object: Introduction, data member and member function access, returning objects, array of objects, scope resolution operator, constructor and destructor, friend function, inline function, function overloading and operators overloading. Inheritance: Introduction, types, access controllers, virtual functions, and abstract class. I/O Streams & Files: Streams Hierarchy, Input Streams & Output Streams, Implementing various file operations on basic data types, Random Access Files, Introduction to exception handling.

**Reference**:


1. E Balagurusamy, "Object Oriented Programming with C++" – Sixth Edition, Tata McGraw-Hill Education.
2. Nicolai M. Josuttis, "The C++ Standard Library: A Tutorial and Handbook", Addison-Wesley Professional.
3. Sarang Poornachandra "Object-Oriented Programming with C++ "2$^{Nd}$ Ed., PHI Learning Pvt. Ltd.


**CA1231: DATABASE MANAGEMENT SYSTEM LAB [0 0 2 1]**

MySQL setup: data migration from MySQL to portable file as well as uploading data from portable file to MySQL. SQL: Creating, Altering, and Dropping tables with Constraints, Insert Table. Detailed SELECT with sub-queries, EQUI-JOINS, correlated sub-queries. GROUPING, SET, UPDATE, DELETE, VIEWS. PL/SQL: Program Development: Iterative PL/SQL Blocks.

**References**:


1. R. Ehmasri, S. Navathe, Fundamentals of Database Systems, (6e), Addison-Wesley, 2011.
2. A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, (6e), McGraw-Hill, 2013.


**CA1232: DATA STRUCTURES USING C++ LAB [0 0 2 1]**

Program Basic: keywords, data types, variables, constants, operators, control and conditional statement, type casting, pointers, dynamic memory allocation, memory deallocation, array & its types and C++ program structure. OOPs concepts: Class & Objects, friend function, inline function, function overloading and operator overloading, Inheritance and its types, virtual function, abstract class, Input/Output operations. Data Structure Basic: Array operations, dynamic memory allocation, Stack and Queue, linked list, types and operations.

**Reference**:


1. E. Balaguruswamy, "Object Oriented Programming with C++", TMH.
2. Herbert Schildt, "C++ The Complete Reference", TMH.


## THIRD SEMESTER

**CA2101: COMPUTER ORGANIZATION AND ARCHITECTURE [3 1 0 4]**

General Computer Architecture: Block Diagram of typical Computer, Memory Section, Input/Output Section, CPU, Registers, Arithmetic Unit, Instruction handling Areas, Stacks. Micro operations: Register Transfer, Bus and Memory Transfer, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit. Basic Computer Organization and Design: Instruction Codes, Operation code, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input Output Instructions and Interrupts. Control Memory: Control Word, Microinstruction, Microprogramming, Control Memory, Hardwired Central Processing Unit: General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, RISC, CISC Pipelining and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Vector Processing, Array Processors Input Output Organization: I/O Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, IOP, Serial Communication. Memory Organization: Associative Memory, Cache Memory, and Virtual Memory Introduction to Microprocessor: Machine Language, Assembly Language, Assembler, High Level Language, Compiler, Interpreter, Internal Architecture 8085.

**References:**


1. C. Hammacher, Computer Organization, (5e), Tata McGraw-Hill, 2011.
2. M.M. Mano, Computer System Architecture, (3e), Pearson, 2007.
3. B.Govindarajalu, Computer Architecture and Organization, (2e), Tata McGraw-Hill, 2017.


**CA2104: DATA COMMUNICATION & PROTOCOLS [3 1 0 4]**

Data Transmission: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity. Transmission Media: Guided Transmission Media, Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission. Signal Encoding Techniques: Analog and Digital Signals, Digital-To-Digital Conversion: Line Coding Schemes, Block Coding, Scrambling, Analog-To-Digital Conversion: Pulse Code Modulation, Delta Modulation, Digital-To-Analog Conversion: Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying. Digital Data Communication Techniques: Asynchronous and Synchronous Transmission, Types of Errors, Error Detection, Error Correction, Line Configurations. Data Link Control Protocols: Flow Control, Error Control, High-Level Data Link Control (HDLC). Multiplexing: Frequency-Division Multiplexing (FDM), Time-Division Multiplexing (TDM), Code-Division Multiple Access (CDMA). Spread Spectrum: The Concept of Spread Spectrum, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS). Cellular Wireless Communication Techniques: Introduction, Generations: 1G, 2G, 3G, 4G, and 5G.

**References:**


1. W. Stallings., Data and Computer Communications, (8e), Pearson Education, 2007.
2. B. Forouzan, Data Communications & Networking, (5e), McGraw Hill, 2012.
3. L. Peterson, T. Davie, Computer Networks: A Systems Approach, (5e), Morgan Kaufmann Publishers, 2012.


**CA2105: JAVA PROGRAMMING [3 1 0 4]**

Introduction to OOP: Features of Java, How Java is different from C++, Data types, Control Statements, identifiers, arrays, and operators. Inheritance: Multilevel hierarchy, method overriding, abstract classes, Final classes, String Class. Packages and Interfaces: Defining, Implementing and Importing Packages. Exceptions: Fundamentals, Types, Uncaught Exceptions, Multiple catch Clauses, Java's Built-in Exception. Multithreading: Creating, Implementing and Extending thread, thread priorities, synchronization suspending, resuming and stopping Threads. String: String Constructors, Various Types of String Operations. Basic Packages of Java: Java.lang, Java.util, Java.io. Event Handling: Event Model, Event Classes, Sources of Events, Event Listener Interfaces AWT: Working with Windows, AWT Controls, Layout Managers. Swings: Class hierarchy and components. Introduction to JSP.

