Institute of Engineering and Technology

HAND BOOK

On

CURRICULUM STRUCTURE AND SYLLABUS

Bachelor of Computer Applications
(Programme Code: 3108)

Batch: 2022-25

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JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
Curriculum Structure
Bachelor of Computer Applications (Batch 2022-2025)

Sem	Courses						Credit
I	Problem Solving with Python	Database Management & Applications	Computer Organization & Systems	Mathematics	Fundamentals of Communication		
	5	5	4	4	2		20
II	Java Programming	Web Application Development	Operating Systems and Linux Administration	Computational Mathematics	OE-I	Critical Thinking and Storytelling	
	5	4	4	4	3	2	22
III	Data Structures	Programming II	Arduino based Embedded System Design	Statistical Computing	Economics and Accounting	Perspectives on Contemporary Issues	
	4	4	3	4	3	2	**20**
IV	Algorithm Design and Analysis	Machine Learning	Computer Networks and Networks Administration	OE-II	DE-I	Communication and Identity	
	4	4	4	4	4	2	**22**
V	Cross platform App Development	PS1/DE-II	SEE-I	OE-III	DE-III	Understanding and Managing Conflicts	
	4	4	2	4	4	2	**20**
VI		Minor Project/ SEE-2	DE-IV	OE-IV	DE-V	Critical Thinking for Decisions at Workplace	
		2	4	4	4	2	**16**
	PS2 (Optional)						
	Total Credits						**120**

List of Electives	
Department Elective (Sem IV, V, Sem VI) **(Tentative, more options to be added)**	**Open Elective (Sem IV, V, Sem VI)** **(Tentative, more options to be added)**
Full Stack Web Development with REACT	Idea to business model
Object Oriented Programming	Numerical and scientific computing
Game design and development	Fundamentals of investing
Android Application Development	Advanced Statistics
Software Engineering	Solid and e-waste management
Artificial Intelligence	Disaster management
Foundation of Blockchain and Smart Contracts	Flexible Electronics
Multi-dimensional and NoSQL databases	Neuromorphic Engineering
Computer Vision	**Skill Enhancement Elective (Sem V, Sem VI)** **(Tentative, more options to be added)**
Advanced Data Structures and Algorithms	Robotic Process Automation Lab
Cybersecurity	Google Cloud Lab
Big Data Engineering	Virtual Reality Lab
Virtualization and Cloud Computing	Geographical Information Systems Lab
Exploring Microservices Development	Applied IoT
	3D Design and Animation Lab
	Multimedia Lab

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BCA (Batch: 2022-2025)				
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2	CS1135	Programming-II	3-0-2	03
3	EE1119	Arduino based Embedded System Design	2-0-2	05
4	AS1106	Statistical Computing	3-0-2	06
5	IL1104	Economics and Accounting	3-0-0	07
6	CC1103	Perspectives on Contemporary Issues	2-0-1	09
Semester IV				
7	CS1126	Algorithm Design and Analysis	3-0-2	11
8	CS1138	Machine Learning	2-1-2	13
9	CS1124	Computer Networks and Network Administrations	2-0-4	15
10	CC1104	Communication and Identity	2-0-1	17
DE-I				
A	CS1212	Full Stack Web Development with REACT	3-0-2	19
B	CS1101	Object Oriented Programming	2-0-4	21
DE-II				
A	CS1123	Android Application Development	3-0-2	23
B	CS1227	Game design and development	1-0-6	25
C	CS1113	Software Engineering	3-0-2	27
	Semester V			
19	CS1215	Cross platform App Development	3-0-2	29
20	CC1105	Understanding and Managing Conflicts	2-0-0	31
21	PS1101	PS-1	4	32
	DE-III/DE-IV			
A	CS1224	Artificial Intelligence	3-0-2	33
B	CS1226	Foundation of Blockchain and Smart Contracts	3-0-2	35
C	CS1225	Multi-dimensional and NoSQL databases	3-0-2	37
D	CS1228	Computer Vision	3-0-2	39
E	CS1213	Advanced Data Structures and Algorithms	3-0-2	41
F	EE1219	Cybersecurity	3-0-2	43
	OE-I			
A	ED1102	Idea to business model	4-0-0	45
B	AS2202	Numerical and scientific computing	3-0-2	47
	OE-II			
A	FA1127	Fundamentals of investing	4-0-0	49

B	AS1202	Advanced Statistics	3-1-0	50
	SEE-I/SEE-II			
A	CS1125	Robotic Process Automation Lab	0-0-4	52
B	CS1223	Google Cloud Lab	0-0-4	54
C	CS1221	Virtual Reality Lab	0-0-4	55
D	CE1114	Geographical Information Systems Lab	0-0-4	57
E	EE1117	Applied IoT	0-0-4	59
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22	PR1103	Minor Project	2	61
23	CC1106	Critical Thinking for Decisions at Workplace	2-0-0	62
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	DE-V			
A	CS1312	Big Data Engineering	2-0-4	65
B	CS1127	Virtualization and Cloud Computing	2-0-4	67
	OE-III/OE-IV			
A	AS1210	Solid and e-waste management	3-1-0	69
B	CE1206	Disaster management	3-1-0	71
C	EE1225	Flexible Electronics	3-1-0	73
D	EE1226	Neuromorphic Engineering	3-1-0	75

Course Title and Code: Data Structures: CS1102	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA Semester III
Prerequisites	Programming-I, Programming -II
Weightage	Theory 60% Practical 40%

Course Objective: This course aims to develop understanding for Design, Analysis, and implementation of data structures and algorithms to solve computational problems using an object-oriented programming language. Topics includes introduction to algorithms and complexity analysis (time & space), Recursion, Linear Data Structures (Arrays, Queue, Stack, Linked list), Non-linear data structures (Trees, Graphs), Searching, Sorting, Indexing and Hashing.

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Write programs for performing basic operations like insertion, deletion, searching, sorting, merging, traversal etc. on various data structures like array, queue, stack, linked list, tree, graph.
2. Use and design appropriate data structures for solving a variety of computational problem.
3. Develop test cases for their programs and debug the code.
4. Analyze the algorithms in terms of asymptotic time and space complexity.
5. Implement and compare various searching and sorting algorithms
6. Convert a recursive algorithm to non-recursive algorithm.

Course Syllabus (Theory)

Unit I: Introduction to linear Data Structures: Types of Data Structures - Linear & Non-Linear Data Structures. Linear Structures: Arrays: Types, Operations and applications (searching sequential and binary, Sorting: bubble, Insertion, Selection, Quick and Merge sorting algorithms for different characteristics of input data. Complexity analysis, Comparison of sorting algorithms in term of complexity-time and space.

Unit II: Stacks and Queues: Operations and Applications, conversion of expression from one form to other form using stack (with & without parenthesis), Evaluation of expression in infix, postfix & prefix forms using stack, Queues: Operations and Applications, Circular Queues: Operations and Applications, De-queue and Priority queue, Recursion.

Unit III: Linear linked lists: Singly, doubly and circularly connected linear linked lists insertion, deletion at/ from beginning and any point in ordered or unordered lists, Application of linked list for polynomial operations, Comparison of arrays and linked lists as data structures. Implementation of stack, and queue, Algorithms for/of insertion, deletion of stack, and queue implemented using linked list data structure.

Unit IV: Trees: Trees definition, characteristics concept of child, sibling, parent child relationship etc., binary tree: different types of binary trees based on distribution of nodes, threaded binary tree and its application, insertion, deletion and traversal of binary trees, constructing binary tree from

traversal results, BST tree: Concept of BST, insertion into and deletion from BST, Height balanced tree: AVL and its operations, Application of trees for representation of sets, Splay Tree and its operation.

Unit V: Graphs: Definition, Relation between tree & graph, directed and undirected graph, representation of graphs using adjacency matrix and list, Depth first and breadth first traversal of graphs, finding connected components and minimum spanning tree- Kruskal and Prims, Dijkstra Algorithm.

Text Books:

T1. Sahni, Sartaj. Data structures, algorithms, and applications in Java. Universities Press, 2005.

T2. Goodrich, Michael T., Roberto Tamassia, and Michael H. Goldwasser. Data structures and algorithms in Java. John Wiley & Sons, 2014.

T3. Data Structures and Algorithms in Java -- Robert Lafore second edition Sams Publication, 2003

Reference Books:

R1. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein.

R2. Alfred V. Aho, Jeffrey D. Ullman, John E. Hop croft, Data Structures and Algorithms. Pearson Education, 2012

Recommended MooC :

Data Structure and Algorithms NPTEL

https://nptel.ac.in/courses/106/102/106102064/
https://nptel.ac.in/courses/106/106/106106127/

Coursera
Data Structures and Algorithms Specialization
https://www.coursera.org/specializations/data-structures-algorithms
Ordered Data Structures
https://www.coursera.org/learn/cs-fundamentals-2

GeekforGeeks
https://www.geeksforgeeks.org/data-structures/

Course Title and Code: Programming II (CS1135)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. CSE II, V (DE) Sem, BCA III Semester
Prerequisite	None
Evaluation	Theory 60% Lab 40%

Course Objective: The purpose of this course is to introduce to students to the field of programming using C language. The students will be able to enhance their analysing and problem solving skills using functional Programming language.

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Design solutions to simple mathematical and engineering problems by applying the basic programming principles of C language.
2. Problem-solving through structures, unions and files.
3. Apply code reusability with functions and pointers.
4. Develop an in-depth understanding of functional and logical concepts of C Programming.
5. Understand and analyze problems, develop and implement algorithms to solve it.

Course Syllabus (Theory)

UNIT I

Overview of C: History and importance of C, Basic structure of C program, executing a C program. Data Types and Operators, Variables, Sequences and Iteration Different types of Data types, Expressions, Precedence Rules, Operators- Operators: arithmetic operators, relational operators, logical operations, bitwise operators, miscellaneous operators, Local Variables, Global Variables.

UNIT II

Conditional Statements, Loops, Arrays and Strings, User Defined Data Types If-else statement, For loop, While Loop, Nested Iteration, Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays, different types of user defined data types, Character Arrays and Strings: Declaring and Initializing String Variables, Reading Strings from Terminal, Writing Strings to Screen, Arithmetic Operations on Characters, String-handling Functions.

Unit III

Functions in C, Passing Parameters (By value & Reference), using returned data, Passing arrays, structures, array of structures, pointer to structures etc., passing characters and strings, The void pointer.

UNIT IV

Pointers, Using pointers to represent arrays, Dynamic Memory allocation, structures, using typedef, Pointers: What is a Pointer? - How do you Define a Pointer? - Pointer Indexing – Pointer Arithmetic - Function data return with a Pointer - A pointer to a Function, Arrays of Structures & pointers Pointer Expressions, Pointer Increments and Scale Factor.

UNIT V

Files — Types of file processing: Sequential access, Random access — Sequential access file – Random access file –Command line arguments
Structure – Nested structures — Pointer and Structures — Array of structures — Example Program using structures and pointers — Self-referential structures — Dynamic memory allocation – Singly linked list – typedef.

TEXT BOOKS:

T1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
T2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCES:

R1. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016.
R2. Griffiths, D., & Griffiths, D. (2012). Head First C: A Brain-Friendly Guide. " O'Reilly Media, Inc.".
R3. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.

Reference Online Material-

Introductory C Programming Specialization
https://www.coursera.org/specializations/c-programming
C for Everyone: Programming Fundamentals
https://www.coursera.org/learn/c-for-everyone

JAVATPOINT
C Programming Language
https://www.javatpoint.com/c-programming-language-tutorial
GeeksforGeeks
C Programming Language
https://www.geeksforgeeks.org/c-programming-language/

Course Title and Code: Arduino based Embedded System Design (EE1119)	
Hours per Week	**L-T-P: 2-0-2**
Credits	**3**
Students who can take	BCA Semester III
Prerequisite: None	
Weightage: Theory -50%, Practical – 50%	
Course Objective- The course aims to develop understanding of Embedded system and write the program to interface different sensor/actuators/display devices with Arduino for different real time applications.	
Course Outcome: On successful completion of this course, the students should be able to: 1. Understand the Arduino platform works in terms of the physical board and libraries and the IDE (Integrated Development Environment) 2. Understand and write the basic programs using Arduino IDE. 3. Interfacing of different sensors, actuators and display devices with Arduino. 4. Designing of embedded system for real life application.	

Syllabus (Theory):

Unit I Introduction to basic Embedded System: Introduction to embedded systems. Components of embedded system. Advantages and applications of embedded systems. Examples of real time embedded systems and how they are manufactured industry ready. History of AVR Microcontrollers and Features. Introduction to sensors and actuators

Unit II Learning Arduino Platform and hardware interfacing: Introduction to ARDUINO, ARDUINO History and Family, Basic Programs using Arduino platform. Interfacing LED's, Switches with Arduino.

Unit III Understanding and interfacing of sensors and actuators using Arduino: Connect and work with different sensors and actuators, such as temperature, IR, Proximity, Light Dependent Resistor (LDR), Ultrasonic, Seven Segment Display, Relays, LCD, Buzzer and Motor.

Unit IV Project Development on Breadboard and PCB.

