CHOICE BASED CREDIT SYSTEM

EVALUATION SCHEME

AND

COURSE OF STUDY

IN

B.TECH.

COMPUTER SCIENCE AND ENGINEERING

(V SEMESTER & VI SEMESTER)

SCHEME OF EXAMINATION & SYLLABUS

FACULTY OF ENGINEERING AND TECHNOLOGY

GURUKULA KANGRI DEEMED TO BE UNIVERSITY, HARIDWAR

(Effective from the academic session 2025-26)

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR

Faculty of Engineering & Technology

Computer Science & Engineering

B. Tech. Third Year

Syllabus in accordance with AICTE Model Curriculum

SEMESTER-V

DSC/SEC/DSE/AEC	SUBJECT	PERIODS			EVALUATION SCHEME				Subject Total	Credits
					SESSIONAL EVALUATION			EXAM		
		L	T	P	CT	TA	Total	ESE		
THEORY										
BCE-C521	Computer Network	3	1	0	20	10	30	70	100	4
BCE-C522	Advance Data Structure	3	1	0	20	10	30	70	100	4
BCE-C523	Design & Analysis of Algorithm	3	1	0	20	10	30	70	100	4
BCE-C524	Cloud Computing	3	1	0	20	10	30	70	100	4
BCE-M001	Universal Human Values	3	0	0	20	10	30	70	100	0
BCE-P5XX	Program Elective - I	3	0	0	20	10	30	70	100	3
BCE-O5XX	Open Elective - I	3	0	0	20	10	30	70	100	3
PRACTICAL										
BCE-C561	Advance Data Structure Lab	0	0	2	10	5	15	35	50	1
BCE-C562	Cloud Computing Lab	0	0	2	10	5	15	35	50	1
BCE-S570	Summer Training and Internship Program-II Presentation*	0	0	2	10	5	15	35	50	1
TOTAL		21	4	6	170	85	255	595	850	25

*****For the Summer Training and Internship program done in summer break after IV semester examination, A certificate of completion to be submitted along with the presentation in the department. In case a student is unable to do an internship in some company, he may do any one extra online skill enhancement course.

Program Elective – I

BCE-P515	Object Oriented Programming Using CPP
BCE-P516	Computer Graphics
BCE-P527	Machine Learning – I
BCE-P518	Software Engineering
BCE-P519	Data Analytics -1
BCE-P520	Complexity Theory

Open Elective Subject List -1

BCE-O530	Advance Operating System
BCE-O531	Functional Programming Principles with Scala
BET-O532	Signals and Systems
BCE-O533	Business Economics and Financial Analysis
BCE-O544	Introduction to AI
BCE-O535	Linux and Shell Programming

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Syllabus in accordance with AICTE Model Curriculum

SEMESTER-VI

DSC/SEC/DSE/AEC	SUBJECT	PERIODS			EVALUATION SCHEME				Subject Total	Credits
					SESSIONAL EVALUATION			EXAM ESE		
		L	T	P	CT	TA	Total			
THEORY										
BCE-C621	Distributed Systems	3	1	0	20	10	30	70	100	4
BCE-C625	Theory of Computation: Classical to Quantum Models	3	1	0	20	10	30	70	100	4
BET-C620	Embedded Systems and IoT Applications	3	1	0	20	10	30	70	100	4
BCE-M002	Intellectual Property Rights	3	0	0	20	10	30	70	100	3
BCE-P6XX	Program Elective – II	3	0	0	20	10	30	70	100	3
BCE-O6XX	Open Elective-II	3	0	0	20	10	30	70	100	3
BCE-S626	Introduction to Financial Investment	1	0	0	0	0	0	0	0	0
PRACTICAL										
BCE-C661	Distributed Systems Lab	0	0	2	10	5	15	35	50	1
BET-C662	Embedded Systems and IoT Applications Lab	0	0	2	10	5	15	35	50	1
BCE-P663	Project	0	0	2	10	5	15	35	50	1
BCE-S670	Seminar on Latest Technologies	0	0	2	10	5	15	35	50	1
TOTAL		19	3	8	160	80	240	560	800	25

Program Elective Subject List- II

BCE-P624	Machine Learning - 2
BCE-P615	Advance Database Management System
BCE-P616	Software Project Management
BET-P617	Digital Signal Processing
BCE-P618	High Performance Computer Architecture
BCE-P619	Full Stack Web Development
BCE-P620	Data Analytics -2
BCE-P621	Cyber Forensics
BCE-P622	Augmented Reality and Virtual Reality

Open Elective –II

BCE-O630	Applied AI
BET-O631	Digital Image Processing
BCE-O632	Industrial Economics and Business Administration
BCE-O633	Introduction to Data Science and Design Thinking
BCE-O634	Data Mining
BCE-O635	Natural Language Processing
BCE-O636	E-commerce & Social Media Analysis
BCE-O647	Java based Object Oriented Programming **
BCE-O667	Java based Object Oriented Programming lab**

Course Code: BCE-C521
Course Name: COMPUTER NETWORK

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	None
Objectives:	• To understand the protocol layering and physical level communication. • To analyze the performance of a network. • To understand the various components required to build different networks. • To learn the functions of network layer and the various routing protocols. • To familiarize the functions and protocols of the Transport layer