**References:**


1. H. Schildt, Java The Complete Reference, (10e), Tata McGraw-Hill, 2017.
2. E. Balaguruswamy, Programming with JAVA, (5e,) McGraw-Hill, 2014.
3. D. Liang, Introduction to JAVA Programming, (7e), Pearson, 2009.


**CA2106: OPERATING SYSTEMS [3 1 0 4]**

Introduction: Basic concepts, Simple Batch Systems, Multi-programmed Batched Systems, Time Sharing Systems, Protection; Processes and CPU scheduling: Process Concept, Process scheduling, Operation on Processes, Cooperating Processes, Inter-process Communication. Scheduling Criteria, Scheduling algorithms; Process Synchronization: The Critical-Section problem, Synchronization Hardware, Basics of Semaphores; Deadlocks: Deadlock characterization, Methods of Handling Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection & Recovery from Deadlock; Memory Management: Logical versus Physical Address Space, Swapping, Contiguous Allocation, Paging. Virtual Memory: Demand paging, Page replacement, Page-replacement algorithms.

**References:**


1. A. Silberschatz , P.B Galvin, G. Gagne ,Operating system concepts,(9e), Wiley, 2016 .
2. H. M. Deitel, An introduction to operating system, (1e), Wiley, 1983.

**CA2109: INTRODUCTION TO DATA SCIENCE [3 1 0 4]**

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications. Data collection and management (ETL): Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources, Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes. Recent trends in various data collection and analysis techniques, application development methods used in data science.

**References:**


1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline, O'Reilly, 2e, 2017.
2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press, (2e), 2016.


**CA2132: JAVA PROGRAMMING LAB [0 0 2 1]**

Programming Basics, classes & objects, constructor, overloading, returning objects, overriding, abstract class, inheritance, interfaces, multithreading, exception handling, event handling, AWT and swings components, graphical user interface, input output handling.

**References:**


1. H. Schildt, Java The Complete Reference, (10e), Tata McGraw-Hill, 2017.
2. E. Balaguruswamy, Programming with JAVA, (5e,) McGraw-Hill, 2014.


**CA2133: OPERATING SYSTEM LAB [0 0 2 1]**

Basic Unix Commands: date, clear, chmod, man, mail, passwd, pwd, cat, ls, mv, mkdir, cd, rm, rmdir, wc etc, introduction to Vi editor ; UNIX shell : wild cards, redirection, pipes, sequencing, grouping, background processing, command substitution, sub shells; Shell programming: shell scripts variables, loops (for, while), and conditional statements (if else, case), Shell variables, arguments to shell procedure, test command, arithmetic with EXPR command, interactive shell procedures with read ;CPU scheduling Algorithms: FCFS, SJF, RR; Semaphores: Readers Writers Problem, Producer-Consumer Problem; Deadlock Avoidance: Bankers Algorithm; Memory allocation: First fit, worst fit, best fit, next fit; Page Replacement : FIFO, Optimal, LRU.

**References:**


1. M. Bach, Design of Unix Operating System, (1e), PHI, 2015.
2. G. Glass, Unix for Programmers and Users- A complete guide, (3e), PHI, 2003.


## FOURTH SEMESTER

**CA2202: PYTHON PROGRAMMING [3 1 0 4]**

Python concepts: Expressions, values, types, variables, operators, control flow, file I/O, the Python execution model. Data structures: List, set, dictionary (mapping), tuple, List slicing (sublist), list comprehension (shorthand for a loop), Mutable and immutable data structures, Distinction between identity and (abstract) value. Functions: Procedural abstraction, functions as values, recursion, function design methodology. OOP: Classes & Object, Inheritance, Polymorphism, The Python Library: String and Text Handling, Threading, Networking, Web Programming, Graphical Programming, Database Access.

**References:**


1. D. M. Beazley, Python Essential Reference, (1e) Amazon Books, 2010.
2. M. Lutz, Programming Python, (4e), O'Reilly Media, 2010.


**CA2203: SOFTWARE ENGINEERING [3 1 0 4]**

Introduction to System Concepts: Definition, Elements of System, Characteristics of System, Types of System, System Concepts. Introduction to Software Engineering: Definition, Need for software Engineering, Software Characteristics, Software Qualities (McCall's Quality Factors) Requirement Analysis: Definition of System Analysis, Requirement Anticipation, Knowledge and Qualities of System Analyst, Role of a System Analyst, Feasibility Study And It's Types, User Transaction Requirement, User design Requirements, SRS(System Requirement Specification) Software Development Methodologies: SDLC (System Development Life Cycle), Waterfall Model, Spiral Model, Prototyping Model, Introduction to Agile Model.

Analysis and Design Tools: Entity Relationship Diagrams, Data Flow Diagrams (DFD), Data Dictionary & Elements of Data Dictionary, Pseudo code, Input and Output Design. Structured System Design: Modules Concepts and Types of Modules, Structured Chart, Qualities of Good Design, Coupling, Types of Coupling, Cohesion, Types of Cohesion. Software Testing: Definition, Test characteristics, Types of testing - BlackBox Testing, White-Box Testing, Stress Testing, Performance Testing.

**References**:


1. R. S. Pressman, Software Engineering, (5e), Tata McGraw Hills, 2009.
2. I. Sommerville, Software Engineering, (6e), Pearson Education Asia, 2005.
3. P. Jalote, An Integrated Approach to Software Engineering, (3e), Narosa, 2010.