Text Books:

1. Arduino-Based Embedded Systems : By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
2. https ://www.arduino.cc/en/Tutorial/HomePage

Reference Books:

1. Arduino Made Simple by Ashwin Pajankar

Course Title and Code: Statistical Computing (AS1106)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA III Semester
Pre-requisite	None
Evaluation	Theory – 70%, Lab – 30%
Course Objective - This course aims to introduce the fundamentals of basic statistics required in a variety of application areas including data science. The computational analysis will be done using MS Excel and Python.	
Course Outcomes: On successful completion of this course, the students should be able to: 1. Classify, summarize data, and graphically represent the data set. 2. Compute central tendencies and measures of variation. 3. Analyse and interpret different datasets using distribution and correlation. 4. Apply regression for modelling, analysis, interpretation, and forecasting.	

Course Syllabus (Theory):

Introduction: Data classification, Tabulation, Presentation

Measures of Central Tendencies and dispersion: Mean, Mode, Median, Partition values, Standard Deviation, variance.

Probability: Concepts of probability, Definition and different approaches, Axioms of probability, Conditional probability, Bayes' Rule.

Probability Distributions: Introduction, Random Variable, Probability distribution functions, Cumulative distribution function, Expected values, Discrete and Continuous probability distributions, Binomial distribution, Poisson distribution, and Normal distribution.

Correlation and Regression: Correlation, Types of correlation, Different methods to calculate correlation, Linear and non-linear regression, Curve fitting, and Estimation.

Textbook

1. Richard A. Johnson, Miller and Freund's Probability and Statistics for Engineers, PHI.

Reference Books:

1. Arnold, Jesse C., and J. Susan Milton. Introduction to probability and statistics. New York: McGraw-Hill, 2003.
2. Kousalya, Pappu. Probability, Statistics, and Random Processes. Pearson Education India, 2013.
3. Rohatgi, Vijay K., and AK Md Ehsanes Saleh. An introduction to probability and statistics. John Wiley & Sons, 2015.

Recommended MOOC:

Basic Statistics: https://www.coursera.org/learn/basic-statistics#syllabus

Course Title and Code: Economics and Accounting (IL1104)	
Hours per Week	**L-T-P: 3-0-0**
Credits	**3**
Students who can take	BCA III Sem.
Prerequisite	None
Weightage	Theory 40% Project 40% Quiz 20%

Course Objective- This course will prepare students to understand business from the perspective of economics and accounting. Economics will impart knowledge towards use of limited resources in decision making while accounting will help to understand the basic financial statements and concepts to perform analysis.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Apply the fundamental economic concepts, theories of economic analysis for decision making.
2. Comprehend the sales, output, pricing and market strategies against the dynamic business environment in different market structures.
3. Apply the various macroeconomic variables/ concepts and their interlinkages with each other.
4. Identify and distinguish the mechanism for recording, classifying and summarizing business transactions.
5. Develop competency for the preparation of the financial statements of a corporate enterprise –Balance Sheet, Statement of Profit and Loss.
6. Analyze and interpret financial statements by performing financial ratio analysis.

Syllabus :

Module I (Economics)

- Basic economic terms
- Working of an economy
- Laws of Demand and Supply and market Equilibrium
- Elasticity of demand and its application
- Production function
- Concepts of cost and revenue
- Price and output determination under different Market Structures
- Measurement National Income
- Major Macroeconomics concepts

Module II (Accounting)

- Financial Accounting Framework
- Preparation of Key Financial Statements
- Financial Statement Analysis
- Digital Accounting

Text Books:

- **T1:** Mankiw, N. G. (2023). Principles of microeconomics (10th ed.). CENGAGE Learning Custom Publishing.
- **T2:** Narayanaswamy, R. (2014). Financial Accounting – A managerial perspective (6th edition), PHI Learning Private Limited.

Reference Books:

- Dwivedi, D. N. (2009). Principles of Economics, Vikas Publishing House Pvt Ltd.
- T.R. Jain and M.L. Grover. Economics for Engineers, V. K. (India) Enterprises
- Horngreen, T. Charles, Sundem, L.Gary, Elliott, A. John, Philbrick and R. Donna.(2019). Introduction to Financial Accounting, 11/e, Pearson Publication, New Delhi.
- Bhattacharya, K. Asish.(2016). Financial Accounting for Business Managers. New Delhi. PHI Publication.
- Kulkarni Mahesh and Mahajan Suhash.(2016). Accounting for Business Decissions, 2/e, Nirali Prakashan, New Delhi.
- Ambrish, Gupta (2019). Financial accounting for management: An analytical perspective, 5/e. New Delhi: Pearson Education.
- Khatri K. Dhanesh. (2018). Financial Accounting,1/e. New Delhi: Mc Graw Hill Education Pvt. Ltd.
- Gabriel, John,S. and Marcus A. (2017). Financial Accounting, 3/e. New Delhi: Mc Graw Hill Education Pvt. Ltd.
- Rajasekaran V. and Lalitha R.(2018). Financial Accounting, 1/e. New Delhi: Derling Kindersey (India) Pvt. Ltd, Licensess of Pearson Education in SouthAsia.

Course Title and Code: Perspectives on Contemporary Issues (CC1103)	
Hours per Week	**L-T-P: 2-0-1**
Credits	**2**
Students who can take	BBA/ Bdes/ B.Tech/BCA Sem III
Prerequisites	None
Weightage	Theory 60%, Practical 40%

Course Objective-

In an era of globalization, there is an increasing need for the youth to be able to empathize with others, value diverse perspectives and cultures and understand how events around the world are intertwined. Global issues revolve around social, economic and environmental factors which ultimately add to the interconnectedness of countries. In this course, students will employ key critical thinking concepts to analyze contemporary issues from multiple perspectives. They will explore the impact at micro and macro levels.

Learning Outcome :

On successful completion of this course, the students should be able to:

1: Identify different perspectives objectively.

2: Explain interconnectedness of the issues and their impact at micro and macro levels.

3: Recognize their own beliefs, biases, claims and assumptions.

4: Evaluate sources, argue and defend effectively.

Syllabus (Theory):

Research, analysis & evaluation of a topic from local, national and global perspectives.

- **Globalization**

With increasing development throughout the world, the focus of this theme will be on the impact of adopting policy of neoliberalism globally. Changes in India after implementation of new economic policy of 1991.

- **Poverty and Inequality**

What do you mean by wealth & equality? Is it enough to ascribe monetary values to human lives? Who has benefited from an increased access to resources, labour & capital due to globalisation? Which groups are historically marginalised & suffer from unequal access to opportunities

- **Social justice and human rights**

An understanding of the impact of inequality and discrimination, the importance of standing up for our own rights and our responsibility to respect the rights of others.

- **Climate Change and Sustainability**

Understanding the magnitude of the issue, its impact and future challenges. How we can meet our current needs without diminishing the quality of the environment or reducing the capacity of future generations to meet their own needs.

- **Technology**

Impact of unprecedented technological growth, challenges and opportunities. Is technocracy a

boon or a bane?

References for reading:

1. Held, D. and McGrew, A., 2016. *The Global Transformations Reader*. 2nd ed. Cambridge: Polity Press.
2. Schmelzer, M., Vetter, A. and Vansintjan, A., 2022. *The Future is Degrowth*. London: Verso.
3. Harvey, D., 2020. A Brief History of Neoliberalism. In: F. Lechner and J. Boli, ed., *The Globalization Reader*, 6th ed. Wiley.
4. Kolbert, E. (2015). The Sixth Extinction: An unnatural History.
5. https://www.downtoearth.org.in/blog/governance/mass-poverty-is-back-in-india-76348
6. https://geographyandyou.com/indias-poverty-line-changing-perspectives/

Course Title and Code: **Algorithm Design and Analysis (CS1126)**	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA IV Sem
Prerequisites	Any Programming language
Weightage	Theory 70% Practical 30%

Course Objective:

This course introduces an understanding of the design and analysis of algorithms. The course aims to develop a familiarity with important algorithms and data structures and an ability to analyze the asymptotic performance of algorithms. It will equip the students to apply important algorithmic design paradigms and methods of analysis to develop efficient algorithms in common engineering design situations.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Analyze the complexity of different algorithms using asymptotic analysis.
2. Analyze and select an appropriate data structure for a computing problem.
3. Differentiate and apply different algorithm designs technique: Divide and ConquerTechnique, Greedy and Dynamic Programming.
4. Develop algorithm and programs using Divide and Conquer technique to solve variouscomputing problems.
5. Develop algorithms and programs using Greedy and Dynamic Programming technique tosolve various computing problems.

Syllabus (Theory):

UNIT I: Introduction: Algorithms, Analyzing algorithms, Complexity of algorithms, Growth of functions, Performance measurements, Types of approaches.

UNIT II: Selection sort, Bubble sort, Insertion Sort, Shell sort, Quick sort, Merge sort, Heap sort, sorting in linear time: Radix sort, Counting Sort, Comparison of sorting algorithms, Divide and Conquer with examples such as Sorting, Matrix Multiplication, BFS, DFS, Topological sort.

UNIT III: Greedy methods, Elements of Greedy Strategy, Minimum Spanning trees – Prim's andKruskal's algorithms, Single-source shortest paths - Dijkstra's and Bellman-Ford algorithms.

UNIT IV: Dynamic programming, Elements of Dynamic Programming, Matrix Chain Multiplication, Longest Common Subsequence, Optimal Polygon

Triangulation, all pair shortest paths – Warshall's and Floyd's algorithms.

Text Book(s)

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, "Introduction to Algorithms", PrenticeHall of India. 2002

Reference Book(s)

1. Jon Klienberg & Eva Tardos. Algorithm Design. Pearson 2006.
2. E. Horowitz & S Sahni. Fundamentals of Computer Algorithms. 1984
3. RCT Lee, SS Tseng, RC Chang and YT Tsai. Introduction to the Design and Analysis of Algorithms.Mc Graw Hill, 2005.
4. Berman, Paul. Algorithms. Cengage Learning. 2002
5. Aho, Hopcraft, Ullman, The Design and Analysis of Computer Algorithms. Pearson Education, 2008.

Reference Online Courses:

NPTEL Swayam Course:

1. https://nptel.ac.in/courses/106/106/106106127/
2. https://nptel.ac.in/courses/106/102/106102064/
3. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html

Course Title and Code: Machine Learning; CS1138	
Hours per Week	**L-T-P: 2-1-2**
Credits	**4**
Students who can take	BCA Sem IV
Prerequisite	Programming-I, Statistical Computing
Evaluation	Theory 30%, Lab 70%

Course Objective:

This course introduces the fundamental concepts of state-of-the machine learning (ML) algorithms. It will cover the development of ML models to solve real-world problems.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Identify machine learning techniques suitable for a given problem.
2. Interpret fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
3. Use the standards and energy efficient ML algorithms.
4. Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
5. Utilize state-of-the art algorithms of Machine Learning for building applications

Course Syllabus (Theory):

Introduction to Machine Learning, Supervised and Unsupervised Learning, Simple and Multiple Linear Regression, Decision Tree Regression, Fitting dataset and evaluating their performance set, Evaluation of selected features, Model evaluation metrics

K-Nearest Neighbor, Decision tree Classification Train/test split, Confusion matrix for evaluation, Class probabilities and class predictions, ROC Curve, Model evaluation metrics. Clustering; K-Means, Introduction to artificial neural network, kinds of neural network, perceptron algorithm

Applications of Artificial Intelligence and Machine Learning; Usage of AI and ML Techniques for achieving sustainable practices, NIST and IEEE standards for AI and ML libraries, tools and techniques

Textbooks:

- Tom M. Mitchell- Machine Learning - McGraw Hill Education, International Edition
- Ethem Alpaydin, Introduction to Machine Learning, Second Edition, 2016
- Aurélien Géron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow,
- O'Reilly Media, Inc. 2nd Edition

Reference Books:

- Trevor Hastie, Robert Tibshirani, and Jerome Friedman - The Elements of Statistical Learning: Data Mining, Inference, and Prediction - Springer, 2nd edition

- Christopher M. Bishop Pattern Recognition and Machine Learning - Springer, 2nd edition
- Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (23 April 2020)

Course Title and Code: Computer Networks and Network Administration (CS1124)	
Hours per Week	**L-T-P: 2-0-4**
Credits	**4**
Students who can take	BCA Semester IV
Prerequisite	None
Weightage	Theory 55% Practical 45%

Course Objective: The course objectives include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and gaining practical experience in installation, monitoring, and troubleshooting of current LAN systems. This course introduces an understanding of the fundamental concepts of computer networking, layers of protocols and network technologies. This course lays the foundation for the courses on Virtualization and Cloud Computing,
Applied IoT as well as Information Security.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes.
2. Identify the different types of network topologies and protocols.
3. Analyse the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
4. Configure routers, switches, and end devices to provide access to local and remote network resources and to enable end-to-end connectivity between remote devices.
5. Configure and troubleshoot connectivity a small network using security best practices. CS1124.6. Evaluate the challenges in building networks and solutions to those.

Syllabus (Theory):

Unit I- Introduction Concepts: Goals and Applications of Networks, Network structure and architecture, The OSI reference model, services, Network Topology Design - Delay Analysis, Back Bone Design, Local Access Network Design, Physical Layer Transmission Media, Switching methods, ISDN, Terminal Handling.

Unit II- Medium Access sub layer: Medium Access sub layer - Channel Allocations, LAN protocols - ALOHA protocols - Overview of IEEE standards - FDDI. Data Link Layer - Elementary Data Link Protocols, Sliding Window protocols, Error Handling.