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Goals and Applications of Networks, Network structure and architecture, The Layered Architecture: Protocol Layering, The OSI Reference Model and the TCP/IP protocol stack,OSI vs TCP/IP model comparison, History of Computer Networking and the Internet, Network Topology, Physical Layer Transmission Media, Switching methods, Transmission modes. Transmission media: Guided media, Unguided media.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-2	**The Data Link Laye**r: Design Issues: Services provided to other Layer, framing, Error control, Flow control; Error detection and Correction; Data link control & protocols - Sliding window protocol, Using Go-Back n, Stop & Wait Protocol ARQ. The Medium Access Sub Layer; IEEE standard 802.3, 802.4, 802.5; CSMA.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**The Network Layer:** Network layer design issues, Shortest path routing, Routing algorithms: Distance Vector, Link State, Congestion control, IP addressing, IPv4 to IPv6, Fragmentation, Routing protocols: RIP,OSPF, BGP	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-4	**The Transport Layer**: QOS, the transport service; Transport protocols: Addressing, Establishing and releasing a connection; TCP/UDP header. Session Layer-RPC, Synchronization, dialog management.	**08**	PO1/ PO2/ PO3/ PO5	PSO1/ PSO2
Module-5	**The Application Layer:** Network Security, FTP, SNMP, Telnet, E- mail, WWW, DNS, SMTP. Presentation Layer: ASN, data compression, encryption. Multimedia Networking: Introduction, Streaming Stored Audio and Video, Real Time Streaming Protocol (RTSP), Protocols for Real Time Interactive Applications: RTP, RTCP, SIP, H.323; Providing multiple classes of service.	**08**	PO1/ PO4/ PO5	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Understand OSI and TCP/IP models ● Analyze MAC layer protocols and LAN technologies ● Design applications using internet protocols ● Understand routing and congestion control algorithms ● Understand how the internet works

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Andrew S. Tanenbaum (3/e), Computer Networks, PHI
2.	Frouzan , Data Communications & Networking(3/e, 4/e)
3.	W.Stallings (5/e), Data and Computer Communications, PHI
4.	Douglas E.Comer (3/e), Interworking with TCP/IP,Principles, Protocols & Architecture
5.	AnuranjanMisra, "Computer Networks", Acme Learning
6.	G. Shanmugarathinam, "Essential of TCP/ IP", Firewall Media

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	√	√	√	√									√	√
CO2	√	√	√	√									√	√
CO3	√	√	√										√	√
CO4	√	√	√	√	√								√	√
CO5	√	√	√		√								√	√

Course Code: BCE-C522
Course Name: ADVANCE DATA STRUCTURES

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	Knowledge of Data Structures
Objectives:	• To ensure that the student evolves into a competent programmer. • To inculcate the capability of designing and analyzing implementations of algorithms and data structures. • To enhance the problem-solving approach of the student. • To expose the student to the algorithm analysis techniques, • To understand the theory of reductions, and to the classification of problems into complexity classes like NP.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Advanced Trees:** Threaded Binary trees, Traversing Threaded Binary trees, recursive and non-recursive traversal of binary tree, Efficient non recursive tree traversal algorithms, B+ Tree, B* Tree, Weight Balanced Trees (Huffman Trees)	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Search Trees:**2-3 Trees, Searching, Inserting, deleting of an Element in a 2-3 Tree, 2-3-4 Trees, Red-Black Trees, Properties of red-black trees, Rotations, Insertion, Deletion, Augmenting Red-Black Trees to Dynamic Order Statics and **Interval Tree**: Elementary intervals, Applications, Operations on Disjoint sets and its union-find problem Implementing Sets. Dictionaries.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**Advance Graphs:** Representation of graph - Graph Traversals - Depth-first and breadth-first traversal, Applications of graphs, Definitions of Isomorphism Components, Circuits, Fundamental Circuits. CutVertices Planer and Dual graphs, Spanning Trees, Strongly Connected Components and Articulation Point	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	**Graph Theory Algorithms:** Algorithms for Connectedness, Spanning Trees and Planarity Testing Breadth First and Depth First Search, Topological Sort, Bellman-Ford algorithm, Floyd's Algorithm, network flow problems, Min-Cut Max-Flow theorem of Network Flows. Ford-Fulkerson Max Flow Algorithms.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-5	**Pattern matching and Tries:** Pattern matching algorithms-Brute force, the Boyer –Moore algorithm, the Knuth-Morris-Pratt algorithm, Standard Tries, Compressed Tries, Suffix tries. **Application of Pattern Matching:** Social Network Analysis, Search Engine Working and Concepts, Search and find operations using string processing and Data Analytics.	**08**	PO1/ PO2/ PO4/P O5	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Design and analyze programming problem statements. ● Choose appropriate data structures and algorithms, understand the adt/libraries, and use it to design algorithms for a specific problem. ● Understand the necessary mathematical abstraction to solve problems. ● Come up with analysis of efficiency and proofs of correctness. ● Comprehend and select algorithm design approaches in a problem specific manner.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Introduction to Algorithms, by T. H. Cormen, C. E. Lieserson, R. L. Rivest, and C. Stein, Third Edition, MIT Press.
2.	Data structures and algorithms in C++(Java): Adam Drozdek
3.	Data structures and algorithms: Aho, Hopcroft and Ullman
4.	Anany Levitin "Introduction to the Design and Analysis of Algorithms" Pearson Education, 2015
5.	E. Horowitz, S.Sahni and Dinesh Mehta, "Fundamentals of Data structures in C++", University Press, 2007
6.	E. Horowitz, S. Sahni and S. Rajasekaran, "Computer Algorithms/C++", Second Edition, University Press, 2007