**CA2204: DATA MINING & VISUALIZATION [3 1 0 4]**

Data Mining – Importance of Data Mining, Data Mining functionalities, Basic Data Mining structure, Data Mining Applications, Differences between Operational Database and Data Warehouse – Multidimensional Data Model, Data Cubes. Schemas, Measures, Data Reprocessing, Data Mining Primitives, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and concept of Hierarchy Generation, Schema Design: Star and snow-Flake Schema, Data Mining Algorithms: Association Rule Mining, Classification and Clustering Basics.
Introduction to data visualization, importance of data visualization, data types, different tools for data visualization. Understanding two-dimensional graph, three-dimensional graph. Introduction to dashboard, need of dashboards. Pie Chart, Bar Chart, Histogram, Gantt Chart, Heat Map, Box and Whisker Plot, Waterfall Chart, Area Chart, Scatter Plot, Pictogram Chart, Timeline, Highlight Table, Bullet Graph, Choropleth Map, Word Cloud, Network Diagram, Correlation Matrices, geographical plots, Density Maps, Bubble Chart, Tree maps. Dashboard development process, dashboard architecture.

**References:**


1. Kamber and Han, "Data Mining Concepts and Techniques", Hartcourt India P. Ltd.,2001.
2. William H Inmon "Building the Data Warehouse", Wiley, Fourth Edition 2005.
3. Paul Raj Poonia, "Fundamentals of Data Warehousing", John Wiley & Sons, 2003.
4. Margret H Dunham,Data Mining Introductory and advanced topics, Pearson Education, 6th ed, 2009.
5. Shawkat Ali and Saleh Wasimi, Data Mining: Methods and Techniques, Cengage Learning, Indian Edition, 2009.
6. Engebretsen, Martin, and Helen Kennedy. Data visualization in society. 2020.
7. Anouncia, S. Margret, Hardik A. Gohel, and Subbiah Vairamuthu. Data Visualization. Springer Verlag, Singapore, 2020.


**CA2206: INTELLIGENT SYSTEMS [3 1 0 4]**

Introduction to knowledge-based intelligent systems, Rule-based expert systems, Frame-based systems, Fuzzy logic and fuzzy expert systems, Artificial neural networks, Evolutionary computation, Hybrid intelligent systems and Knowledge engineering and data mining.

**References:**


1. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, Second edition, Pearson Education Limited.
2. Rich and Knight, "Artificial Intelligence", Tata McGraw Hill, 1992.
3. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Second Edition.


**CA2231: PYTHON PROGRAMMING LAB [0 0 2 1]**

Implement a sequential search, create a calculator program, explore string functions, Implement Selection Sort, Implement Stack, Read and write into a file, demonstrate usage of basic regular expression, Demonstrate use of advanced regular expressions for data validation. Demonstrate use of List, demonstrate use of Dictionaries, Create Comma Separate Files (CSV), Load CSV files into internal Data Structure. Write script to work like a SQL SELECT statement for internal Data Structure made in earlier exercise. Write script to work like a SQL Inner Join for an internal Data Structure made in earlier exercise.

**References:**


1. D. M. Beazley, Python Essential Reference, (1e) Amazon Books, 2010.
2. M. Lutz, Programming Python, (4e), O'Reilly Media, 2010.

**CA2232: DATA MINING & VISUALIZATION LAB [0 0 2 1]**

Data Preparation – Cleaning – Missing data, Data Reduction – PCA, Data Transformation – Normalization, Generate Association Rules using the Apriori algorithm, generating association rules using fp growth algorithm, Build a Decision Tree by using J48 algorithm, Naïve bayes classification on a given data set, Applying k-means clustering on a given data set, Calculating Information gains measures, OLAP Cube and its different operations, Case studies.

Introduction to data visualization, importance of data visualization, data types, different tools for data visualization. Understanding two-dimensional graph, three-dimensional graph. Introduction to dashboard, need of dashboards. Pie Chart, Bar Chart, Histogram, Gantt Chart, Heat Map, Box and Whisker Plot, Waterfall Chart, Area Chart, Scatter Plot, Pictogram Chart, Timeline, Highlight Table, Bullet Graph, Choropleth Map, Word Cloud, Network Diagram, Correlation Matrices, geographical plots, Density Maps, Bubble Chart, Tree maps. Dashboard development process, dashboard architecture.

**References:**


1. Kamber and Han, Data Mining Concepts and Techniques, Hartcourt India P. Ltd.,2001.
2. William H Inmon, Building the Data Warehouse, Wiley, Fourth Edition 2005.
3. Paul Raj Poonia, Fundamentals of Data Warehousing, John Wiley & Sons, 2003.
4. Margret H Dunham, Data Mining Introductory and advanced topics, Pearson Education, 6 th ed, 2009
5. Shawkat Ali and Saleh Wasimi, Data Mining: Methods and Techniques, Cengage Learning, Indian Edition,2009
6. Engebretsen, Martin, and Helen Kennedy. Data visualization in society. 2020.
7. Anouncia, S. Margret, Hardik A. Gohel, and Subbiah Vairamuthu. Data Visualization. Springer Verlag, Singapore, 2020.


## FIFTH SEMESTER

**CA3102: MOBILE APPLICATION DEVELOPMENT [3 1 0 4]**

Introduction: Android, Android versions and its feature set, the various Android devices on the market, The Android Market application store, Android Development Environment - System Requirements, Android SDK, Installing Java, and ADT bundle - Eclipse Integrated Development Environment (IDE). An Overview of Threads, The Application Main Thread. Multimedia: Audio, Video, Camera Playing Audio and Video, Recording Audio and Video, Using the Camera to Take and Process Pictures. Android Architecture Overview: The Android Software Stack, The Linux Kernel, Android Runtime - Dalvik Virtual Machine, Android Runtime – Core Libraries, Dalvik VM Specific Libraries, Java Interoperability Libraries, Android Libraries, Application Framework, Android Software Development Platform: Understanding Java SE and the Dalvik Virtual Machine, The Directory Structure of an Android Project, Common Default Resources Folders. Android Framework Overview: Android Application Components, Android Activities: Defining the UI, Android Services: Processing in the Background, Broadcast Receivers: Announcements and Notifications Content Providers: Data Management, Android Intent Objects: Messaging for Components Android Manifest XML: Declaring Your Components. Understanding Android Views, View Groups and Layouts Designing for Different Android Devices, Views and View Groups, Android Layout Managers, The View Hierarchy, Designing an Android User Interface using the Graphical Layout Tool. Graphical User Interface Screen with views: Displaying Text with TextView, Retrieving Data from Users, Using Buttons, Check Boxes and Radio Groups, Getting Dates and Times from Users, Using Indicators to Display Data to Users. Displaying Pictures: Gallery, ImageSwitcher, GridView, and ImageView views to display images, Creating Animation. Files, Content Providers, and Databases: Saving and Loading Files, SQLite Databases, Android Database Design, Exposing Access to a Data Source through a Content Provider, Content Provider Registration, Native Content Providers.