Unit III- Network Layer: Network Layer - Point - to Pont Networks, routing, Congestion control Internetworking -TCP / IP, IP packet, IP address, IPv6.

Unit IV- Transport Layer: Transport Layer - Design issues, connection management, session Layer- Design issues, remote procedure call. Presentation Layer-Design issues, Data compression techniques, cryptography - TCP - Window Management.

Unit V- Application Layer: Application Layer: File Transfer, Access and Management, Electronic mail, Virtual Terminals, Other application. Example Networks - Internet and Public Networks.

Introduction to Firewall, IDS, SSH, Key Certificates, etc. Understanding Exposure Risk.

Text Books:

1. Forouzen Behrouz A., "Data Communications And Networking", Tata Mcgraw-Hill, 2nd Ed., 2000.
2. Tanenbaun Andrew S., "Computer Networks", PHI, 3rd Ed., 1998.
3. Stalling William., "Data And Computer Communications", PHI, 3rd Ed., 2000.

Reference Books:

1. Computer Networking and the Internet (5th edition), Fred Halsall, Addison Wesley
2. W. Stallings, Data and Computer Communication, Macmillan Press
3. TCP/IP Protocol Suite (6th edition), Behrouz Forouzan, McGraw Hill

Recommended MooC:

Computer Networks - NPTEL https://nptel.ac.in/courses/106/105/106105183/ https://nptel.ac.in/courses/106/105/106105081/

Computer Networks - SWAYAM https://onlinecourses.swayam2.ac.in/cec20_cs01/preview **Bits and Bytes of Networking – Coursera** https://www.coursera.org/learn/computer-networking

Course Title and Code: Communication and Identity (CC1104)	
Hours per Week	**L-T-P: 2-0-1**
Credits	**2**
Students who can take	B.Tech/BCA/BBA/B.Des Semester- IV
Prerequisite	None
Weightage	Theory 40%, Practical 60%

Course Objectives: This course enables students to explore their identities to mark their distinctive presence in professional spaces. It intends to help them gain an understanding of the basic purpose, benefits, and responsibilities of self-presence, and to begin the process of defining their values, strengths, and goals, which helps them enhancing their employability skills through exposing themselves through various activities.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Analyze their personal identities by identifying their personal attributes, values, strengths and vision statement.
2. Articulate their personal statement and use it to craft an influential pitch.
3. Express themselves professionally on various social media platforms.
4. Write a well-structured professional business document.

Course Topics

Module(s)	Topics to be covered
Identifying Self	Discovering Identities: Words That Describe Me, Your Personal Identity, A Portrait of Yourself, Personal Identity Wheel, Self-Awareness from five aspects that influence our identity - Personal Attributes, Value and Principles, Emotional Awareness, Tendencies and Habit, Needs Assessment.
	Personal Branding: Meaning, Importance and how to create and use it; Identify, Build and Market your brand story.
Persuasive Communication	Personal Brand Statement, Resume, Cover Letter and The Elevator Pitch, Presence in Group Discussion and Personal Interviews
	Online Brand Communications- Creating an online presence for professional branding on social media platforms (LinkedIn, Facebook, Instagram, etc)

	Writing a well-structured and effective business documents (Agenda, Minutes of the meetings (MoM) Emails, Executive Summary)

Referred MOOCs –

Course Name- Introduction to Personal Branding
Course duration - approx. 7 hours
Offered by University of Virginia
https://www.coursera.org/learn/personal-branding

Course Name- Digital Footprint (If I Googled you, what would I find?)
Course duration - approx. 9 hours
Offered by The University of Edinburgh
https://www.coursera.org/learn/digital-footprint

Course Name- High Impact Business Writing
Course duration - approx. 7 hours
Offered by University of California, Irvine
https://www.coursera.org/learn/business-writing

Referred Books -

- Garner, B. A. (2012). HBR Guide to Better Business Writing. United States: Harvard Business Review Press.
- Westfall, C. (2012). The New Elevator Pitch. United States: Marie Street Press.
- Arruda, W., Dixson, K. (2010). Career Distinction: Stand Out by Building Your Brand. Germany: Wiley.
- Hedges, K. (2017). The Power of Presence: Unlock Your Potential to Influence and Engage Others. United States: AMACOM.
- Lacy, K., Deckers, E. (2012). Branding Yourself: How to Use Social Media to Invent Or Reinvent Yourself. United Kingdom: Pearson Education.

Course Title and Code: Full Stack Web Development with REACT (CS1212)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA III Semester
Prerequisite	Web Application Development
Weightage	Theory 30% Practical 70%

Course Objective: This course will equip the students with understanding and skills for MERN stack web development using NodeJS, Express and React library.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Develop high-level plans for script solutions for web to evaluate the post-production outcome.
2. Implement front end web design in ReactJs.
3. Design scripts to meet given interface and media control requirements.
4. CS1212.4 Devise, carry out and evaluate functional test strategies of web design.
5. CS1212.5 Implement and evaluate techniques for the installation of cross platform mobile applications and delivery via various channels.
6. CS1212.6 Communicate to the client side through a RESTful API and web services.

Course Contents:

JavaScript application development and the React library, React Router and Single Page Applications, Reactstrap, React Native UI Elements and Redux.

React Native Alerts, Animations, Gestures, and Persist Redux Store, Accessing Native Capabilities of Devices: The Expo SDK

Front-end Web UI Frameworks Overview: Bootstrap, Bootstrap CSS Components, Bootstrap JavaScript Components

Web Tools - Bootstrap JavaScript, CSS preprocessors, Less and Sass, automation using NPM scripts, and task runners like Grunt and Gulp.

Introduction to Server-side Development - Node, Node modules and the Node HTTP server, Express framework and set up a REST API using Express.
REST API server with Express, Mongo and Mongoose, Mongoose population, secure communication using HTTPS.

Text Books:

1. Fullstack React Native: Create beautiful mobile apps with JavaScript and React Native
2. Learning React: Functional Web Development with React and Redux
3. Practical React Native: Build Two Full Projects and One Full Game using React Native

Course Title and Code: Object Oriented Programming (CS1101)	
Hours per Week	**L-T-P: 2-0-4**
Credits	**4**
Students who can take	BCA. III Sem
Prerequisite	None
Weightage	Theory 40% Practical 60%

Course Objective: This Course will provide the students with a solid theoretical understanding of, as well as practical skills in, object-oriented programming. It focuses on object-oriented programming using JAVA and C++. The main concepts are Classes, Objects, Data Abstraction, Data Encapsulation, Overloading, Overriding, Polymorphism, Inheritance, Interfaces, Exception Handling, and Database Connectivity. This course also covers basic concepts for software design and reuse.

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Apply object-oriented programming concepts using class and objects to solve problems.
2. Develop Java Programs using Object Oriented Programming Principles such as Classes, Objects, Data Abstraction, Data Encapsulation, Overriding, Polymorphism, Inheritance, and Interfaces.
3. Design, develop and debug programs using coding and documentation standards.
4. Incorporate exception handling in Java Programs.
5. Use overloading methodology on methods and constructors to develop application programs.
6. Use JDBC API connectivity in between Java Programs and database.

Course Contents:

Basics of Java & Decision Statements - Introduction to Java: Features of Java, Byte Code and JVM, JDK, JRE; Data types and Operators: Lexical Tokens, Identifiers, Keywords, Literals, Comments, Primitive Datatypes, ADT, Operator types and precedence, Statements and Flow Control: Conditional statements, looping, return, etc., Abstract data types and their specification. How to implement an ADT. Concrete state space, concrete invariant, abstraction function.

Control Structures, Methods & Constructors - Object Oriented Programming in Java: Object Lifetime & Garbage Collection.

Methods & Constructors - Constructor & initialization code block, Parameterized Constructor, Loops, Methods.

Array & String - Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Operation on String, Mutable & Immutable String, Collection Bases Loop for String, tokenizing a String, Creating Strings using StringBuffer.

OOP's Concept I - Class Fundamentals, Object & Object reference, Access Control, Modifiers, Methods in Java: Method Declarations, Method Signatures, Invoking Methods,

OOP's Concept II - Static vs. Instance Data Fields, Static vs. Instance Methods, Method Overloading, Encapsulation.
Inheritance, Composition, and Aggregation, Invoking Base Class Constructors, Overriding vs. Overloading, Polymorphism Overloading.
Interfaces - Inner Class & Anonymous Classes, Abstract Class, Interfaces.
Exception Handling - Introduction to Exception handling.

JDBC Programming - The JDBC Connectivity Model, Database Programming: Connecting to the Database, creating a SQL Query, Getting the Results, and Updating Database Data.
NOTE: Integrated Development Environments (IDEs) to be used in this Course are Eclipse or NetBeans – Both are compatible for Object Oriented Programming using Java.

Text Books:

1. Schildt, H. (2018). Java: The Complete Reference, Eleventh Edition. (n.p.): Oracle Press.
2. Liang, Y. D. (2015). Introduction to Java Programming: Comprehensive Version. United Kingdom: Pearson.
3. Horstmann, C. (2018). Core Java Volume I--Fundamentals. United Kingdom: Pearson Education.
4. Lafore, R. (2009). Object Oriented Programming using Turbo C++.

Reference Online Course:

https://www.geeksforgeeks.org/java/

https://www.w3schools.com/java/default.asp

https://www.coursera.org/specializations/object-oriented-programming

https://www.coursera.org/learn/object-oriented-java

Course Title and Code: Android Application Development: CS1123	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA Sem IV
Prerequisite	Object Oriented Programming
Weightage	Theory 30% Practical 70%

Course Objectives: This Course is designed to offer learners an introduction to Android platform and related applications in the real world. Learners would be introduced to android studio platform using Java. The Course lays the foundation for cross-platform app development course.

Course Outcome:

On successful completion of this course, the students should be able to:

1. develop high-level plans for script solutions for mobile and evaluate the post-production outcome.
2. design scripts to meet given interface and media control requirements
3. explain the principles of technologies which support media production and delivery on a variety ofplatforms.
4. integrate Android XML resources with Java code and create complete apk file for installation.
5. create a Google Play Store account and preparing apps for the Play Store.

Syllabus (Theory)

Module I – Mobile Application Overview

Introduction to Mobile Computing, Introduction to Android Development Environment, Mobile Software Engineering, Design of application (view level).

Module II – Framework and User Interface Development

Frameworks and Tools, Generic UI Development, Android User (privileges), VUIs and Mobile Apps Text- to-Speech Techniques, Designing the Right UI, Multichannel and Multimodial UIs, Android Intents and Services, Characteristics of Mobile Applications
Successful Mobile Development.

Module III – Storing Retrieving Data with Real-time Database

Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider, Communications Via Network and the Web, State Machine, Correct Communications Model, Android Networking and Web.

Module IV – Notifications, Alarming and Location

Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics and Multimedia, Mobile Agents and Peer- to-Peer Architecture, Android Multimedia, Mobility and Location Based Services.

Text Books and References:

1. Android Cookbook, 2nd Edition by Ian F. Darwin Publisher: O'Reilly Media, Inc. Release Date:May 2017
2. Sam's Teach yourself Android Application Development. by Lauren Darcey and Shane Conder :2012
3. Professional Android 4 Application Development by Reto Meier, 2012
4. Android Programming for Beginners by John Horton, 31 Dec 2015
5. https://developer.android.com/

Course Title and Code: Game Design and Development (CS1227)	
Hours per Week	**L-T-P: 1-0-6**
Credits	**4**
Students who can take	BCA IV Semester
Prerequisite	None
Evaluation	Theory 20% Lab 80%

Course Objective: An introduction to VR game development using the Unity3D game engine. This is a project driven course where students will learn the cross-platform game engine Unity3D and develop a series of game projects. Students are expected to demonstrate the techniques taught in class through their projects.

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Create multiple gaming applications, utilizing industry-standard tools and software.
2. Introduce them to scientific work in the areas of virtual reality, computer graphics, and artificial intelligence.
3. Gain programming capability to develop games.
4. Apply the mathematics and physics to game design.
5. Practice art creation, music and animations and various tools needed to create assets.
6. Learn to structure and define the duties of the game development team.

Course Syllabus (Theory)

Introduction to Unity and Unity Setup, Unity Basics, Using Prefab Objects, Getting Started with AI, Third Person Mechanics, Building a Scene, Unity Interface, Re-arranging different panels such as game window, console window, Project Explorer, Scene window etc.

Creating new layouts, Saving a layout, Understanding 3D Game Objects, Components of Game Objects, Scaling, rotating, zooming and positioning game objects, Learning useful shortcuts, Building a wall using Cubes, Snapping, Unity Scripts, Methods of Mono Behaviour class, Materials, Prefabs, Adding Lights to Game Object, Moving a game object, Rotating and scaling game object using script, Moving game, objects using keys.

Creating a game object at run time, Physics vs Kinematic movements in Unity, PhysX engine, Drag, Collider, Activating / De-activating a game object, Enabling / Disabling game objects, Instantiating Game Objects, Destroying Game Objects.

Reference Books

1. Blackman, S. (2013). Beginning 3D Game Development with Unity 4: All-in-one, multi-platform game development. Apress.
2. Lanzinger, F. (2020). 2D Game Development with Unity. CRC Press.
3. Sung, K., & Gregory, S. (2019). Basic Math for Game Development with Unity 3D. Apress.