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√										√	√
CO4	√	√	√	√	√								√	√
CO5	√	√	√		√								√	√

Course Code: BCE-C523
Course Name: DESIGN AND ANALYSIS OF ALGORITHM

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	Basic knowledge of data structure
Objectives:	• Analyze the asymptotic performance of algorithms. • Write rigorous correctness proofs for algorithms. • Demonstrate a familiarity with major algorithms and data structures. • Apply important algorithmic design paradigms and methods of analysis. • Synthesize efficient algorithms in common engineering design situations.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction:** Definition and characteristics of Algorithms; Analyzing algorithms; Program performance: time and space complexity, Asymptotic notation, complexity analysis. Recurrence equations and their solutions.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Sorting and order Statistics** Heap sort, Quick sort, Sorting in Linear time, Medians and Order Statistics. **Advanced Data Structure**: Red-Black Trees, Augmenting Data Structure. BTrees, Binomial Heaps, Fibonacci Heaps, Data Stricture for Disjoint Sets.	**08**	PO1/ PO2	PSO1/ PSO2
Module-3	**Dynamic Programming** with Examples Such as Knapsack. All Pair Shortest Paths – Warshal's and Floyd's Algorithms, Resource Allocation Problem. Backtracking, Branch and Bound with Examples Such as Travelling Salesman Problem, Graph Coloring, n-Queen Problem, Hamiltonian Cycles and Sum of Subsets.	**08**	PO1/ PO2	PSO1/ PSO2
Module-4	**Divide and Conquer** with Examples Such as Sorting, Matrix Multiplication, Convex Hull and Searching. Greedy Methods with Examples Such as Optimal Reliability Allocation, Knapsack, **Minimum Spanning Trees** – Prim's and Kruskal's Algorithms, Single Source Shortest Paths - Dijkstra's and Bellman Ford Algorithms.	**08**	PO1/ PO2/ PO3/PO 4	PSO1/ PSO2
Module-5	**Infeasibility:** P and NP classes; NP-hard problems Parallel algorithms: Introduction, data and control parallelism, parallel algorithms for matrix multiplication; embedding of problems graphs into processor graphs, load balancing and scheduling problems.	**08**	PO1/ PO2	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand basic techniques for designing algorithms, including the techniques of recursion, divide-and-conquer, and greedy. • Design new algorithms, prove them correct, and analyze their asymptotic and

	absolute runtime and memory demands. • Apply classical sorting, searching, optimization and graph algorithms. • Explain the major graph algorithms and their analyses. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them. • Analyze randomized algorithms. Employ indicator random variables and linearity of expectation to perform the analyses. Recite analyses of algorithms that employ this method of analysis.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Sahni S, Data structures, Algorithms and applications in C++, McGraw Hill
2.	Aho, A.V., Hopcroft, J.E. & Ullman, J.D, The Design and Analysis of Computer algorithms, PHI
3.	Mchugh J.A., Algorithmic Graph Theory, PHI
4.	Quinn M.J., Parallel Computing Theory & Practice, McGraw Hill
5.	Goodman, S.E. &Hedetniemi, Introduction to the Design and Analysis of Algorithms, McGraw Hill

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√										√	√
CO4	√	√	√	√								√	√	√
CO5	√	√	√									√	√	√

Course Code: BCE-C524
Course Name: CLOUD COMPUTING

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	Discrete Mathematics, Computer Networks
Objectives:	• To understand the concepts of Cloud Computing. • To learn Taxonomy of Virtualization Techniques. • To learn Cloud Computing Architecture. • To acquire knowledge on Aneka Cloud Application Platform. • To learn Industry Cloud Platforms.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Overview of cloud computing:** What is a cloud, Definition of cloud, Characteristics of cloud, why use clouds, How clouds are changing, Driving factors towards cloud, Comparing grid with cloud, Public clouds (commercial), **Cloud Service Models** (IaaS, PaaS, SaaS – Overview)	**08**	PO1	PSO1/ PSO2
Module-2	**Cloud computing concepts:** Concepts of cloud computing, Cloud computing leverages the Internet, Positioning cloud to a grid infrastructure, Elasticity and scalability, Virtualization, Characteristics of virtualization, Benefits of virtualization, Virtualization in cloud computing, Hypervisors, Multitenancy, Types of tenancy, Application programming interfaces (API), Billing and metering of services, Management, tooling, and automation in cloud computing.	**08**	PO1/ PO2	PSO1
Module-3	**Cloud service delivery:** Cloud service , Cloud service model architectures, Infrastructure as a service (IaaS) architecture , Infrastructure as a service (IaaS) details, Platform as a service (PaaS) architecture, Platform as a service (PaaS) details, Platform as a service (PaaS) , Examples of PaaS software, Software as a service (SaaS) architecture, Software as a service (SaaS) details,Function as a Service (FaaS) / Serverless Computing,Container as a Service (CaaS),AI as a Service (AIaaS) and ML as a Service (MLaaS),Backup as a Service (BaaS) , Examples of SaaS applications , Trade-off in cost to install versus , Common cloud management platform reference architecture: Architecture overview diagram, Common cloud management platform, Database as a Service - Monitoring as a Service – Communication as services.	**08**	PO2/ PO3	PSO1/ PSO2
Module-4	**Cloud deployment scenarios:** Cloud deployment models, Public clouds, Hybrid clouds, Community, Virtual private clouds, Vertical and special purpose, Migration paths for cloud, Selection criteria for cloud deployment, Case study example: AWS Platform.	**08**	PO3/ PO5/ PO12	PSO1/ PSO2