**References:**


1. B. Phillip, C. Stewart, B. Hardy, K. Marsicano, Android Programming, The Big Nerd Ranch Guide, (3e), Big Nerd Ranch LLC, 2017.
2. R. Meier, Professional Android 4 Application Development, (3e), Wiley India (Wrox), 2012.
3. J. C. Sheusi, Android Application Development for Java Programmers, (1e), Cengage Learning, 2013.
4. W.M.Lee, Beginning Android 4 Application Development, (1e), Wiley India (Wrox), 2013.

**CA3106: MACHINE LEARNING [3 1 0 4]**

Introduction to Machine Learning: Basics of Machine Leaning, Supervised Machine Learning, K- Nearest Neighbors, Naïve Bayes, Decision tree, Support Vector Machines, Unsupervised Machine Learning: Cluster analysis, K means, Association Rule Mining, Apriori algorithms, Regression Analysis: Linear Regression, Nonlinear Regression, Problem Solving: State Space Search, Production System, Depth First Search, Breadth First Search, Heuristic Search (Hill Climbing, Best First Search and Problem Reduction).

**References:**


1. T.M. Mitchell, Machine Learning, (1e), McGraw- Hill Education, 2017.
2. E. Alpaydin, Introduction to Machine Learning, (3e), PHI, 2015.


**CA3108: BUSINESS DATA ANALYTICS [3 1 0 4]**

Analytics: Basic Nomenclature, Analytics Process Model, Analytics part in different profiles, Analytical Model Requirements. Data Sources for data collection, Sampling and Sampling distribution, Types of data elements, Missing Values, Outlier Detection and Treatment, Standardization using Min/max and z-score, categorization, Segmentation. Correlation, Simpsons Paradox, Some Other Correlational Caveats, Correlation and Causation, Correlation Statistics-ANOVA. Statistical Hypothesis Testing, p-Values, Confidence Intervals Data Visualization: Graphs in Python: Line Graph, Bar charts, Pie-charts, Scatter plots, multiple plots, Subplots, Legends, Changing figure Size, Styling plots using Matplotib Library. Functions like relplot(), displot() and catplot (). Seaborn Library: Introduction, Line plot, Dist plot, Lmplot, Count plot, Color palettes.

**References:**


1. Analytics in a Big Data World, Essential Guide to Data Science and its Application, Bart Baesens, Wiley Big Data Series.
2. Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data Published by John Wiley & Sons, Inc.
3. Data Science from Scratch, 2nd Edition by Joel Grus Publisher(s): O'Reilly Media, Inc.


**CA3131: MOBILE APPLICATION DEVELOPMENT LAB [0 0 2 1]**

Develop an application that uses GUI components, Font and Colors. Develop an application that uses layout managers and event listeners. Develop a native calculator application to calculate the arithmetic operations. Write an application that draws basic graphical primitives on the screen. Develop an application that makes use of database for add the info and show the search result. Implement an application that implements multi-threading. Develop a native application that uses GPS location information. Implement an application that writes data to the SD card. Implement an application that creates an alert upon receiving a message. Write a mobile application that creates alarm clock.

**References:**


1. B. Phillip, C. Stewart, B. Hardy, K. Marsicano, Android Programming, The Big Nerd Ranch Guide, (3e), Big Nerd Ranch LLC, 2017.
2. R. Meier, Professional Android 4 Application Development, (3e), Wiley India (Wrox), 2012.
3. J. C. Sheusi, Android Application Development for Java Programmers, (1e), Cengage Learning, 2013.
4. W. M. Lee, Beginning Android 4 Application Development, (1e), Wiley India (Wrox), 2013.


**CA3132: MACHINE LEARNING LAB [ 0 0 2 1]**

Introduction to R Programming, History of R, and R packages, CRAN, R community, R-bloggers, StackOverflow, Coursera, DataCamp. R Syntax Basics: Constants, operators, functions, variables. Random numbers, Vectors and vector indexing, simple descriptive stats, Loops, Conditional expressions. Data Types: Levels of measurement (nominal, ordinal, interval, ratio scale) Vector types, data. Frame objects, rows and columns, indexing, Characteristics of tidy data. Basic Data Transformations: Create new variables in a data. Frame, Filter rows and columns, merging datasets. Introduction to Complex Data Transformations: Filtering and ordering data, Summaries and aggregates, new variables, Relational data, Joins on Keys, Introduction into fuzzy joins, transforming wide and long tables, Converting Numeric Variables into Factors, Date Operations, String Parsing, Geocoding. Data Visualization using R. Dirty Data Problems, Data Sources: sqlite examples for relational databases, Loading SPSS and SAS files, Reading from Excel and Google Spreadsheets, API and web scraping examples.

**References:**

1. G. Grolemund, Handbook of programming with R, (1e), O'REILLY, 2014.

**CA3170: MINOR PROJECT [0 0 2 1]**

**Introduction**

The Bachelor of Computer Applications (BCA) program is designed with an aim to get students ready for careers as software engineers, systems designers, and other professions in the IT industry. The curriculum is created to give students thorough understanding including the fundamental concepts and domains of computer science in both theory and practise. The last semester of the BCA curriculum includes a six-month minor project. The main goal of project work is to assist the student in acquiring the skills necessary to solve real-world issues that arise in business, academia, and research labs by using theoretical and practical tools and methodologies. Students are expected to use their knowledge from numerous courses—both theoretical and practical—to create high-quality software solutions for the major project.