Coursera-

Game Design and Development with Unity 2020 Specialization

https://www.coursera.org/specializations/game-design-and-development

Unity and C# basics
https://www.coursera.org/learn/unity-and-c-basics

Course Title and Code: Software Engineering (CS1113)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA IV Semester
Prerequisites	Programming I, Programming II
Weightage	Theory 50% Practical 50%

Course Objective: In this course, students will gain a broad understanding of the discipline of software engineering and apply theories, models, and techniques to solve real-world problems.

Course Outcomes:

On successful completion of this course, the students will be able to:

1. Use software development lifecycle models for project development.
2. Design solutions in various application domains using software engineering approaches that integrate ethical and economic concerns.
3. Elicit and evaluate functional and non-functional requirements for a software system.
4. Design, represent and document software requirements specifications according to IEEE standards.
5. Apply UML modeling for software design.
6. Apply coding standards and guidelines.
7. Prepare code checklist and perform code inspections, code reviews and walkthrough.
8. Develop and implement various manual and automated testing procedures.
9. Estimate the cost of the software project.
10. Evaluate software in terms of software quality and quality assurance according to ISO standards.

Course Syllabus (Theory)

UNIT I: Basics, Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Software Development Life Cycle (SDLC) Models: Waterfall Model, Iterative waterfall model, Incremental Process Model, Evolutionary Development Models, Specialized Process Model, V-Model, An Agile view of the process, Agile process models namely Extreme Programming (XP), Adaptive software development (ASD), Scrum and Crystal.

UNIT II: Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modeling, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS.

UNIT III: Basic Concept of Software Design, Architectural Design, Low-Level Design, Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design methods and Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design.

UNIT IV: Coding and Software Testing: Coding standards, programming style, code inspection, code review and walkthrough; Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-down and Bottom-up, Testing Strategies, Test Drivers and Test Stubs, Structural Testing (White Box

Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products.

UNIT V: Software Measures, Metrics and Models: Various Size Oriented Measures, Hallstead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures, Control Flow Graphs, Software metrics classification, Cost estimation models, Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO); Software quality and quality assurance, ISO standards; Software Re-engineering, Reverse engineering and Software Configuration.

Reference/Text Books:

1. R. S. Pressman, "Software Engineering – A practitioner's approach", Eighth Edition, McGraw Hill International editions, 2019.
2. Ian Somerville, "Software Engineering", Tenth Edition, Pearson Education, 2017.
3. Rajib Mall, "Fundamentals of Software Engineering", Fifth Edition, Prentice-Hall of India Pvt. Ltd., 2018.

Reference Online Courses:

Coursera Courses:
1. Introduction to Software Engineering offered by IBM
2. IBM DevOps and Software Engineering by IBM.

Course Title and Code: Cross-Platform App Development (CS1215)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA Sem V
Prerequisite	Any Programming Language
Weightage	Theory 30% Practical 70%

Course Objective: This course will equip the students with understanding and skills for native components of mobile app using MongoDB database, NodeJS, Express and React Native. This course complements learning of the course on mobile application development.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Develop high-level plans for script solutions for mobile app to evaluate the post-production outcome.
2. Implement front end app design in **React Native**.
3. Design scripts to meet given interface and media control requirements.
4. Devise, carry out and evaluate functional test strategies of app design.
5. Implement and evaluate techniques for the installation of cross platform mobile applications and delivery via various channels.
6. Implement NoSQL databases using **MongoDB**, work within a **Node.js** environment and **Express** framework.
7. Communicate to the client side through a RESTful API.

Syllabus (Theory)

Module I – Multiplatform Mobile App Development with React Native

This module introduces you to hybrid mobile application development. You will learn about React Native and explore some of the features of React Native to implement a mobile app based on the React application that was implemented in the previous course on React.

Module II – React Native UI Elements and Redux

This module introduces you to various React Native UI elements. We will look at how we can make use of these elements in designing the various views of our application. You will get an overview of the Flux architecture and introduced to Redux as a way of realizing the Flux architecture

Module III – React Native Alerts, Animations, Gestures, and Persist Redux Store

In this module we look at enhancing the user experience through the use of animations and

support for gesture-based interaction. We also look at persisting the redux state, and alerting the users

Module IV – Accessing Native Capabilities of Devices
In this module you will explore the Expo SDK that enables you to access the native capabilities of the mobile devices. You will use a few SDK APIs in order to understand the general concepts and the patterns for using these APIs within your React Native application

Text Books and References:

1. Fullstack React Native: Create beautiful mobile apps with JavaScript and React Native
2. React Native in Action: Developing iOS and Android Apps with JavaScript
3. Practical React Native: Build Two Full Projects and One Full Game using React Native
4. https://reactnative.dev/docs/getting-started

Course Title and Code: Understanding and Managing Conflict (CC1105)	
Hours per Week	**L-T-P: 2-0-0**
Credits	**2**
Students who can take	BCA. V Sem
Prerequisite	None
Weightage	Theory 60%, Practical -40%

Course Objective: In today's increasingly complex and fragmented world, it is important to be able to resolve conflicts and build healthy relationships. Interpersonal and group dynamics is a course designed to prepare students to identify conflicts, manage emotions, analyze the situation and characters, and practice different frameworks to deal with conflicts

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Define a group and explain the stages of group development.
2. Describe conflicts and explain the types and causes of conflict.
3. Use inquiry and advocacy to engage with groups.
4. Give and receive feedback effectively.
5. Identify sources of conflict and manage them using different conflict handling styles.

Course Contents:

UNIT I: Group Development and Personality Enhancement: Introduction to the stages of group development. Introduction to the personality, perception and learning as a source of difference in individuals and groups.

UNIT II: Conflict and Conflict Management Strategies: Names and types of conflicts, Intra and Interpersonal conflict, and conflict resolution strategies.

UNIT III: Emotional Intelligence: Development of emotional intelligence. Significance of empathy and feedback in intra and inter-personal development.

UNIT IV: Inquiry and Advocacy: Concept of Silence (Masking, Avoiding, Withdrawing) and Violence (Controlling, Labelling, Attacking).

Reference Online Course:

1. Fisher, R., & Ury, W. (2011). *Getting to Yes: Negotiating Agreement without Giving In*. Toronto, ON: Penguin Random House.
2. Harper, G. (2004). *The Joy of Conflict Resolution: Transforming Victims, Villains and Heroes in the Workplace and at Home*. Gabriola Island, BC: New Society Publishers.
3. Miles, E. W. (2013). Developing Strategies for Asking Questions in Negotiation. *Negotiation Journal*, 29(4): 383–412. doi: 10.1111/nejo.12034.
4. Morrison, E. W., & Rothman, N. B. (2009). Silence and the Dynamics of power. In J. Greenberg and M. S. Edwards (eds.), *Voice and silence in organizations*, pp. 111-133. Bingley, UK: Emerald Group Publishing

Course Title and Code: Practice School – I (PS-I), PS1101	
Total Duration	**45 Days**
Credits	**04**
Students who can take	BCA Semester-V
Prerequisite	None
Weightage	Practical 100%

Course Objective:

The purpose of Practice School-I is to give an opportunity to re-understand their theoretical knowledge in the context of real life situations.

Learning Outcomes:

After course completion, the student will be able to:

1. Identify skills and capabilities that interconnect effectively with the needs of industry.
2. Demonstrate problem solving skills in the context of some real life situation.
3. Reflect and evaluate on future employment opportunities.

Course Title and Code: Artificial Intelligence (CS1224)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA. V Sem
Prerequisites	Data Structures
Evaluation	Theory 75%, Lab 25%

Course Objective: This course discusses the origin and evolution of the field of Artificial Intelligence, failures, successful applications and philosophical foundations. This course will cover state of the art topics in AI as covered in various universities throughout the world. It will cover the basics of uninformed search, A* search and heuristics, constraint satisfaction problems, minimax, expectimax, probabilistic decision making using Hidden Markov Models, Bayes Net, Naïve Bayes, Reinforcement learning.

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Identify problems that are amenable to solution by AI methods.
2. Reason about the state-space search algorithm to use under different problem specific conditions.
3. Implement two player games like TicTacToe.
4. Understand use of Markov decision process and reinforcement learning for real-life applications.
5. Design and code solutions to a wide variety of artificial intelligence problems where the machine can learn from the world and act accordingly.

Course Syllabus (Theory):

Unit I: Introduction to Artificial Intelligence, History and Philosophy of AI, Intelligent Agents, Classical AI problems, Problem Spaces and Problem Analysis.

Unit II: Solving problems by Searching, Uninformed search (DFS/BFS), Informed Search/Heuristics based search techniques, Generate and test, hill climbing, best first search. Adversarial Search.

Unit III: Graph Pruning, Min-Max Algorithm, Alpha-Beta Pruning. Game Trees. Constraint Satisfaction Problems.

Unit IV: Markov Decision Processes. Introduction to Reinforcement Learning.

Unit V: Knowledge Reasoning and Planning, Logical Agents, First-Order Logic, Inference in First order logic, Knowledge representation, Uncertain knowledge and probabilistic reasoning,

Text Book:

There is no particular book for the course. However, they serve as good references:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2022.

Reference Online Course:

CS188 Fall 2022 – UC Berkley: Artificial Intelligence.
Online available at: https://inst.eecs.berkeley.edu/~cs188/fa18/

Course Title and Code: Foundation of Blockchain and Smart Contracts (CS1226)	
Hours per Week	**L-T-P:3-0-2**
Credits	**4**
Students who can take	B.Tech(VII +V sem) Department Elective , BCA-V
Prerequisite	Database Management System, Any Programming Language
Weightage	Theory 60%, Lab 40%

Course Objectives: This course aims to provide an understanding of the essential concepts of blockchain technology by initially exploring the Bitcoin protocol followed by the Ethereum protocol to lay the foundation necessary for developing applications and programming for Blockchain Technology.

Learning Outcome: On successful completion of this course, the students should be able to:

1. Be able to state core blockchain concepts, the benefits, and the limitations of blockchain technologies.
2. Be able to state the key differentiators for blockchain from other technology systems.
3. Develop, Test and Execute a smart contract.
4. Apply the consensus mechanism on application.
5. Identify use cases and develop the application.
6. Recognize the differences between the most prominent blockchain structures and permissioned blockchain service providers.

Course Syllabus (Theory)

Unit -1. Blockchain Overview : History and Origin of Blockchain (and Cryptocurrency) , Blockchain Architecture and design, Technical Concepts of Blockchain Systems : Physical Ledger Technology and Security , Digital Ledger Technology ,Digital Security Technology : Cryptographic Hash Functions ,Digital Signatures, Hash chain to Blockchain, Basic consensus mechanisms: Requirements for the consensus protocols, Proof of Work (PoW), Proof of Concept

Unit -2 DLT Technical Concepts: Mining, Distributed Consensus, Incentives, Proof of Work, Cryptosystems in practice ,Distributed Networks Attacks Introduction to Smart Contracts , Cryptocurrency, Types of Blockchain

Unit -3 The Ethereum 'Ecosystem' : Ethereum network, EVM, Transaction fee, Ether, gas, Solidity, Smart contracts, Smart Contract Languages. Solidity, Remix IDE etc.

Unit-4 NFTs and ERC-721 Tokens : Stable Coins and other ERC tokens, DeFi, Crypto exchanges, Cyber Security.

Unit -5 Emerging Applications of Blockchain in industry : Use cases of Blockchain in Agriculture, Bank, Healthcare, Insurance, Science, Supply chain etc. . Comparing Blockchain Ecosystems: Bitcoin, Ethereum, Hyperledger.

Text Books:

1. Imran Bashir: Mastering Blockchain. O'Reilly, Packt Publishing, 2017.
2. Narayanan, Arvind, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. *Bitcoin and cryptocurrency technologies: A comprehensive introduction*. Princeton University Press, 2016.
3. Mougayar, William. *The business blockchain: promise, practice, and application of the next Internet technology*. John Wiley & Sons, 2016

Reference Online Courses:

MOOC course : Blockchain Specialization by Coursera https://www.coursera.org/specializations/blockchain

NPTEL Course : Introduction to Blockchain Technology & Applications, By IIT Kanpur https://nptel.ac.in/courses/106/104/106104220/

Course Title and Code: Multi-Dimensional and NoSQL Databases (CS1225)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. V Sem and VII sem; BCA V Sem
Prerequisites	Database Management Systems
Weightage	Theory 45% Lab 55%

Course Objective: The student learns about data warehouse systems and implements such a system using Facts and Dimensions. This course also introduces the concepts of distributed databases. Building on this, the architectures of the different NoSQL databases are discussed along with the CRUD operations.