	Virtualization For Cloud Need for Virtualization – Pros and cons of Virtualization – Types of Virtualization – System Vm, Process VM, Virtual Machine monitor – Virtual machine properties - Interpretation and binary translation, HLL VM - Hypervisors – Xen, KVM , VMWare, Virtual Box, Hyper-V.			
Module-5	**Security in cloud computing:** Cloud security reference model, How security gets integrated, Cloud security, Understanding security risks, Principal security dangers to cloud computing, Data corruption or loss, User account and service hijacking, Steps to reduce cloud security breaches. Classification of Cloud Implementations: Amazon Web Services, The Elastic Compute Cloud (EC2). The Simple Storage Service (S3),AWS Lambda (Serverless), AWS RDS (Relational Database Service, The Simple Queuing Services (SQS), Google AppEngine - PaaS, Windows Azure; Aneka, Hadoop,IBM Cloud,Oracle Cloud, Alibaba Cloud, A Comparison of Cloud Computing Platforms.	**08**	PO1/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand the concept of virtualization and how this has enabled the development of Cloud Computing • Know the fundamentals of cloud, cloud Architectures and types of services in cloud • Understand scaling, cloud security and disaster management • Design different Applications in cloud • Ability to use AWS/IBM Cloud/Google cloud

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Practices and Paradigms in Cloud Computing, RajKumarBuyya
2.	IBM , Handouts
3.	Michael Miller, Cloud Computing (1 ed.), Que Publishing, 2008. ISBN 978-0789738035.
4.	Cloud Computing, Publisher: Jones and Barret India, Author : Kris Jasm
5.	Anthony Velte, Toby Velte and Robert Elsenpeter, Cloud Computing: A practical Approach (1 ed.), Tata McGrawHill, 2009. ISBN 978-0070683518.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√										√	√
CO4	√	√										√	√	√
CO5	√	√	√		√							√	√	√

Course Code: BCE-S626
Course Name: Introduction to Financial Investment

MM: 100 **Time: 3 Hr.** **L T P** **1 0 0**	**Sessional:0** **ESE:0** **Credit :0**

Prerequisites:	Basic understanding of mathematics and logical reasoning. No prior knowledge of finance is required.
Objectives:	To equip Computer Science students with foundational knowledge of finance and financial instruments, enabling them to make informed financial decisions and understand how technology intersects with finance.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction to Finance :** Importance of financial literacy for engineers, Time Value of Money: Simple and Compound Interest, Financial goals: Short-term vs Long-term, Overview of financial system: Banks, NBFCs, FinTech, Basics of Income Statement, Balance Sheet, and Cash Flow, Classification of assets: Investment assets vs Expense assets, Concept of appreciating vs depreciating assets with examples (e.g., car vs rental property)	**08**	PO1	PSO1/ PSO2
Module-2	**Understanding Stocks:** What is a stock? Types: Common vs Preferredm Stock exchanges: NSE, BSE, NYSE, How to invest in stocks: Demat accounts, brokers, IPOs and how companies raise capital, Reading stock charts and basic indicators, Risks and returns in stock market, Introduction to Stock Market Indices: NIFTY, Sensex; Role of indices in tracking market performance; Sectoral indices: NIFTY IT, NIFTY Bank, etc.	**08**	PO1/ PO2	PSO1
Module-3	**Mutual Funds**: What are mutual funds? Types: Equity, Debt, Hybrid; SIP vs Lump sum investment; NAV, expense ratio, and returns; How to invest in mutual funds: Apps and platforms; Role of fund managers and AMC; Comparison with direct stock investment	**08**	PO2/ PO3	PSO1/ PSO2
Module-4	**Bonds and Fixed Deposits:** Bonds- Government vs Corporate bonds, Concepts of coupon rate, maturity, and yield; Fixed Deposits: Bank FDs, company FDs; Taxation on interest income; Risks associated with fixed-income instruments; When to choose bonds/FDs over equity	**08**	PO3/ PO5/ PO12	PSO1/ PSO2
Module-5	**Investing in Real Estate:**Real estate as a financial asset; Residential vs Commercial properties; Real Estate Investment Trusts (REITs); Loan concepts: Home loan, EMI, interest rates; Stamp duty, registration, and tax benefits; Risks and rewards in property investment	**08**	PO1/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand and explain the importance of financial literacy in daily life and professional growth. • Analyze and compare different financial instruments including stocks, mutual funds, bonds, and FDs. • Apply basic concepts of financial planning, such as time value of money and asset classification. • Evaluate investment opportunities and make recommendations based on risk and return. • Demonstrate basic knowledge of market indices such as NIFTY and their significance in tracking performance.