**Course Outcome**

**CA3170.1** To show a thorough understanding of today's technologies.
**CA3170.2** To learn project organization.
**CA3170.3** To build a project by applying Software Engineering methods.
**CA3170.4** To acquire the skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms.
**CA3170.5** To reflect learning and take appropriate actions to improve entrepreneur skills.

**Syllabus**

The project work is a part of the course and should focuses on developing a software application to solve some real-world problems. In the project work each student should develop a working software application with the help of different skills acquired from previous semesters and prepare a project report as per the project guidelines. Following guidelines must be followed while creating a project.

**Text Book(s):**

1. Prasanna Chandra; Projects- Planning, Analysis, Selection, Financing, Implementation and Review', VI Edition, Tata Mc Graw Hill.

**Reference Book(s):**

1. Chaudhary S.; Project Management, Tata Mc Graw Hill.
2. Kerzner H.; Project Management, II Edition, CBS Publishers.

**Project Guidelines**

- Each student should submit a unique project title unless/otherwise in a team project.
- Project work should include software development.
- Only two students can work on one project as a team. However, there contribution should be clearly specified and reported.
- The project should focus on solving some real-life problems, though it is not mandatory. However, the project idea should be creative, and it can be a fresh take on an old idea which is often worth as much as a brand-new idea.
- The project work may be done internally in the university campus or in any external organizations/institutes approved by the head of the department/university authority.
- Prior to starting project work, a student must get his/her project idea/problem statement approved by the supervisor.
- The student must submit a project synopsis, presenting his idea. The student may start working on project only if the synopsis is approved.
- The student should present the progress of the project works as per the timeline specified by the department /project coordinator/ supervisor.

**Project Synopsis Format**

The project synopsis must be prepared and approved with the supervisor's input. The synopsis should include a detailed description of the proposed project and objectives. The synopsis should be prepared as per the following format.

- Title of the project
- Name of the supervisor/project guide
- Project Introduction

- Objectives of the project
- DFD, ER Diagrams
- Project Timeline
- Tools / platform, hardware and software requirement specifications
- References

**Project Report Format**

The final project report should describe the detailed work completed by the student. The report must be prepared as per the following format.

General Guidelines

- Project Report to be minimum 35 pages. Reports less than 35 pages will be rejected.
- Project report to be maximum 50 - 60 pages (preferred but not mandatory).
- Paper Size: A4; Left = Right = Top = Bottom Margins = 0.7".
- Page Numbering Position: Bottom with right justified and continuous numbering from the Introduction Chapter.
- Use Times New Roman Font with Normal Style, paragraph justified and 1.15 line spacing.
- Paragraph Heading: Times New Roman Font, Bold, Font Size 14; Paragraph Matter: Times New Roman Font, Normal, Font Size 12.
- Sub-paragraphs be appropriately numbered as in 1.1, 1.2, 1.3 etc; Sub-paragraph Heading: Times New Roman Font, Italics, Font Size 12; Sub-paragraph Matter: Times New Roman Font, Normal, Font Size 12.
- Figure captions below Figure with chapter wise numbering.
- Tables captions above Table with chapter wise numbering.
- All references must be listed in the order in which they appear in the report (follow IEEE format for referencing).
- Only hard bound reports will be accepted, colour of the front cover to be in mustard yellow.

  *Note: The Cover page color as mentioned above has CMYK Values are C: 00 M:20 Y:75 K:00 & Hex is: FFCC00*

Project Report Structure

The following structure should be followed while preparing the final project report.

1. Title Page
2. Certificate of Completion (internal/External)
3. Acknowledgement
4. Table of contents / index with page numbering
5. List of tables
6. List of figures
7. Introduction / objectives of the project
8. System analysis
9. Feasibility study
10. Software and hardware requirement specifications
11. System design (DFD, ER Diagram, Class diagram etc.)
12. Database Schema
13. Project code
14. Screenshot of the project
15. Implementation/deployment details
16. Testing (testing techniques and testing strategies used along with the test data and the errors listed for each test case).
17. Conclusion
18. Future scope and further enhancement of the project
19. Bibliography/ references
20. Appendices (if required)

Note: Reports, tables figures should be properly numbered/labelled. Two hard copies of the project report should be submitted. The soft copy of the project report in PDF should also be submitted along with the hard copy.

**CA3110: APTITUDE AND TECHNICAL DEVELOPMENT [1 0 0 1]**

Section I: Quantitative: Number System, Percentage, Time & Distance, Profit & Loss, Time & Work, Average, Permutation & Combinations, Game Based. Verbal: Sentence Improvement, Sentence Rearrangement, Fill in the Blanks. Logical: Coding & Decoding, Direction, Blood Relation, Puzzle, Series, Statement & Arguments. Mock Interview Preparation and Group Discussion.
Section II: C Programming: C Fundamentals, Function, Array, Pointers, Structure and File Handling. Object Oriented Concepts. Data Structure: Types of Data Structure and their implementation. Program Logic Development and MCQ Solving. DBMS; SQL Queries. Software Engineering: Use case preparation and Implementation. Overview of Operating Systems and Computer Networks.

**Program Elective I**

**CA3143: INTERNET OF THINGS [3 0 0 3]**
Internet of Things: An overview, System Architecture, Design Principles for Connected Devices, Design Principles for Web connectivity for Connected Devices, Internet Connectivity Principles, Data Acquiring, Organizing and Analytics in IoT, data Collection, Storage & Computing Using Cloud Platform, Sensors and Actuators, Radio Frequency Identification, Wireless Sensor Networks and Participatory Sensing Technology, Prototyping of Embedded Devices for IoT, Gateways, Internet and Web/Cloud Services Software Component, IoT Privacy, Security and governance. IoT based Case studies.