Learning Outcome:

On successful completion of this course, the students should be able to:

1. Conceptually design data warehouse (DW) system
2. Implement, Extraction Transformation Load (ETL) pipelines for DW on relational data stores
3. Write OnLine Analytical Processing (OLAP) queries DW system
4. Understand the fragmentation strategies of distributed databases
5. Understand the architecture of column and document NoSQL data stores
6. Build conceptual models and query NoSQL databases
7. Implement DW on a column store and document store

Course Syllabus (Theory):

Unit 1. **Decision Making and Data Warehousing:** Decision Making; OLTP versus OLAP, Data Warehouse and Data Marts, Data Warehouse Design: Multidimensional Model/ Data Modelling, Hierarchy of Data, Multidimensional Schema, Star Schema, Snowflake Schema, ETL, OLAP operations, OLAP Models

Unit 2. **Introduction to NoSQL Databases:** Evolution of DBs; Data fragmentation strategies. ACID Versus BASE; CAP theorem and its impact; PACLEC theorem and its impact. RDBMS vs NoSQL; Types of NoSQL Databases

Unit 3. **Column Family Databases**: Notion of column; Data Modelling using columns and query first model; CRUD operations of Cassandra; Architecture of Cassandra. **Document Store**: Document and its structure; Data Modeling of Documents, MongoDB architecture, Writing Aggregation Pipeline

Unit 4. **Graph Database**: Types of Graphs: Querying with CypherQL: Key Value Databases: Introduction to Redis, Redis Commands, Querying Data

Unit 5. **Future of warehousing using NoSQL databases**, Data Lakes versus Data Warehouses, Multi Model Database systems

Text Books:

1. Principles of Distributed Database Systems, T Ozsu and P. Valduriez, Prentice Hall, 2011, ISBN: 978-1-4419-8833-1.
2. Star schema the complete reference, Adamson

3. Cassandra: The Definitive Guide, Eben Hewitt and Jeff Carpenter, O'Reilly Media, 2nd Edition, 2016, ISBN-10: 1491933666
4. MongoDB: The Definitive Guide, Kristina Chodorow, 2nd Edition, O'Reilly Media, 2013, ISBN-10: 1449344682.
5. Graph Databases, Ian Robinson, Jim Webber and Emil Eifrem, O'Reilly Media, 2nd Edition, 2015, ISBN-10: 1491930896
6. Redis Cookbook: Tiago Macedo, Fred Oliveira, O' Reilly Media, July 2011, ISBN: 9781449305048

Reference Online Course:

1. Introduction to NoSQL Databases | Coursera
2. NoSQL systems | Coursera
3. IBM Data Warehouse Engineer Professional Certificate | Coursera

Course Title and Code: Computer Vision (CS1228)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	BCA 5th Sem
Prerequisites	Programming I, Mathematics-I, Mathematics-II, Machine Learning
Evaluation	Theory 55%, Lab 45%

Course Objective: This course introduces the fundamental concepts of image and video-based features and how to use them for training ML/DL models for recognition tasks. It will cover object detection, segmentation, convolutional network model construction and training pipeline for image/video-based recognition applications. The course will also discuss the end-to-end development of state-of-the-art machine learning and deep learning models used in computer vision. This course will provide a hands-on state-of-the-art experience with tools and libraries used for building a vision pipeline.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Understand the fundamentals of Image Processing, Computer Vision and its applications.
2. Learn about the major vision tasks (detection, recognition, segmentation and tracking) along with their evaluation methodology.
3. Learn about state-of-the-art deep learning models for solving the major vision tasks applied for images and videos.
4. Learn the tools and techniques for implementing the core functionality of a computer vision system.
5. Identify the domain-specific requirements and build custom image/video processing learning based models and pipeline.

Course Syllabus (Theory):

UNIT-I: *Introduction to Image Processing and Computer Vision*: Image Formation, Digital Camera, Image data representation, Color Spaces, Filtering, Histogram Equalization, Fourier Transforms, Pyramids, Wavelets, Edge Detection, Image Features.

UNIT-II: *Convolutional Neural Networks (CNN) - Features and Applications:* CNN architectures for Classification, and Detection tasks (AlexNet, VGG, ResNet, FasterRCNN, MaskRCNN, YOLO). Video action classification features and models (Two-stream, 3DCNNs).

UNIT-III: *Spatial Features and working with video data:* Low level image features - SIFT, HOG, LBP. Face/Pedestrian/Object Detection, Video data representation, RGBD, background modeling / subtraction, MBH, BoVW based model training. Semantic Segmentation.

UNIT-IV: *Motion understanding:* Optical Flow, Shot Boundary Detection, detection and tracking in videos, Trajectory extraction (iDTs), trajectory clustering, FlowNet, SLAM.

UNIT-V: *Benchmark Datasets and Video Action Recognition:* Large-scale datasets, ActivityNet, Kinetics, AVA, TRECVid. Transformer Models, ViT, PixelCNN, Self-supervised learning on videos. Generative models. Applications of Action Recognition. Eigen Faces.

Reference Books:

1. Richard Szeliski – 'Computer Vision'.
2. Computer Vision: A Modern Approach, David A. Forsyth and Jean Ponce, Pearson 2nd Edition.
3. Deep Learning – Ian Goodfellow.
4. CVPR/ICCV/ECCV/BMVC conference and journal papers.
5. PyTorch and OpenCV tutorials.

Reference Online Course:

Computer Vision - CAP5415 UC CRCV
https://www.youtube.com/playlist?list=PLd3hlSJsX_IkXSinyREhlMjFvpNfpazfN

Computer Vision and Image Processing – IIT Guwahati NPTEL
https://www.youtube.com/playlist?list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo

Computer Vision (Univ of Washington)
https://courses.cs.washington.edu/courses/cse455/22sp/

Computer Vision (Univ of Washington - Shapiro)
https://courses.cs.washington.edu/courses/cse576/22sp/

NYU Deep Learning 2021: Alfredo and Yann LeCun
https://www.youtube.com/playlist?list=PLLHTzKZzVU9e6xUfG10TkTWApKSZCzuBI

Course Title and Code: **Advanced Data Structures and Algorithms CS1213**	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. Sem (VI), BCA Sem (V)
Prerequisites	Data Structures
Weightage	Theory 70% Practical 30%

Course Objective-The course aims to develop a deeper understanding of algorithmic design paradigms and advanced data structures for solving complex algorithmic problems.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Argue the correctness of algorithms using inductive proofs and loop invariants.
2. Analyze algorithms using amortized analysis, including the accounting and potential methods, as required.
3. Write programs to solve algorithmic problems using divide-and-conquer and dynamic-programming paradigms.
4. Implement variants of the self-balancing tree.
5. Analyze, implement and use heap structures and hashing techniques.
6. Apply and implement the disjoint set data structures to solve problems modelled by the graph.
7. Evaluate and apply appropriate energy-efficient algorithmic design techniques for solving complex algorithmic problems.

Syllabus (Theory)

Unit 1: Amortized Analysis: Aggregate, Accounting and Potential Method, Dynamic tables, **External Sorting**: Introduction to external sorting. Selection trees & k-way merging. Run generation—the optimal merging of runs.

Unit 2: Trees Variants: B Tree (2-3/2-3-4 Tree), RB Tree, Optimal Binary Search Tree, Splay tree, AA-Tree, Treap

Unit 3: String Matching Algorithms: Knuth Morris Prat, and Boyer Moore. **String Processing Data Structures**: Tries, Suffix Tree, **Disjoint Set Data Structures:** Disjoint-set operations, representation of disjoint sets, Disjoint-set forests

Unit 4: Heaps: Binomial Heap, Fibonacci Heap, Pairing heap **Space partitioning tree**: Binary space partitioning, KD tree, Quad tree, Interval Tree, Segment Tree.

Unit 5: Hashing: Introduction, Perfect hash function - Cuckoo hashing, Coalesced hashing, Universal Hashing. **Applications**: Searching, Memory Indexing, Computer Graphics, Image Data Structures.

Text Books:

1. Saha, Suman, and Shailendra Shukla. Advanced-Data Structures: Theory and Applications. CRC Press, 2019.
2. Samet, Hanan. Foundations of multidimensional and metric data structures. M. Kaufmann, 2006.
3. Mehlhorn, Kurt. "Sorting and Searching, volume 1 of Data Structures and Algorithms." (1984).
4. Mehta, Dinesh P., and Sartaj Sahni. Handbook of data structures and applications. Chapman and Hall/CRC, 2004.
5. Langsam, Yedidyah, Moshe Augenstein, and Aaron M. Tenenbaum. Data Structures using C and C++. Vol. 2. New Jersey: Prentice Hall, 2001.
6. Sartaj, Sahni. "Data Structures, Algorithms and Applications in C++." Computer Science, Singapore: McGraw-Hill (1998), reprint 2005.
7. Robert, L. Krune, Clovis L. Tondo, and Bruce P. Leung. "Data structures & Program Design in C." In O'Dougherty (production process staff workers)(second (hc) textbook ed.). Prentice-Hall, Inc. div. of Simon & Schuster, 2002.

Reeference Books:

1. Allen, Weiss Mark. Data structures and algorithm analysis in C++. Pearson Education India, 2007.
2. Cormen, T. H., Charles E. Leiserson, R. L. Rivest, and C. Stein. "Introduction to algorithms 2nd edition. chpater 9: Medians and order statistics."
3. Hopcroft, John E., and Jeffrey D. Ullman. Data structures and algorithms. 1983 reprint 2001.
4. Standish, Thomas A. Data structures in Java. Addison-Wesley Longman Publishing Co., Inc., 1997. Reprint Pearson Education Asia (Adisson Wesley), New Delhi, 2000
5. Knuth, Donald E. "The art of computer programming. Vol. 1: Fundamental algorithms." Atmospheric Chemistry & Physics (1978).
6. Heileman, Gregory L. "Data Structures, Algorithms, and Object-Oriented Programming. 1996.", Tata Mc-Graw Hill, 2002
7. Tremblay, Jean-Paul, and Paul G. Sorenson. "An introduction to data structures with applications." McGraw-Hill Computer Science Series, New York: McGraw-Hill, 1976 (1976).

Course Title and Code: Cybersecurity (EE1219)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. semester VI ECE, CSE; BCA V semester
Prerequisite	None
Weightage	Theory 40% Practical 60%

Course Objective- This course introduces the NIST Cybersecurity framework and sensitizes the students on security risks, malware, and social engineering attacks. It builds skills for ensuring good cyber hygiene, monitoring, and reporting cyber-attacks for an online computer.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Recommend the implementation tier for the NIST framework for a specific organization.
2. Explain methods to implement confidentiality, integrity, and availability of services for secure data transmission.
3. Use Wireshark pcap file and analyze the protocol used.
4. Analyze network and application attacks, analyze the alerts generated using SIEM/IDS.
5. Execute stages of forensic investigation by taking memory backups, data recovery, analyzing registry, traffic logs etc.
6. Apply SQL injection, DOS attack, and other ethical hacking on virtual boxes and understand how hackers work.

Course Syllabus (Theory):

Introduction to frameworks and standards: NIST framework, ISO/ IEC 27000 Information Security Standard, PCI DSS, HIPPA certification, Overview of zero trust.

Network and Application Security- What is network security, Principals of Cryptography, Message Integrity, Digital Signatures, End point Authentication, Securing Email, Securing TCP connection, Securing Wireless LAN.

Intrusion Detection systems (IDS), Intrusion Prevention systems (IPS). Study OWASP top 10 vulnerabilities and methods to prevent these.

Forensic - Introduction, Benefits and Challenges of Digital Forensic, Methodology, setting up Forensic workstation, Computer, Registry, Mobile forensic tools, difference between Digital and Electronic Forensic. Hands-on using tools-Autopsy, RAM triage, Registry acquisition using FTK Imager, Shell bag explorer, Registry viewer.

Ethical Hacking -White hat hackers, big bounty programs, familiarization with Common Vulnerabilities and Exploits (CVE), Nmap to locate attack vectors, Metasploit framework, Burp Suite for automated scanning.

Online resources:

1. https://www.coursera.org/learn/ethical-hacking-essentials-ehe
2. https://www.wireshark.org/
3. https://www.splunk.com/en_us/download
4. https://www.volatilityfoundation.org/

Textbooks:

1. Computer Networking -A top-down approach – Kurose, Ross. Pearson.
2. Cryptography and Network security- William Stallings, Pearson

Course Title and Code: IDEA TO BUSINESS MODEL (ED1102)	
Hours per Week	**L-T-P: 4-0-0**
Credits	**4**
Students who can take	B.Tech /BCA V Semester Elective
Pre-requisite	None
Weightage	Exam, Presentations, Assignments, Activities and Quiz 80%; Project 20%

Course Objective:

To encourage students to nurture their entrepreneurial traits and think creatively to develop innovative ideas/products for commercial exploitation.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Identify problem worth solving through design thinking.
2. Identify customer segment and niche for specific markets.
3. Craft Value Preposition Canvas.
4. Analyse competition
5. Create business model using Lean Canvas Template
6. Design and validate solution demo and MVP.
7. Analyse cost, revenue, key channels and pricing model for the venture.
8. Craft positioning statement of a new venture.
9. Classify the different sources of funding

TOPICS

1. Overview of Entrepreneur and Entrepreneurship
2. Self-Discovery & Entrepreneurial Thinking
3. Opportunity Discovery
4. Identify Customer
5. Value Preposition Canvas
6. Competition Analysis
7. Business Model
8. Minimum Viable Product
9. Money (Revenue, Costs, Pricing and Financing)
10. Marketing and Sales
11. Funding your Venture
12. Support (Institutional and Government policies)
13. Project

TEXT BOOK AND ADDITIONAL READING MATERIALS

NextGen (It is a leading digital learning platform provided by Wadhwani Foundation)

Additional Reading Material

1. Robert D Hisrich, Michael P Peters, Dean A Shepherd (2017).

Entrepreneurship/10e..New Delhi; Tata McGraw-Hill.
2. Poornima M Charantimath (2012). Entrepreneurship Development Small Business Enterprises. New Delhi: Pearson.
3. Rajeev Roy (2011). Entrepreneurship. New Delhi: Oxford 4. Arya Kumar (2015). Entrepreneurship: Creating and Leading an Entrepreneurial Organisation. New Delhi: Pearson.
4. Vasant Desai (2016). Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House.