Assessment

- Weekly quizzes/unit tests
- Group discussion on latest market trends
- Mini project: Virtual portfolio management or investment analysis
- Final Viva or Case Study presentation

Course Code: BCE-M001
Course Name: UNIVERSAL HUMAN VALUES

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :0**

Prerequisites:	None
Objectives:	• Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. • Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence. • Strengthening of self-reflection. • Development of commitment and courage to act.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Course Introduction** - Need, Basic Guidelines, Content and Process for Value Education. Purpose and motivation for the course, recapitulation from Universal Human Values-I Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Priority Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Understanding Harmony in the Human Being** - Harmony in Myself**,**Understanding human being as a co-existence of the sentient 'I'& the Material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.	**08**	PO1/ PO2/ PO3/ PO12	PSO1/ PSO2

Module-3	**Understanding Harmony in the Family and Society-** Harmony in Human- Human RelationshipUnderstanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention & competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.	**08**	PO1/ PO2/ PO3/	PSO1/ PSO2
Module-4	**Understanding Harmony in Nature and Existence -** Whole existence as Coexistence. Understanding the harmony in Nature, Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature. Understanding Existence as Coexistence of mutually interacting units in all- pervasive space. Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.	**08**	PO1/ PO2/	PSO1/ PSO2
Module-5	**Implications of the above Holistic Understanding of Harmony on Professional Ethics** Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: At the level of individuals: as socially and ecologically responsible engineers, technologists and managers. At the level of society: as mutually enriching institutions and organizations. Sum up Include practice Exercises and CaseStudies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature). ● They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). ● It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. ● This is only an introductory foundational input. It would be desirable to follow it up by o faculty-student or mentor-mentee programs throughout their time with the institution. o Higher level courses on human values in every aspect of living. E.g. as a professional.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, 2010
2.	JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
3.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4.	The Story of Stuff (Book).
5.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6.	Small is Beautiful - E. F Schumacher.
7.	Slow is Beautiful - Cecile Andrews
8.	Economy of Permanence - J C Kumarappa
9.	Bharat Mein Angreji Raj – PanditSunderlal
10.	Rediscovering India - by Dharampal
11.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12.	India Wins Freedom - Maulana Abdul Kalam Azad
13.	Vivekananda - Romain Rolland (English)
14.	Gandhi - Romain Rolland (English)

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√										√	√	√
CO2	√	√	√									√	√	√
CO3	√	√	√										√	√
CO4	√	√											√	√

Course Code: BCE-C561
Course Name: Advance Data Structure Lab

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	• *To demonstrate the Graph and Tree traversal techniques*. • To make students to learn the concepts of iterative and recursive algorithms • To enable the student to learn about different type of trees

NOTE:	1. In practical examination the student shall be required to perform one experiment. 2. A teacher shall be assigned 20 students for daily practical work in laboratory. 3. No batch for practical class shall consist of more than 20 students. 4. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students. 5. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean

LIST OF EXPERIMENTS	No. of Hours	POs mapped	PSOs mapped
1. Implementation of Weighted Balanced Trees. 2. Implementation of Red-Black Tree. 3. Implementation of Threaded Binary Tree and their Traversal. 4. Implementation of Priority Queue. 5. Implementation of Heap Tree. 6. Implementation of Graphs. 7. Implementation of Depth First Search. 8. Implementation of Breadth First Search. 9. Implementation of Hashing. 10. Graph Implementation Min. cost spanning tree, shortest path algorithm.	**03**	PO1/ PO2/ PO3/ PO4/ PO5/ PO12	PSO1/ PSO2

Learning Outcomes:	• Construct Weighted Balanced Trees, Red-Black Tree, heap tree via program • Develop threaded Binary Tree and their Traversal via program • Illustrate the concept of priority queue via program • Apply Depth First Search and Breadth First Search using graph implementation • Find Min. cost spanning tree, shortest path algorithm using graph via program

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√										√	√
CO4	√	√		√								√	√	√
CO5	√	√	√	√	√							√	√	√

Course Code: BCE-C562
Course Name: CLOUD COMPUTING LAB

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	• To develop web applications in cloud • To learn the design and development process involved in creating a cloud-based application

NOTE:	1. In practical examination the student shall be required to perform one experiment. 2. A teacher shall be assigned 20 students for daily practical work in the laboratory. 3. No batch for practical class shall consist of more than 20 students. 4. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students. 5. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean.

LIST OF EXPERIMENTS	**No. of Hours**	**POs mapped**	**PSOs mapped**
1.How to create a Virtual Machine on AWS cloud using EC2 service. 2.How to download and install applications on VM. 3.How to train a model using amazon sage maker in Machine Learning on AWS. 4.How to Deploy code on AWS. 5.How to deploy a static website by using the S3 service of AWS. 6.Create a chatbot using AWS services. 7.How to create users and roles in IAM services. 8.How to change policies in S3 Bucket services. 9.How to deploy serverless applications on Lambda by using serverless architecture. 10. How to download VMWare Workstation and install a VM on it.	**03**	PO1/ PO2/ PO3/ PO4/ PO5/ PO12	PSO1/ PSO2

Learning Outcomes:	• Apply the steps and procedures to create a Virtual Machine on AWS EC2 • Identify and select appropriate AWS services for building a chatbot • Utilize IAM services to create and manage user accounts and groups • Utilize AWS Lambda to develop and deploy serverless applications • Configure and create a Virtual Machine using VMWare Workstation

CO-PO/PSO MAPPING

Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√		√								√	√
CO4	√	√		√	√							√	√	√
CO5	√	√	√	√	√							√	√	√

Course Code: BCE-S570
Course Name: SUMMER TRAINING AND INTERNSHIP PROGRAM-II PRESENTATION

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	• The objective of the summer training and internship program on recent/ latest technologies is to make students acquire knowledge of latest technologies and also to work under the guidance of industry professionals. • Students will develop presentation, listening and communication skills. • Students will develop Argumentative Skills and Critical Thinking.