**References:**


1. Theoleyre, Fabrice, and Ai-Chun Pang, eds," Internet of Things and M2M Communications", River Publishers, (1e), 2013.
2. Delsing, Jerker, ed, "IoT automation: Arrowhead framework. CRC Press", (1e), 2017.
3. Raj Kamal, "Internet of Things", (1e), McGraw-Hill, 2017.


**CA3148: NATURAL LANGUAGE PROCESSING [3 0 0 3]**
Basics of Finite State Automata, Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithm. Survey of English Morphology, Finite-State Morphological Parsing, Building a Finite State Lexicon, FSTs for Morphological Parsing, Lexicon-Free FSTs. Words and sentence tokenization, Detecting and Correcting Spelling Errors. Case study: Normalizing Text, Segmentation. N-Grams, Unsmoothed N-Grams, Smoothing, Interpolation, and Backoff. English Word Classes, Tag-sets for English, Part-of-Speech Tagging, The Noisy Channel Model for Spelling. Case study: Automatic Tagging. Constituency, Some Grammar Rules for English, The Penn Treebank project, Dependency Grammar. Parsing with Context Free Grammars, CKY algorithm, Statistical Parsing.

**References:**


1. J. E. Hopcroft, R. Motwani & J. D. Ullman, Introduction to Automata Theory Languages, and Computation, (3rd Edition), Pearson Education.
2. Daniel Jurafsky & James H. Martin, Speech and Language Processing, (2e), Pearson, 2009.
3. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, (1e), O'Reilly Media, 2009.
4. Akshar Bharati, Rajeev Sangal and Vineet Chaitanya, Natural Language Processing: A Paninian Perspective, Prentice-Hall of India, New Delhi, 1995.


**CA3149: COMPUTER VISION [3 0 0 3]**
Introduction: Image Processing, Components of Image processing system, Image formation and digitization concepts, Neighbours of pixel adjacency connectivity, regions and boundaries, Distance measures, Image processing operations, Arithmetic, Logical, Geometrical, Convolution and Correlation Operations. Image enhancement techniques in spatial and frequency domains. Morphological image processing, image segmentation, and object recognition. Various applications of computer vision: Document Image Analysis, Biometrics, Medical Image Analysis, object detection.

**References:**


1. R. C. Gonzalez, R. E. Woods. "Digital Image Processing". Pearson, Inc., Edition-Fourth, ISBN. 978-0131687288, 2017.
2. A. K. Jain. "Fundamentals of Digital Image Processing. Prentice-Hall, Pearson; Edition: First, ISBN-13: 978-0133361650, 1994.

## SIXTH SEMESTER

**CA3204: WIRELESS COMMUNICATION [3 1 0 4]**

Introduction: Mobile Communication and Overall View of the Syllabus and Lesson Plan, Introduction to Wireless Communication: Evolution of Mobile communications, Wireless and Mobile Radio-The First 150+ Years, Transmission fundamentals: Basics of Propagation, Propagation Models, Free-Space Propagation Model, Large-Scale Path Loss, Small Scale Multipath Propagation, Modulation Techniques for Mobile Radio: Modulation Criteria, Modulation Techniques, Liner Modulation Techniques - ASK, PSK, FSK, MSK, Spread spectrum modulation Cellular concepts: Frequency reuse, Channel assignment strategies, Handoff strategies; Mobile Computing: Mobile IP, ubiquitous and nomadic computing WWWW & Mobile Agent wireless world wide web; IEEE 802.11 Standards, Mobile agent technology and standards.

**References:**


1. T.S. Rappaport, Wireless Communications - Principle and Practice, (2e), PHI, 2005.
2. W. Stallings, Wireless Communication and Network, (2e), PHI, 2004.
3. K. Garg, Mobile Computing, (1e), Pearson Education India, 2010.


**CA3205: UNIX AND SHELL PROGRAMMING [3 1 0 4]**

Introduction: UNIX System Overview, Program and Processes, Error Handling, User Identification, Signals, System Calls and Library Functions.: File I/O: File Descriptors, Function for File Modification, I/O Efficiency, File Sharing, Atomic Operations.; Directories: Stat, Fstat, and Lstat Functions, File Types, Set-User-ID and Set-Group-ID, File Access Permissions, Function for modifying file permission and ownership, Symbolic Links, System Data Files and Information: Password File, Shadow Passwords and Other Data Files.; Process Environment: Process Termination, Memory Layout of a C Program, Memory Allocation, setjmp and longjmp Functions.; Process Control: fork Function, vfork Function, exit Functions, wait and waitpid Functions, Race Conditions, Changing User IDs and Group IDs.; Process Relationship: Logins, Process Groups, Sessions, Controlling Terminal, Job Control.; Signals: Signal Concepts, Functions to raise and handle Signals, Program Termination, abort and system functions.; Threads: Thread Concepts, Creation, Termination and Synchronization, Threads Control, Threads and Signals, Threads and fork, Threads and I/O. Shell programming: Basics of Shell Programming, UNIX shell commands, shell scripts variables, loops (for, while), and conditional statements (if else, case), Shell variables, arguments to shell procedure, test command, arithmetic with EXPR command, interactive shell procedures with read.

**References:**


1. W. R. Steven, S. A. Rago “Advanced Programming in the Unix environment”, Addison Wesley, (1e), 2011
2. Y. P. Kanetkar “Unix Shell Programming”. BPB Publication, (1e), 2009.