Note: Latest edition of the readings will be used

Course Title and Code: Numerical and Scientific Computing (AS2202)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Pre-requisite	None
Students who can take	B. Tech and BCA Semester-V Elective
Evaluation	Theory – 70%, Lab – 30%

Course Objective:

This course aims to introduce advanced numerical methods to model engineering systems and to solve them using various computational techniques. Laboratory sessions involve the application of numerical analysis to various physical problems.

Course Outcomes: After course completion, the student will be able to:

1. demonstrate an understanding of common numerical methods and used them to obtain approximate solutions to otherwise intractable mathematical problems.
2. develop numerical techniques for different mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. analyze and evaluate the accuracy of common numerical methods.
4. write efficient, well-documented programming code and present numerical results in an informative way.

Course Syllabus (Theory)

Modeling, Computers, and Error Analysis: Mathematical Modeling and solution using Programming and Software, Computer Arithmetic and Errors: Approximations and Round-Off Errors, Truncation Errors, and the Taylor Series.

Transcendental and polynomial equations: Solution of non-linear Equations: Bracketing Methods, Open Methods, Roots of polynomials.

Linear Algebraic Equations: LU Decomposition and Matrix Inversion, Iterative methods for solving system of linear equations, finding eigenvalues and eigenvectors.

Interpolation and approximation: Interpolation for equally and unequally spaced points, Lagrangian Polynomial.

Numerical Differentiation and Integration: Numerical Differentiation and Integration, Newton-Cotes Integration Formulae.

Ordinary Differential Equations: Difference equation, Single step methods, Stiffness and Multistep Methods, Predictor-corrector method.

Partial Differential Equations: Finite Difference: Elliptic and Parabolic Equations.

Textbooks:

1. M.K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, New Delhi.

2. JV Lambers, ACS Mooney, VA Montiforte, Explorations in Numerical Analysis: Python Edition, WSPC (January 18, 2021).

Reference Books:

1. Q Kong, T Siauw, A Bayen, Python Programming, and Numerical Methods: A Guide for Engineers and Scientists, Academic Press; 1st edition (December 16, 2020)
2. K. E. Atkinson, Introduction to Numerical Analysis, John Wiley and Sons.
3. Steven C Chapra, Raymond P Canale, Numerical Methods for Engineers, 6/e, Mc Graw Hill
4. Srimanta Pal, Numerical Methods: Principles, Analyses, and Algorithms, Oxford University Press, New Delhi.
5. Cheney and Kincaid, Numerical Methods and Applications, Cengage Publications, New Delhi.
6. Cleve B. Moler, Numerical Computing with MATLAB, Prentice Hall of India, New Delhi.

Course Title and Code: Fundamentals of Investing (FA1127)	
Hours per Week	**L-T-P: 4-0-0**
Credits	**4**
Students who can take	BCA Semester-V Elective
Pre-requisite	None
Weightage	Theory 70% Practical 30%

Course Objective:

The income that a person receives may be used for purchasing goods and services that he currently requires or it may be saved for purchasing goods and services that he may require in the future. In other words, income can be what is spent for current consumption. savings are generated when a person or organization abstain from present consumption for a future use. The person saving a part of his income tries to find a short term or long term investment avenues for his savings until they are required to finance his future expenditure, this result in investment. The course is primarily designed for novice investors who want to better understand the concept of investing and investment decision making. This course will cover different investment vehicles, Time value of money and power of compounding, balancing risk and return, project valuation and the capital budgeting process, financial services and institutions.

Course Outcomes:

After course completion, the student will be able to:

1. Comprehend the fundamentals of investment and different investment vehicles.
2. Evaluate and Explore the effects of investments on personal finances
3. Apply the concept of Time value of money to your personal finance and retirement planning.
4. Analyze viability of different projects for investment decision making.
5. Comprehend the role of financial markets and intermediaries and financial services.

Course Syllabus (Theory):

Module-I Investment Environment

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets (Equity, Mutual funds, Debt), Introducing investment tools- Deposits, Bonds, saving schemes such as PF, PPF, NPS, SSY, NSC, Post office saving schemes, Insurance- Term, Endowment plans, Gold, SGBs etc.

Module-II Time Value of Money and balancing Risk and Return

Fundamental Valuation Concept- Time value of Money: Concept and Rationale, Compounding and Discounting of cash flows. FV & PV of Annuity, Risk & Return Trade.

Module-III Project Valuation and capital budgeting process

Capital Budgeting: Capital budgeting process, Non-Discounting cash flow techniques, Discounting cash flow techniques, Accept Reject Rules.

Module IV: Introducing Financial Markets and Institutions: The Indian securities market, the market participants (Stock exchanges, Stock brokers, Clearing House, Depositories, Depository Participants, FIIs, Domestic institutional investors, Individual investors), Online and offline trading in securities, security market indices, sources of financial information.

Course Title and Code: Advanced Statistics (AS1202)	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Pre-requisite	None
Students who can take	BCA Sem V (Open Elective)
Evaluation	Theory – 100%

Course Objective- To familiarize students with concepts of multiple random variables and their properties to use them to analyze real-life problems. This course also focuses on developing an understanding of regression models, data analysis, model building, interpretation of results and statistical computation.

Course Outcome:

On successful completion of this course, the students should be able to:

1. identify, formulate, and derive various properties of probability distributions and density functions of one and more random variables.
2. choose appropriate descriptive properties to summarise a variety of data sets.
3. apply the concepts of the central limit theorem and algebra of random variables to analyze linear systems.
4. analyze a system of multiple random variables using the appropriate regression model.
5. model experiments as processes and analyze them using ANOVA.

Course Syllabus (Theory)

Random Variables

Random variables, Distribution and density functions of random variables, Discrete and continuous random variables, Gaussian, Exponential, Rayleigh, Cauchy, Uniform, discrete Uniform and conditional distributions, general properties of distributions.

Multiple Random Variables

Joint and marginal distributions for discrete and continuous random variables. Joint moments, Conditional distributions, correlation coefficient, statistical independence. Multiple random variables, expected value, Variance, standard deviation, moments of multiple random variables.

Operations On Multiple Random Variables

Central limit theorem, Chebyshev's Inequality, covariance, variance of a linear combination of random variables, and distribution of sums of independent random variables.

Regression Analysis

Introduction to the regression model, Types of regression models, Least square estimators, Estimation of the regression coefficients and error variance, Inferences for the regression coefficients, Predicting future observations, Inverse prediction, and regulation. Multiple linear regression models.

Design of Experiments

Analysis of variance, one-way ANOVA, two-way ANOVA, and nonparametric tests.

Recommended MOOC :

1. **https://www.coursera.org/learn/linear-models**
2. https://www.coursera.org/projects/linear-regression-numpy-python

Reference Books:

1. J. Susan Milton and Jesse C. Arnold, 'Introduction to Probability and Statistics', McGraw Hill Education.
2. Papoulis, 'Probability, Random Variables And Stochastic Processes', TMH.
3. VK Rohatgi and AK Saleh, 'An Introduction to Probability and Statistics', Wiley India.
4. Sheldon M. Ross, 'Stochastic Processes', 2ed, Wiley.
5. Shumway & Stoffer (2011) Time Series Analysis and its applications, with examples in R , 3rd edition, Springer.
6. K. L. Chung, 'Introduction to Probability Theory with Stochastic Processes', Springer International Student Edition.
7. Applied Linear Statistical Models by Kutner, Nachtsteim, Neter and Li (5th edition).

Course Title and Code: Robotic Process Automation Lab (CS1125)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	BTech (CSE, ECE, CE, ME) Sem VI + BCA Sem V
Prerequisite	Any Programming Language
Weightage	Quiz 20% Practical 80%

Course Objective- The course aim is to develop an understanding of Intelligent Automation through Robotic Process Automation for automating business processes using software robots with cost-efficient digital delivery.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Use and understand the various functionalities and features of UiPath Studio and Orchestrator.
2. Design, implement, and use RPA activities.
3. Develop basic robots using UiPath Community Edition.
4. Explore various data extraction techniques.
5. Identify processes which can be automated.
6. Develop business BOTs using Automation Anywhere (360).
7. Apply best practices in RPA projects.

Course Syllabus (Theory):

Unit I: Programming Basic & Recap: Programming concept basic; **Introduction to RPA:** scopes and techniques of automation, RPA components and various RPA platforms, Introduction to UiPath as RPA platform, Applications and Benefits of RPA, Introduction to UiPath Studio, UiPath robot, types of robots, and UiPath Orchestrator. Brief on Studio interface and components.

Unit II: **RPA Projects:** Types of Projects in RPA: Sequence, Flowcharts, and State machines; Variables, Arguments, Data Types and Control flow: flow chart activities and sequences activities. **Data Manipulation:** Text and Data Manipulation**,** Data tables, clipboard management, file operation, importing from and exporting to CSV/Excel file and data table.

Unit III: **Control of Controls:** Attach window activity, Find and wait for the control, Introduction to Recorder, OCR, types of OCR and Screen Scrapping Using OCR. **Selectors:** Selectors, Defining and Assessing Selectors, Customization, Debugging, Dynamic Selectors, Partial Selectors, RPA Challenge.

Unit IV: **Application with Plugins and Extensions:** Mail plugins, PDF plugins, Web integration, excel and word plugins. Extensions- Java, chrome and firefox. **UiPath Advanced Automation concepts and techniques:** Image, Text and introduction of Citrix Automation; **Excel Data Tables & PDF:** Data Tables in RPA, Excel and Data Table basics, Data Manipulation in excel, Extracting Data from PDF, Extracting a single piece of data, Anchors. **Email Automation:** Incoming Email automation, Sending Email automation.

Unit V: **Automation Anywhere (AA):** Overview and Installation of Automation Anywhere Community Edition; Configuration of profile and device credentials; AA Architecture, Flow, List, and Dual Views of projects, Variables and Triggers; and Capstone Projects.

Text Material & Resources:

Text Books:

T1 Tripathi, Alok Mani. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool–UiPath. Packt Publishing Ltd, 2018.

T2 Murdoch, Richard. "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant." Middletown, DE. Omakustanne (2018).

T3 Mahey, H. Robotic Process Automation with Automation Anywhere: Techniques to fuel business productivity and intelligent automation using RPA. Packt Publishing Ltd (2020).

Reference Books:

R1. Abhinav Sabharwal, “Introduction To RPA”, Independently Published Kindle Edition on Amazon Asia-Pacific Holdings Private Limited, 201 8

R2. Gerardus Blokdyk, “RPA Robotic Process Automation”, 5 Star cook, Second Edition, 2018

R3. Kelly Wibbenmeyer, “The Simple Implementation Guide to Robotic Process Automation (RPA): How to Best Implement RPA in an Organization” Paperback, iUniverse, 2018

R4. Willcocks, Leslie P., Mary Lacity, and Andrew Craig. "The IT function and robotic process automation." (2015).

R5. Mullakara, Nandan, and Arun Kumar Asokan. Robotic process automation projects: build real-world RPA solutions using UiPath and automation anywhere. Packt Publishing Ltd, 2020.

Course Title and Code: Google Cloud Lab (CS1223)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	BCA. V Sem
Prerequisite	None
Weightage	Practical 100%

Course Objective: This course aims to provide hands-on training on Google cloud. The students will learn the Infrastructure and services provided by Google cloud based on well-known practices.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Create and deploy resilient, elastic, cost-effective cloud applications on Google Cloud.
2. Examine the trade-offs between deploying applications in Google Cloud and over the local Infrastructure.
3. Deploy applications over commercial cloud computing infrastructures, i.e., Google Cloud.
4. Evaluate the performance, scalability, and availability of the underlying cloud
5. technologies and software.

Course Contents:

Getting Started with Compute Engine, Getting Started with Cloud Marketplace, Getting Started with Cloud Storage and Cloud SQL, Getting Started with GKE, Getting Started with App Engine, Getting Started with Deployment Manager and Cloud Monitoring

Getting Started with BigQuery, Working with the Cloud Console and Cloud Shell, Infrastructure Preview, VPC Networking. Implement Private Google Access and Cloud NAT

Creating virtual machines, Working with Virtual Machines, Cloud IAM, Cloud Storage, Implementing Cloud SQL, Examining Billing Data with BigQuery, Resource Monitoring, Error Reporting, and Debugging

Virtual Private Networks (VPN), Configuring an HTTP Load Balancer with Autoscaling, Configuring an Internal Load Balancer, Automating the Infrastructure of networks using Terraform, Building a DevOps Pipeline, Deploying Apps to Google Cloud, Monitoring Applications in Google Cloud

Text Books:

1. Google Cloud Associate Examination Workbook, Google Cloud 2022
2. Thomas Erl, Ricardo Puttini, Zaigham Mahmood. Cloud Computing: Concepts, Technology & Architecture. Pearson, 2013.
3. Michael J. Kavis. Architecting the Cloud: Design Decisions for Cloud Computing Service Models. Wiley, 2014.

Course Title and Code: Virtual Reality Lab (CS1221)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	BCA CSE Semester V
Prerequisite	None
Weightage	Practical 100%

Course Objective: This course presents an introduction to virtual reality technologies, with an emphasis on designing and developing interactive virtual reality experiences. The course will cover 3-D modelling, interaction techniques, and specific application areas. Students will be able to work on real-life projects using VR technology.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Understand how the design of VR technology relates to human perception and cognition.
2. Apply the acquired knowledge for the analysis and design of VR systems.
3. Apply and use several types of Hardware and software in Virtual Reality systems.
4. Gain first-hand experience with using virtual environment technology, including 3D rendering software, tracking hardware, and input/output functions for capturing user data.
5. Develop and deploy VR (Virtual Reality) applications using Blender and Unity/ Unreal tools.