PRESENTATION DETAILS	**No. of Hours**	**POs mapped**	**PSOs mapped**
The presentation will be held for the Summer Training and Internship program done in summer break on recent/ latest technologies after IV semester examination, a certificate of completion to be submitted along with the presentation in the department. In case, any student is unable to do an internship in some company, he is allowed to do any one extra online skill enhancement course, for which the course completion certificate along with the presentation has to be submitted in the department.	**03**	PO1/ PO2/ PO3/ PO5/ PO12	PSO1/ PSO2

Learning Outcomes:	• Students will gain knowledge of the current and upcoming technologies. • Students will be able to look into the working environment in the industry. • Students will develop better communication skills and critical thinking.

Suggested books:

S. No.	**Name of Authors /Books /Publisher/Year**
1.	Ford, Neal, Matthew McCullough and Nathaniel Schutta, Presentation patterns: Techniques for crafting better presentations (1 ed.), Addison- Wesley, 2012. ISBN 978-0321820808.

CO-PO/PSO MAPPING

Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√									√	√	√
CO3	√	√	√		√							√	√	√

Program Elective - I

BCE-P515	Object Oriented Programming Using CPP
BCE-P516	Computer Graphics
BCE-P527	Machine Learning – I
BCE-P518	Software Engineering
BCE-P519	Data Analytics -1

Course Code: BCE-P515
Course Name: OBJECT ORIENTED PROGRAMMING USING CPP

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic knowledge of programming.
Objectives:	● Introduction to Object oriented Paradigm ● Features of object-oriented programming, class and object: state, identity, and behavior ● Data Abstraction and Data Hiding ● Encapsulation, Inheritance and polymorphism. ● Inheritance in OO design. ● Implementing OO language features. ● Memory management. ● Generic types and collections

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction:** Review of C, Difference between C and C++, Cin, Cout, new, delete operators, abstraction, encapsulation, inheritance, polymorphism, Structured versus object-oriented development, elements of object-oriented programming. **Class Overview:** Class specification, class objects, accessing class members, defining member functions, outside member functions as inline, accessing member functions within a class, data hiding, access boundary of objects revisited, empty classes, pointers within a class, passing objects as arguments, returning objects from functions, friend functions and friend classes, constant parameters and member functions, structures and classes, static data and member functions, class, objects and memory resource, class design steps.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Object Initialization and Cleanup:** Class revisited, constructors, parameterized constructors, destructor, constructor overloading, order of construction and destruction, constructors with default arguments, copy constructor, static data members with constructors and destructors. **Operator Overloading:** Introduction, over loadable operators, unary operator overloading, operator keyword, operator return values, limitations of increment/decrement operators, binary operator overloading, arithmetic operators, data conversion, conversion between basic data types, conversion between objects and basic types, conversion between objects of different classes, overloading with friend functions.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**Inheritance :** Introduction, class revised, derived class declaration, forms of inheritance, inheritance and member accessibility, constructors in derived classes, destructors in derived classes, constructors invocation and data members initialization, overloaded member	**08**	PO1/ PO2/ PO3/ PO5	PSO1/ PSO2

	functions, multilevel inheritance, multiple inheritance, hierarchical inheritance, multipath inheritance and virtual base classes, hybrid inheritance.			
Module-4	**Virtual Functions and Classes:** Introduction, need for virtual functions, static and dynamic binding, pointer to derived class objects, definition of virtual functions, pure virtual functions, abstract classes, virtual destructors. **Generic Programming with Templates:** Introduction, function templates, overloaded function templates, multiple argument's function templates, user defined template arguments, class templates	**08**	PO1/ PO2/ PO4/ PO5/ PO12	PSO1/ PSO2
Module-5	**Stream Computation with Files:** Introduction, hierarchy of file stream classes, opening and closing of files, file modes, file pointers, sequential access to a file, saving and retrieving of objects, file input/output with stream class. **Exception Handling:** Introduction, error handling, exception handling model, exception handling constructs.	**08**	PO1/ PO2/ PO3/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	CO1. Remembering (Knowledge) Define key OOP concepts, including classes, objects, inheritance, and polymorphism. Recall the syntax and basic rules of C++ for OOP.List the fundamental data types in C++. Memorize the basic C++ operators used in object-oriented programming. CO2. Understanding (Comprehension) Explain the concept of encapsulation and its benefits in OOP. Describe the difference between a class and an object. Compare and contrast inheritance and composition in C++. Interpret and explain code examples that involve OOP principles. Illustrate the concept of dynamic memory allocation in C++. CO3. Applying (Application) Develop C++ programs that utilize classes and objects to model real-world entities. Implement inheritance hierarchies to model relationships between classes. Create polymorphic functions and use them in practical programming scenarios. Solve problems using object-oriented design principles. Apply access specifiers (public, private, protected) to control class member visibility and access. CO4. Analyzing (Analysis) Evaluate and critique code for adherence to OOP principles. Analyze and debug C++ programs involving inheritance-related issues. Identify and resolve design flaws in class hierarchies. CO5 Creating (Evaluation) Develop a C++ application that demonstrates a deep understanding of inheritance, polymorphism, and encapsulation.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	E.Balagurusamy, Object Oriented Programming with C++, TMH
2.	R.Lafore, Object Oriented Programming using C++, Galgotia
3.	S.B.Lippman&J.Lajoie, C++ Primer, Addison Wesley
4.	G.Booch, Object Oriented Design & Applications, PHI