**CA3208: DEEP LEARNING [3 1 0 4]**

Introduction – Overview of Machine Learning, Introduction to Artificial Neural Network (ANN), Perceptron, Training a Neural Network, Activation Functions, Loss Function, Hyperparameters, Gradient Descent, Stochastic Gradient Descent, Backpropagation and regularization, Batch normalization, Building an ANN in Python, Frameworks-TensorFlow, Keras. What is Deep Learning? Deep vs Shallow Networks, Convolution Neural Networks (CNN) – Convolution Layers, Pooling Layer, Flattening, FullyConnected Layers, Softmax and CrossEntropy, Building a CNN in Python, Fully Connected CNN, CNN Architectures – LeNet, AlexNet, ZFNet, GoogLeNet, VGGNet, ResNet, DenseNet, Training a Convnet: weights initialization, batch normalization, hyperparameter optimization Deep Belief Networks, Auto Encoders, Concept of Dimensionality Reduction, Autoencoder, Denoising Autoencoders, Deep Autoencoders, Concept of Reinforcement Learning Recurrent Neural Networks (RNN), LSTM, Sequence Prediction and Time Series Forecasting with LSTM, Overview of Object Detection Techniques using Deep Learning, Overview of Transfer Learning.

**References:**


1. Adam Gibson and Josh Patterson, Deep Learning: A Practitioner's Approach, (O'Reilly).
2. Mohamed Elgendy, Deep Learning for Vision Systems, Manning Publications, ISBN: 9781617296192.
3. Navin Kumar Manaswi, Deep Learning with Applications Using Python, Apress (2018).

**CA3231: DEEP LEARNING LAB [0 0 2 1]**

Introduction – Overview of Machine Learning, Introduction to Artificial Neural Network (ANN), Perceptron, Training a Neural Network, Activation Functions, Loss Function, Hyperparameters, Gradient Descent, Stochastic Gradient Descent, Backpropagation and regularization, Batch normalization, Building an ANN in Python, Frameworks-TensorFlow, Keras. What is Deep Learning? Deep vs Shallow Networks, Convolution Neural Networks (CNN) – Convolution Layers, Pooling Layer, Flattening, FullyConnected Layers, Softmax and CrossEntropy, Building a CNN in Python, Fully Connected CNN, CNN Architectures – LeNet, AlexNet, ZFNet, GoogLeNet, VGGNet, ResNet, DenseNet, Training a Convnet: weights initialization, batch normalization, hyperparameter optimization Deep Belief Networks, Auto Encoders, Concept of Dimensionality Reduction, Autoencoder, Denoising Autoencoders, Deep Autoencoders, Concept of Reinforcement Learning Recurrent Neural Networks (RNN), LSTM, Sequence Prediction and Time Series Forecasting with LSTM, Overview of Object Detection Techniques using Deep Learning, Overview of Transfer Learning.

**References:**


1. Adam Gibson and Josh Patterson, Deep Learning: A Practitioner's Approach, (O'Reilly).
2. Mohamed Elgendy, Deep Learning for Vision Systems, Manning Publications, ISBN: 9781617296192.
3. Navin Kumar Manaswi, Deep Learning with Applications Using Python, Apress (2018).


**CA3270: MAJOR PROJECT [0 0 4 2]**

**Introduction**

The Bachelor of Computer Applications (BCA) program is designed with an aim to get students ready for careers as software engineers, systems designers, and other professions in the IT industry. The curriculum is created to give students thorough understanding including the fundamental concepts and domains of computer science in both theory and practise. The last semester of the BCA curriculum includes a six-month minor project. The main goal of project work is to assist the student in acquiring the skills necessary to solve real-world issues that arise in business, academia, and research labs by using theoretical and practical tools and methodologies. Students are expected to use their knowledge from numerous courses—both theoretical and practical—to create high-quality software solutions for the major project.

**Course Outcome**

**CA3270.1** To show a thorough understanding of today's technologies.
**CA3270.2** To learn project organization.
**CA3270.3** To build a project by applying Software Engineering methods.
**CA3270.4** To acquire the skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms.
**CA3270.5** To reflect learning and take appropriate actions to improve entrepreneur skills.

**Syllabus**

The project work is a part of the course and should focuses on developing a software application to solve some real-world problems. In the project work each student should develop a working software application with the help of different skills acquired from previous semesters and prepare a project report as per the project guidelines. Following guidelines must be followed while creating a project.

**Text Book(s):**


1. Prasanna Chandra; Projects- Planning, Analysis, Selection, Financing, Implementation and Review', VI Edition, Tata Mc Graw Hill.


**Reference Book(s):**


1. Chaudhary S.; Project Management, Tata Mc Graw Hill.
2. Kerzner H.; Project Management, II Edition, CBS Publishers.


**Project Guidelines**

- Each student should submit a unique project title unless/otherwise in a team project.
- Project work should include software development.
- Only two students can work on one project as a team. However, there contribution should be clearly specified and reported.
- The project should focus on solving some real-life problems, though it is not mandatory. However, the project idea should be creative, and it can be a fresh take on an old idea which is often worth as much as a brand-new idea.
- The project work may be done internally in the university campus or in any external organizations/institutes approved by the head of the department/university authority.

- Prior to starting project work, a student must get his/her project idea/problem statement approved by the supervisor.
- The student must submit a project synopsis, presenting his idea. The student may start working on project only if the synopsis is approved.
- The student should present the progress of the project works as per the timeline specified by the department /project coordinator/ supervisor.

**Project Synopsis Format**

The project synopsis must be prepared and approved with the supervisor's input. The synopsis should include a detailed description of the proposed project and objectives. The synopsis should be prepared as per the following format.

- Title of the project
- Name of the supervisor/project guide
- Project Introduction
- Objectives of the project
- DFD, ER Diagrams
- Project Timeline
- Tools / platform, hardware and software requirement specifications
- References

**Project Report Format**

The final project report should describe the detailed work completed by the student. The report must be prepared as per the following format.