Course Syllabus (Theory):

Hands-on Modeling using Blender

- Overview
- Start Modeling
- Installing Blender
- Blender: Essential Training
- Blender: Essential Concepts Summary
- Optimization and Rendering
- Create interactive 3D models
-

Introduction to Virtual Environment Technology

- VR and its relation to humans
- The relation of VR to research, training, design, and manufacturing.
- An overview of VR applications.
- VR design: perceptual and cognitive factors.

Introduction to Unity/Unreal Engine:

- Interface overview and navigation
- Creating a new project, importing standard assets, adding a player character
- Tracking, Latency, Field of View in Real life,
- Fidelity, depth, isolation, smell, range of motion (DoF)

- Sensory Influence: Kinetics, Spatial Audio, Haptics, Other senses?
- Megascans plugin for Unity/Unreal

Note - Tools recommended: - Blender, Unity/Unreal

FINAL PROJECT: Building one VR Application.

Reference Books:

1. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented & Virtual Realities", 1stedition, O'REILLY, 2019.
2. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016
3. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013
4. Fei GAO. Design and Development of Virtual Reality Application System, Tsinghua Press, March 2012.
5. Guangran LIU. Virtual Reality Technology, Tsinghua Press, Jan. 2011.

Recommended MooC:
Introduction to Virtual Reality– Coursera
https://www.coursera.org/learn/introduction-virtual-reality#syllabus
Introduction to Augmented Reality and ARCore– Coursera
https://www.coursera.org/learn/ar

Course Title and Code: Geographical Information Systems Lab (GIS) (CE1114)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	B.Tech V sem (B Tech CSE, EEE and ME), BCA V Sem
Prerequisite	None
Weightage	Practical 100%

Course Objective: This course presents an introduction to virtual reality technologies, with an emphasis on designing and developing interactive virtual reality experiences. The course will cover 3-D modelling, interaction techniques, and specific application areas. Students will be able to work on real-life projects using VR technology.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Assess the various sources for remote sensing data and analyze the various type of images.
2. Analyze the data acquisition and data output through GIS, with the help of open-source tool of QGIS and Python.
3. Automate GIS processes with Python-based plugin development for QGIS.
4. Incorporate GIS in resource management and climate change applications

Course Syllabus

- Remote sensing satellites and their data products, Sensors and orbital characteristics, Satellite Image - Characteristics and formats, Introduction to Image rectification, Image Enhancement, Land use and land cover classification system.
- Basic concepts of geographic data, GIS and its components, Data acquisition, Raster and Vector formats, Topology and Data models, Spatial modeling, Data output
- Applications of GIS: Climate change, Natural resources management, Forest management, Water Resources management, Drought Management, Location-based services.

Syllabus (Practical with QGIS and Python)

QGIS experiments

1. Creating and Exploring a Basic Map
2. Classifying and Creating Vector Data
3. Laying Out of the Maps
4. Classifying and Creating Raster Data
5. Terrain Analysis
6. Raster to Vector Conversion
7. Hydrologic Analysis

Python-based experiments

1. Working with Shapely package and geometric objects
2. Vector data analysis with Geopandas
3. Geocoding in Geopandas

4. Analyzing raster data and automatically detecting features
5. Working with Maps
6. Plugin development and integration with QGIS

Links to Some Sample Github implementations (for plugin development)
https://github.com/ConservationInternational/trends.earth
https://github.com/ghtmtt/DataPlotly

Talks on Python integration with QGIS
https://vimeo.com/106874213
https://www.youtube.com/watch?v=z_QEi212DEQ

Text /Reference Books:

1. Erik Westra - "Python Geospatial Development", Packt Publishing.
2. Joel Lawhead - "QGIS Python Programming Cookbook", Packt Publishing.
3. Bhatta B., "Remote sensing and GIS", Oxford University Press, 2011.
4. Satish G., "Advanced Surveying: Total Station, GIS and Remote Sensing", Pearson, 2011.
5. QGIS 3 and PyQGIS online documentation files.

https://autogis-site.readthedocs.io/en/latest/
https://nptel.ac.in/courses/105/108/105108077/

Course Title and Code: Applied IoT (EE1117)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	BCA Semester V
Prerequisites	Basic Programming
Weightage	Practical 100%

Course Objective- The course aims to develop understanding of Internet of Things concepts and also develop skills for working on IoT development boards to interface sensors and actuators. The course will enable the students to upload data from sensors on a web server and to use this data for analytical purposes or to actuate some transducers.

Course Outcome:

On successful completion of this course, the students should be able to:

1. Interface the Analog and Digital sensors to Node-MCU.
2. Develop Embedded C programs to read sensor data and upload to public cloud platform.
3. Use Python-based IDE (integrated development environments) for the interfacing of I/O devices with Raspberry Pi.
4. Visualize sensor data uploaded on public cloud.
5. Apply standard protocol(s) for implementation of IoT Systems.
6. Analyse and Improve existing systems with innovative IoT based approaches.

Syllabus (Theory):

UNIT 1: Introduction to IoT Fundamentals: Definition, Characteristics, Applications, Connectivity Layers, Addressing, Networking.

UNIT 2**:** Sensors and Actuators: Understanding and working of different Types of Sensors and Actuators, Sensor Types, Actuator Basics, Actuator Types

UNIT 3**:** Basics of IoT Networking & Protocol: IoT Components, Inter-dependencies, Protocol Classification, HTTP, MQTT, Bluetooth, 802.11.

UNIT 4**:** Introduction to NodeMCU and Server: Basic Concepts of Arduino Platform, Examples of Arduino Programming, Interfacing different sensors with NodeMCU. Introductio to Blynk App, Uploading and downloading data from server using Blynk App. Intoduction to ThingSpeak Server, Uploading and downloading data from ThingSpeak server.

UNIT-5 Raspberry Pi: Basic functionality of the Raspberry Pi, Setup and Configuring Raspberry Pi, programming on the Raspberry Pi using Python, Python functions to access the Raspberry Pins, Raspberry Pi with online cloud services.

Reference Books:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
3. IoT fundamentals: networking technologies, protocols, and use cases for the internet of things : Hanes, David | Salgueiro, Gonzalo | Grossetete, Patrick | Barton, Robert Henry, Jerome, Pearson, 2018, ISBN: 9789386873743.
4. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning IOT by David Etter.

Course Title and Code: Minor Project (PR1103)	
Credits	2
Students who can take	BCA Sem VI
Prerequisites	None
Weightage	Report and Project 100%
Course Objective- This course offers an opportunity to apply and extend knowledge learned throughout the program to solve real world issues. The minor projects undertaken span a diverse range of topics, including design, simulation, and experimental studies. The course emphasizes, facilitating student learning in technical, project implementation and presentation spheres.	
Course Outcome: On successful completion of this course, the students should be able to: 1. Identify and formulate industrial and societal problems. 2. Design engineering solutions for complex problems. 3. Develop/fabricate, and implement solutions for identified problem. 4. Demonstrate the knowledge, skills and attitudes of a professional engineer.	

Course Title and Code: Critical Thinking for Decisions at Workplace (CC1106)	
Hours per Week	**L-T-P: 2-0-0**
Credits	**2**
Students who can take	BCA Semester VI
Prerequisite	None
Weightage	Theory 40% Practical 60%
Course Objectives- In today's world, the idea of right and wrong is being challenged by businesses, use of technology, economic conditions, and norms of societies. The relevance of a well-reasoned decision is crucial. This course intends to make students take better decisions keeping in mind purpose, context, and ethics.	
Learning Outcomes: The students will be able to: 1 Apply strategies of Critical Thinking to examine organisational problems through positive inquiry 2 Describe and examine suitable problem-solving and ethical decision-making processes 3 Choose the simplest and logical decision among multiple alternatives 4 Evaluate solutions and count on possible risks based on purpose, context and ethics	

Course Syllabus:

Topics
• Importance of decision making at workplace • Robust decision making by David G Ullman • Taxonomy of decision making by Rowe and Boulgarides • Factors impacting decision-making • Concept of enquiry circle • Theories of ethics (Teleological, Deontological, Virtue Ethics, Conduct Ethics, Rights based, Utilitarianism, Hedonism, Egoism) • Concept of moral development by Kohlberg • Role of ethics and values in decision Making • Role of Stakeholders in decision making. • Root cause analysis

Suggested Readings

1. Jonah Lehrer, 2009: **How we Decide.** Houghton Mifflin Harcourt, Boston, New York
2. Chip Heath and Dan Heath, 2013. **Decisive: How to Make Better Choices in Life and Work.** Crown Business, ISBN 0307956393
3. John S. Hammond, Howard Raiffa, Ralph L. Keeney, 2002. **Smart Choices: A Practical Guide to Making Better Decisions.** Crown Business, ISBN 0767908864
4. Ramesh K. Arora, **Ethics, Integrity and Values in Public Service.** New Age International Publishers, New Delhi.
5. Bradley H. Dowden, 1993. **Logical Reasoning.** Wadsworth Publishing Company,

Belmont, California, ISBN 0534176887

Course Title and Code: Practice School – II (PS-2), PS1102	
Total Duration	**4-4.5 months**
Credits	**16**
Students who can take	BCA Semester-VI
Prerequisites	None
Weightage	Practical 100%

Course Objective:

The aim of this course is to expose students to the real-world industrial environment to acquire knowledge of various professional skills, working of industry, and interaction with the people. Practice school-II is essential to inculcate confidence and encourage to take-up professions/entrepreneurship to serve the society in general

Course Outcomes:

On successful completion of Practice school-II, the students be able to:

1. Apply skills and engineering knowledge to identify various Industrial problems.
2. Analyze and solve engineering related problems in industry using methods, tools and techniques learnt at the university.
3. Demonstrate ethic and professionalism in engineering practice.
4. Communicate effectively with the technical community and produce effective reports and presentations

Course Title and Code: Big Data Engineering (CS1312)	
Hours per Week	**L-T-P: 2-0-4**
Credits	**4**
Students who can take	B.Tech CSE Sem VI/BCA Sem VI
Prerequisite	Operating System, Database Management System
Weightage	Theory 20% Practical 80%

Course Objective- The main goal of this course is to help students learn, understand, and practice modern big data technologies for scaling up data science techniques focusing on industry applications. This course builds upon the foundations laid on operating system, databases, and machine learning.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Identify the characteristics of datasets and compare the trivial data and big data for various applications.
2. Develop Big Data Solutions using Hadoop Eco System
3. Select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.
4. Integrate Data Science libraries in Python with big data technologies.
5. Utilize big data technologies for data analysis.

Course Syllabus (Theory):

Introduction to Big Data and Hadoop

Data Overview, Industry Applications, Case Studies, Understanding Big Data; Hadoop overview: Hadoop Introduction, Hadoop architecture, HDFS Introduction, HDFS architecture, MapReduce v 1.0 and YARN differences and their architecture, Hadoop Security, Hortonworks Data Platform (HDP)

Hadoop Eco System

Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

Sqoop: Sqoop commands

Big Data Analytics

Introduction to Big Data Analytics, Descriptive analytics, Data-driven Decision Making, Web scraping and data acquisition, Data Pre-processing, Data visualization, Model Development, Model Validation, Model Diagnostics, Model Deployment**,** Regression, Classification and Clustering methods, Dimensionality reduction, Network analysis, Ethics of big data

Reference Books:

1. U Dinesh Kumar, “Business Analytics – The Science of Data Driven Decision Making”, Wiley, 2017.
2. Benjamin Bengfort and Jenny Kim. Data Analytics with Hadoop: An Introduction for Data Scientists. O'Reilly Media, 2016.
3. Jake VanderPlas. Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media, 2016

Course Title and Code: Virtualisation and Cloud Computing (CS1127)	
Hours per Week	**L-T-P: 2-0-4**
Credits	**4**
Students who can take	BCA Sem VI
Prerequisites	Operating Systems and Linux Administration, Computer Network and Network Administrations, Database Management and Applications, Computer Organization
Weightage	Theory 40% Practical 60%

Course Objective:

This course introduces a broad spectrum of components that comprise virtualization and cloud computing. The student will learn about the technologies involved with these components and how they relate to each other to form a virtualization/cloud architecture based on well-known practices. This course builds upon the Operating System, Computer Networks, Database, Computer Architecture.