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√		√								√	√
CO4	√	√		√	√							√	√	√
CO5	√	√	√									√	√	√

Course Code: BCE-P516
Course Name: COMPUTER GRAPHICS

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	C, C++, Linear algebra, Matrices
Objectives:	● To understand about the different graphics display units. ● To study about the scan line and circle drawing algorithms. ● To learn about the various 2D and 3D transformations. ● To introduce the various hidden surface elimination algorithms. ● To study about the various color models used in computer graphics.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction:** Graphic displays: Random scan displays, raster scan displays, Frame buffer and video controller, points and lines, Raster and Random Scan-Line and circle drawing algorithms-Polygon filling.	**08**	PO1/ PO2/	PSO1/ PSO2
Module-2	**2D Geometric Transformations:** 2D Viewing – Window-Viewport Transformation - Two dimensional Geometric transformations – Line, Polygon, Curve and Text clipping algorithms.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**3D Geometric Transformations:** Need for 3-Dimensional Imaging, Techniques for 3-Dimesional displaying, Parallel Projections, Perspective projection, Splines, viewing.	**08**	PO1/ PO2/ PO3/ PO4/ PO5	PSO1/ PSO2
Module-4	**Hidden Surface Elimination:** Hidden line elimination-Hidden surface elimination-Painter's algorithm- Scan the algorithm-Octree method-Z- buffer-Ray tracing.	**08**	PO1/ PO2/ PO4/ PO12	PSO1/ PSO2
Module-5	**Color Models:** Chromaticity diagram-RGB, CMY, HSV, HLS, CIE models-Realism in rendering, halving-Illumination and shading-Gouraud and Phong shading	**08**	PO1/ PO2/ PO3/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand the basics of computer graphics, different graphics systems and applications of computer graphics. • Discuss various algorithms for scan conversion and filling of basic objects and their comparative analysis. • Use of geometric transformations on graphics objects and their application in composite form. • Explore projections and visible surface detection techniques for display of 3D scene on 2D screen. • Explore about Shading: illumination and surface modeling, Phong shading model, polygon shading.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Hearn D and Baker M.P., Computer Graphics, Second Edition, PHI.
2.	Foley J.D., Van Dam A, Fiener S.K. and Hughes J.F., Computer Graphics, Addison Wesley.
3.	Newman W.M. and Sproull R.F., Principles of Interactive Computer Graphics, Tata McGraw Hill Publishing Company Limited.
4.	Hughes, Van Dam, et al. Computer Graphics Principles and Practice 3e, Pearson, 2014.
5.	P Shirley, Fundamentals of Computer Graphics, 2e, AK Peters, 2005.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√	√	√								√	√
CO4	√	√		√								√	√	√
CO5	√	√	√									√	√	√

Course Code: BCE-P527
Course Name: MACHINE LEARNING – I

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Understanding ofBasic Programming Concept and Mathematics (probability and statistics).
Objectives:	● To learn the fundamentals of Machine Learning. ● To understand basic component of an intelligence system. ● To explore applications of machine learning. ● To understand different types of machine learning algorithms and tools. ● To learn how to use machine learning model to solve real world problem.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction to Machine Learning** Definition and types of learning: supervised, unsupervised, semi-supervised, reinforcement, Applications of ML (heathcare, finance etc) in real-world scenarios. **Tools, Framework, Libraries for ML:**Numpy, Pandas, Scikit-learn, matplotlib, jupyter notebook, google colab, Keras, Pytorch	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-2	Basic concept of Probability theory and Linear Algebra, Bias, Variance, Bias-Variance trade-off, overfitting and underfitting. Pre-processing of data - Data cleaning, wrangling and filtering, Handling missing and categorical data, Data scaling, Feature extraction and selection, covariance matrix, Dimensionality Reduction, Train-Test splitting strategy, Training Set, Validation Set, Test Set, Importance of cross validation – Holdout Method and K-fold cross validation.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	Introduction to performance metrics for Machine Learning Algorithm – Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Confusion Matrix, Classification Accuracy, Classification Report (Precision, Recall/Sensitivity, Specificity, F1-Score, Area Under ROC curve).	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	Introduction to Linear Regression, cost Function and its intuition, Gradient Descent, simple linear regression, multivariate linear regression, Regularization, Model Evaluation. Real world case-study (House price prediction, Startup Profit predication, student performance prediction etc).	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-5	. Introduction to classification problems and Types of classification - Binary Classification, Multi-Class Classification, Imbalanced Classification, Introduction to Logistic Regression (with Sigmoid Function) Real-world applications case study (Spam Detection, Medical Diagnosis, Fraud Detection, Digit Recognition,	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2