General Guidelines

- Project Report to be minimum 35 pages. Reports less than 35 pages will be rejected.
- Project report to be maximum 50 - 60 pages (preferred but not mandatory).
- Paper Size: A4; Left = Right = Top = Bottom Margins = 0.7".
- Page Numbering Position: Bottom with right justified and continuous numbering from the Introduction Chapter.
- Use Times New Roman Font with Normal Style, paragraph justified and 1.15 line spacing.
- Paragraph Heading: Times New Roman Font, Bold, Font Size 14; Paragraph Matter: Times New Roman Font, Normal, Font Size 12.
- Sub-paragraphs be appropriately numbered as in 1.1, 1.2, 1.3 etc; Sub-paragraph Heading: Times New Roman Font, Italics, Font Size 12; Sub-paragraph Matter: Times New Roman Font, Normal, Font Size 12.
- Figure captions below Figure with chapter wise numbering.
- Tables captions above Table with chapter wise numbering.
- All references must be listed in the order in which they appear in the report (follow IEEE format for referencing).
- Only hard bound reports will be accepted, colour of the front cover to be in mustard yellow.

  *Note: The Cover page color as mentioned above has CMYK Values are C: 00 M:20 Y:75 K:00 & Hex is: FFCC00*

Project Report Structure

The following structure should be followed while preparing the final project report.

1. Title Page
2. Certificate of Completion (internal/External)
3. Acknowledgement
4. Table of contents / index with page numbering
5. List of tables
6. List of figures
7. Introduction / objectives of the project
8. System analysis
9. Feasibility study
10. Software and hardware requirement specifications
11. System design (DFD, ER Diagram, Class diagram etc.)

12. Database Schema
13. Project code
14. Screenshot of the project
15. Implementation/deployment details
16. Testing (testing techniques and testing strategies used along with the test data and the errors listed for each test case).
17. Conclusion
18. Future scope and further enhancement of the project
19. Bibliography/ references
20. Appendices (if required)

Note: Reports, tables figures should be properly numbered/labelled. Two hard copies of the project report should be submitted. The soft copy of the project report in PDF should also be submitted along with the hard copy.

**Program Elective II**

**CA3246: ROBOTICS & AI [3 0 0 3]**

Introduction – History, Definition of AI, Emulation of human cognitive process, Intelligent agents – The concept of rationality, the nature of environments, the structure of agents. Problem – Solving Agents: Problem Definitions, Formulating Problems, Searching for solutions – Measuring Problem – Solving Performance with examples. Search Strategies: Uninformed search strategies – Breadth – first Search, Uniform – Cost Search, depth –first search, depth – limited search, Iterative deepening depth – first search, bidirectional search, comparing uniformed search strategies. Informed search strategies – Heuristic information, Hill climbing methods, best – first search, branch – and – bound search, optimal search and A* and Iterative deepening A*. LISP, Syntax and numerical function, LISP and PROLOG distinction, input, output and local variables, interaction and recursion, property list and arrays alternative languages, formalized symbolic logics – properties of WERS, non-deductive inference methods. Fundamentals of Robotics, Robot Kinematics: Position Analysis, Dynamic Analysis and Forces, Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

**References:**


1. E. Rich and K. Knight, “Artificial intelligence”, TMH, 2nd ed., 1992.
2. N.J. Nilsson, “Principles of AI”, Narosa Publ. House, 1990.
3. John J. Craig, “Introduction to Robotics”, Addison Wesley publication.


**CA3247: EMBEDDED SYSTEMS [3 0 0 3]**

Embedded Systems Basics: Introduction to Embedded systems, Examples of embedded systems, Typical Hardware, Gates, Timing Diagrams, Memory, Microprocessors, Buses, Direct Memory Access, Interrupts, Microprocessor Architecture, and Interrupt Basics. The 8051 Architecture: Introduction, 8051 Micro controller Hardware, Input/output Pin Ports and Circuits, External Memory, Serial data Input/output, Interrupts. Basic Assembly Language Programming Concepts: The Assembly Language Programming Process, Programming Tools and Techniques, Programming the 8051. Moving Data: Introduction, Addressing Modes, External Data Moves, Code Memory Read Only Data Moves, Push and Pop Opcodes, Data Exchanges. Basic Design Using a Real-Time Operating System: Message Queues, Mailboxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment. Applications: Introduction, keyboards, Human Factor, Key Switch Factors, Keyboard Configurations, Displays, Seven-Segment Numeric Display, D/A and A/D Conversions.

**References:**


1. An Embedded Software Primer, David E. Simon, Pearson Education.
2. The 8051 Microcontroller, Third Edition, Kenneth J. Ayala, Thomson.

**CA3248: STATISTICAL INFERENCE [3 0 0 3]**

Introduction to sampling distribution, standard error and its significance, Testing of Hypothesis: Statistical hypothesis, Null and alternative hypothesis, simple and composite hypothesis, two types of error, critical region, power of test, level of significance. Small sample tests based on t, F and Chi-square distribution and test based on normal distribution, confidence interval for single mean, difference of means and variance (only for normal case) confidence interval for single mean, difference of means and variance (only for normal case). Test of significance for large samples for attributes and variable, proportions and means, single sample, two samples (both paired and independent). Non- parametric tests: Concept of Non-parametric tests, advantages of non-parametric tests over parametric tests. Sign test for single sample and two sample problems (for paired and independent samples), Wilcoxon-signed rank test, Mann-Whitney U-test, run test. Median test and test for independence based on Spearman's rank correlation.

**References:**


1. Goon, Gupta and Dass Gupta, An outline of statistical inference, Vol-II.
2. H.C. Saxena, Statistical inference, edition 1, Open library.
3. Gibbons, J.D., Non-parametric statistical inference, 2003.