Course Outcomes:

On successful completion of this course, the students should be able to:

1. Create Virtual Machines (VM) using Hypervisors, install Kali Linux on the VM and demonstrate IaaS, PaaS and SaaS through real life examples
2. Build and deploy cloud applications that are resilient, elastic and cost-efficient
3. Analyse the trade-offs between deploying applications in the cloud and over the local infrastructure.
4. Deploy applications over commercial cloud computing infrastructures, i.e., Google Cloud
5. Analyse the performance, scalability, and availability of the underlying cloud technologies and software

Course Syllabus (Theory)

Virtualization, Concept, Types of Virtualization, Full Virtualization, Hardware-assisted Virtualization, Partial Virtualization, Paravirtualization, OS-level Virtualization

Hypervisor, Type of Hypervisor, Snapshot (storage), Migration, Application Virtualization, Portable Application, Memory Virtualization, Storage Virtualization, Network Virtualization, Software-defined Networking, Network-function Virtualization

Cloud Computing Overview: Definition and evolution of Cloud Computing, Enabling Technologies, Service and Deployment Models, Popular Cloud Stacks and Use Cases, Benefits, Risks, and Challenges of Cloud Computing, Economic Models and SLAs, Topics in Cloud Security

Cloud Infrastructure: Historical Perspective of Data Centres, Datacentre Components: IT Equipment and Facilities, Design Considerations: Requirements, Power, Efficiency, & Redundancy, Power Calculations, PUE and Challenges in Cloud Data Centres, Cloud

Management and Cloud Software Deployment Considerations

Overview of Google Cloud Platform Fundamentals: Google App Engine, Google Compute Engine, Google Kubernetes Engine, Google Cloud Storage, Google Cloud SQL, and BigQuery, Google Cloud Resource Manager hierarchy and Google Cloud Identity and Access Management, infrastructure design, and virtual networking configuration with Virtual Private Cloud (VPC), Projects, Networks, Subnetworks, IP addresses, Routes, and Firewall rules

Reference(s)

1. Nhu Gia Nguyen, Dac-Nhuong Le, Jyotir Moy Chatterjee, Raghvendra Kumar, Cloud Computing and Virtualization. Wiley
2. Thomas Erl, Ricardo Puttini, Zaigham Mahmood. *Cloud Computing: Concepts, Technology & Architecture*. Pearson, 2013.
3. Michael J. Kavis. *Architecting the Cloud: Design Decisions for Cloud Computing Service Models*. Wiley, 2014.

Reference Online Courses:

MOOC on Cloud Computing and Virtualization: An Introduction, Udemy, https://www.udemy.com/course/cloud-computing-and-virtualization-an-introduction/

Google Cloud Fundamentals: Core Infrastructure
https://www.cloudskillsboost.google/course_templates/60

Essential Google Cloud Infrastructure: Foundation
https://www.cloudskillsboost.google/course_templates/50

Essential Google Cloud Infrastructure: Core Services
https://www.cloudskillsboost.google/course_templates/49

Elastic Google Cloud Infrastructure: Scaling and Automation
https://www.cloudskillsboost.google/course_templates/178

Course Title and Code: Solid and E-Waste Management (AS1210)	
Hours per Week	**L-T-P: 3-1-0**
Credits	4
Students who can take	Open Elective
Pre-requisite	None
Weightage	Theory 55% Practical 45%

Course Objective: This course provides an in-depth understanding of solid and hazardous waste characteristics and management. This course will also discuss the overall scenario of E-Waste management. This imparts life skills about E-waste management in routine daily life to minimize the different wastes and apply effective management throughout society.

Course Outcomes:

After course completion, the student will be able to:

1. Analyze key sources, typical quantities generated, composition, and properties of solid and hazardous wastes.
2. Compare effective methods of solid & hazardous waste handling and segregation of wastes at source.
3. Test the most common techniques for preventing, minimizing, recycling, disposing, and treatment of solid and e-waste and their application in on-site remediation.
4. Recognize the important regulations which are applied for the effective management of solid and E-wastes.
5. Use engineering methods to identify, formulate, and solve waste problems.

Course Syllabus (Theory):

INTRODUCTION: Types and Sources of solid wastes and E-waste- Indian and global scenario of the - Need for solid and E-waste management – Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of E-waste, Possible hazardous substances present in E-waste, Environmental and Health implications.

WASTE LEGISLATION: Legislations on management and handling of solid waste. The regulatory regime for e-waste in India, the hazardous waste (Management and Handling) rules 2003, E-waste management rules 2015, Regulatory compliance including roles and responsibilities of different stakeholders – producer, manufacturer, consumer, etc., Proposed reduction in the use of hazardous substances (RoHS), Extended producer responsibility (EPR).

WASTE PROCESSING & TECHNOLOGY: Composition - Hazardous Characteristics –Source reduction of wastes – Recycling and reuse. Handling and segregation of wastes at source – storage and collection of solid & E-wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations - labeling and handling of hazardous wastes. Processing technologies – thermal conversion technologies - energy recovery – incineration. Life cycle assessment of a product (LCA) method, Emerging recycling, and recovery technologies

DISPOSAL: Guidelines for environmentally sound management of e-waste, environmentally sound treatment technology for e-waste, Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills, leachate, and landfill gas management. Case studies, and unique initiatives from around the world. Case study -Optimal planning for computer waste.

Text Book:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York, 1993
2. Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi

REFERENCE BOOKS:

Refer to all courses related books, other than textbooks here.

1. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
2. George Tchobanoglous; Frank Kreith Handbook of Solid Waste Management, Second Edition ISBN: 9780071356237 Publication Date & Copyright: 2002.The McGraw-Hill Companies, Inc
3. Thomas H. Christensen; Solid Waste Technology & Management, 1 & 2; First published:23 November 2010 Print ISBN:9781405175173 |
4. NPTL course IIT Kharagpur. (https://nptel.ac.in/courses/105105169)

Course Title and Code: **Disaster Management (CE 1206)**	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Students who can take	BCA Sem VI (OE)
Prerequisite	None
Weightage	Theory 50% Practical 50%

Course Objective: This course aims to develop understanding of various natural and manmade disasters. Natural disasters include earthquake, Tsunami, Flood, forest fires and Land Slides. Manmade disasters include fire, Industrial Pollution, embankment failure, structural failure and due to electric supply. Topics includes the causes for these disasters and remedial measures which can minimize the losses to the life and property. The course also includes the identification and description of electric supply resilience and restoration.

Course Outcomes

On completion of the course, the student should be able to:

1. Asses the types of disasters, causes and their impacts.
2. Assess vulnerability and various methods of risk reduction measures and mitigation.
3. Draw the hazard and vulnerability profile of a given region.
4. Analyze the impact of Storms and Severe Weather on electric utility.
5. Plan and execute framework to black start and restoration procedure with considering security criteria and power system reliability.

Course Syllabus (Theory)

Unit-1 Introduction to Disasters, Various types of disaster, Natural: Flood, Earthquake, cyclone, Land slide, Manmade: Fire, Industrial Pollution, embankment failure, structural failure, Loss of resources.

Unit-2

Risk and Vulnerability:

Risk: Its concept and analysis, Risk reduction, Vulnerability: Its concept and analysis, strategic development for vulnerability reduction

Unit 3

Disaster Management in Electrical Systems:

Causes of Extended Outages, System Impact of the Loss of Major Components, Methods to Reduce Energy System Vulnerability, Development of an On-Site and Off-site Disaster management Plan, Accident prevention techniques and Reporting procedures, Investigation reports, Impacts of Blackouts.

Unit – 4

Management- Objectives, Processes, Events, analysis, base-line data, forecasting and Warnings. Disaster preparedness plan concept and nature, Emergency operation center and IT aids-physical environment, Applications. Public-private agency co-ordination- federal, state and local disaster response organization and network, Citizen and community role in disaster response and recovery.

Text /Reference Books:

1. M. Pandey, “Disaster Management” Wiley India Pvt. Ltd.
2. Tushar Bhattacharya, “Disaster Science and Management” McGraw Hill Education (India) Pvt. Ltd.
3. Crisis and disaster management plan for power sector by central electricity authority of India
4. N. Malla, S. Poudel, N. R. Karki and N. Gyawali, "Resilience of electrical power delivery system in response to natural disasters," 2017 7th International Conference on Power Systems (ICPS), Pune, 2017, pp. 806-811.doi: 10.1109/ICPES.2017.8387400
5. Sahni, Pardeepet. al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall of India, New Delhi.

Course Title and Code: Flexible Electronics EE1225	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Students who can take	BCA VI Sem
Prerequisite: None	
Weightage: Theory 70%, Assignment and Quiz 30%	

Course Objectives:

Gain a fundamental understanding of the field of organic and printed electronic materials, fabrication techniques and devices and their potential impact.

1. Learn the fundamentals of flexible and printable electronics and deepen your understanding of them.

2. Develop a grasp of the link between soft matter electronics printing techniques, device performance, and intended applications.

3. Understand the fundamental concepts of device integration on flexible platforms, as well as the benefits and drawbacks of emerging technology that will be employed in future devices.

4. Acquire a basic knowledge of Future Trends in Flexible/Printable Electronics Technology, as well as the commercialization paths for new materials, methods, and tools for printed and flexible electronic systems.

Course Outcome:
On successful completion of this course, the students should be able to:

1. Understand the trends and technologies of flexible electronics and its road map.

2. Identify the materials used in the design and manufacturing of flexible electronic devices.

3. Recognize and introduce the various thin-film deposition techniques used in fabrication of Flexible and Printable electronics devices.

4. To provide an understanding of the structure and features of TFT devices.

5. Develop an ability to design a system, component, or process to meet desired needs using novel materials and devices.

Course Syllabus:

1 Motivation for study of organic and printed flexible electronics

2 Materials properties/synthesis of printable semiconductors:
Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, structure and property relationships, paper-based electronics,

textile substrates, barrier materials.

3 Thin-film Deposition and Processing Methods for Flexible: Devices CVD, PECVD, PVD, etching, photolithography, low-temperature process integration

4 Introduction: display and lighting technology, solar cells and sensors

5 Organic and Printable Flexible Electronics (Flexible displays technologies, Flat panel lighting technologies, Flexible solar cells and Flexible electronics for RF applications)

6 Thin Film Transistors: Thin Film Thin Film Transistors device structure and performance. Fundamental issues for low-temperature processing, Low temperature thin-film transistor Devices, Device structures and materials processing, Low-temperature a-Si:H and a-IGZO thin-film transistor device performance, I-V characteristics, device stability.

7 Organic sensors (bio & chemical): Organic material synthesis and Deposition techniques, challenges and road block in fabrication and development of flexible and organic electronics devices.

Reference Books:

Text / Reference book:

1. Wong, William S., Salleo, Alberto, Flexible Electronics: Materials and Application, https://doi.org/10.1007/978-0-387-74363-9.
2. Guozhen Shen and Zhiyong Fan, Editors, Flexible Electronics: From Materials to Devices, MRS Bulletin 41, 818–819 (2016). https://doi.org/10.1557/mrs.2016.227

Related Online Courses for Reference:

1. NPTEL course: Fundamentals Of Electronic Materials And Devices By Prof. Parasuraman Swaminathan | IIT Madras

Course Title and Code: Neuromorphic Engineering EE1226	
Hours per Week	**L-T-P: 3 1 0**
Credits	**4**
Students who can take	BCA VI sem
Prerequisite: None	
Weightage: Theory 70%, Assignment and Quiz 30%	

Course Objectives:

This course aims to provide an insight of neuromorphic electronic devices, circuits and system design.

1. Learn Ultra-low power computing electronics concepts mimicking computing by biological neurons.

2. Develop a grasp of different Design and simulation techniques of CMOS and nano electronic circuits modelling biological brain.

3. Understand Commercial neuromorphic systems and processors for machine learning applications.

4. Acquire a basic knowledge of Future Trends in neuromorphic engineering Technology, as well as the commercialization paths for new materials, methods, and tools for neuromorphic electronic systems design.

Course Outcome:
On successful completion of this course, the students should be able to:

1. Build power-saving hardware devices to analyse real-world noisy data utilizing brain-like mechanisms.
2. Identify and learn basic concepts and current trends in neuromorphic device, circuit, and system design.
3. Design, Develop and Document Analog and Digital neuromorphic systems.
4. Apply neuromorphic systems to develop new VLSI circuits and make report on the same.
5. The students will learn how electronics circuits mimic biological neurons, and will explore their novel variations in these circuits.

Course Syllabus:

1 Introduction to classic neuromorphic circuits. Signalling and operation of Biological neurons, neuron models, signal encoding and statistics; Synapses and plasticity rules, biological neural circuits.

2 MOSFETs for Neuromorphic electronics : FETs - device physics and sub-threshold circuits.

3 Analog and digital electronic neuron design.

4 Programmable Neuromorphic Circuits and Synapses: (Spiking Neural Network, Non-volatile memristive semiconductor devices; Electronic synapse design; Interconnection Networks; Interconnection schemes for large non-spiking and spiking neural networks).

5 Analog and Digital Neuromorphic Circuit and System Design: Analysis of design, architecture and performance characteristics of demonstrated chips employing Analog neuromorphic and Digital neuromorphic VLSI, Electronic synapses and other neuromorphic systems.

Reference Books:

1. Shih-Chii Liu, Jörg Kramer, Giacomo Indiveri, Tobias Delbrück, Rodney Douglas, Analog VLSI: circuits and principles, MIT press, 2002, ISBN 0262122553

2. Carver Mead, Analog VLSI and neural systems, Addison-Wesley, 1989, ISBN0201059924

3. Eric Kandel, James Schwartz, Thomas Jessell, Steven Siegelbaum, A.J. Hudspeth, Principles of neural science, McGraw Hill 2012, ISBN 0071390111

4. Dale Purves, Neuroscience, Sinauer, 2008, ISBN 0878936971

Online Courses for Reference:

1. EE 698P: Memory Technology and Neuromorphic Computing by Prof Shubham Sahay, IIT Kanpur available online at https://www.youtube.com/playlist?list=PLP-rjhz_nIi7vrSb2YyZaLvEMiLC7l26N