	Animal Species Classification)			
Total No. of Hours		**40**		

Learning Outcomes:	• List various approaches of Machine Learning. • Describe machine learning algorithms to solve the real-world problems. • Develop Hypothesis and machine learning models. • Identify appropriate models for solving machine learning problems. • Apply learning techniques to solve real world machine learning problems.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Introduction to Machine Learning, Alpaydin, E., MIT Press, 2004.
2.	Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller and Sarah Guido, O'Reilly, 2016.
3.	Elements of Machine Learning, Pat Langley Morgan Kaufmann Publishers, Inc. 1995.
4.	The elements of statistical learning, Friedman, Springer series in statistics, 2001.
5.	The Hundred-page Machine Learning Book, AndriyBurkov, 2019
6.	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, AurelienGeron, O'Reilly, 2017.
7.	Introduction to Machine Learning, Alpaydin, E., MIT Press, 2004.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	√	√	√	√									√	√
CO2	√	√	√	√									√	√
CO3	√	√	√										√	√
CO4	√	√	√	√									√	√
CO5	√	√	√										√	√

Course Code: BCE-P518
Course Name: SOFTWARE ENGINEERING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	None
Objectives:	● To meet the Computer Science Program Objectives. ● To understand principles, concepts, methods, and techniques of the software engineering approach to producing quality software (particularly for large, complex systems). ● To organize and manage a medium-sized software development project, including project plans and documentation, schedule and cost estimates, and quality assurance activities. ● To think critically about ethical and social issues in software engineering.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction:** Introduction to software Engineering, Software characteristics, Software components, Software applications, Software Engineering Principles, Software metrics and measurement, monitoring and control. Software development life-cycle, Water fall model, prototyping model, Incremental model, Iterative enhancement Model, Spiral model.	**08**	PO1/ PO2/	PSO1/ PSO2
Module-2	**Software Requirement Specification:** Requirements Elicitation Techniques, Requirement's analysis, Models for Requirements analysis, requirements specification, requirements validation. **System Design:** Design Principles: Problem partitioning, abstraction. Top down and bottom up – design, structured approach. Functional versus object-oriented approach of design, design specification, Cohesiveness and Coupling. Overview of SA/SD Methodology, structured analysis, data flow diagrams, extending DFD to structure chart.	**08**	PO1/ PO2	PSO1/ PSO2
Module-3	**Software project Management:** Project planning and Project scheduling. Software Metrics: Size Metrics like LOC, Token Count, Function Count. Cost estimation using models like COCOMO. Risk management activities. Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, ISO 9000 certification for software industry, SEI capability maturity model.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	**Testing:** Verification and validation, code inspection, test plan, test case specification. Level of testing: Unit, Integration Testing, Top down and bottom-up integration testing, Alpha and Beta testing, System testing and debugging. functional testing, structural testing, Software testing strategies.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2

Module-5	**Software Maintenance**: Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand design process. • Implement large programs of greater than 2.5k lines of code • Design and execute tests to identify software bugs • Repair software bugs, redesigning and refactoring code when necessary • Utilize, analyze, and critique code written by others

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	R. S. Pressman, "Software Engineering – A practitioner's approach", 3rd ed., McGraw Hill Int. Ed..
2.	K. K. Aggarwal &Yogesh Singh, "Software Engineering", 2ndEd.,
3.	New Age International Sommerville, "Software Engineering", Addison Wesley.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	√	√	√	√									√	√
CO2	√	√											√	√
CO3	√	√	√										√	√
CO4	√	√	√	√									√	√
CO5	√	√	√										√	√

Course Code: BCE-P519
Course Name: DATA ANALYTICS-1

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic knowledge of data structure
Objectives:	● To provide an overview of an exciting growing field of big data analytics. ● To introduce the tools required to manage and analyze big data like Hadoop, NoSqlMapReduce. ● To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability. ● To enable students to have skills that will help them to solve complex real-world problems in for decision support.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction to Data Analytics:** Sources and nature of data, classification of data (structured, semi-structured, unstructured), characteristics of data, introduction to Big Data platform, need of data analytics, evolution of analytic scalability, analytic process and tools, analysis vs reporting, modern data analytic tools, applications of data analytics. Data Analytics Lifecycle**.**	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Data Analysis:** Regression modelling, multivariate analysis, Bayesian modelling, inference and Bayesian networks, support vector and kernel methods, analysis of time series: linear systems analysis & nonlinear dynamics, rule induction	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**Neural Networks:** Learning and Generalisation, competitive learning, principal component analysis and neural networks, fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, stochastic variables and search methods.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-4	**Mining Data Streams:** Introduction to streams concepts, stream data model and architecture, stream computing, sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting oneness in a window, decaying window, Real-time Analytics Platform (RTAP) applications.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-5	**Frequent Itemsets and Clustering:** Mining frequent itemsets, market-based modelling, Apriori algorithm, handling large data sets in main memory, limited pass algorithm, clustering techniques: hierarchical, K-means, clustering high dimensional data, CLIQUE and ProCLUS, frequent pattern-based clustering methods, clustering in non-euclidean space, clustering for streams and parallelism.	**08**	PO1/ PO2/ PO3/ PO5/ PO6	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Describe the life cycle phases of Data Analytics through discovery, planning and building. • Learn various Data Analysis Techniques. • Implement various Data streams. • Understand item sets, Clustering, frame works & Visualizations. • Apply R tool for developing real time applications.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press.
2.	Bill Franks, Taming the Big Data Tidal wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & Sons.
3.	Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
4.	David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big Data Analytics”, EMC Education Series, John Wiley
5.	Frank J Ohlhorst, “Big Data Analytics: Turning Big Data into Big Money”, Wiley and SAS Business Series
6.	Michael Berthold, David J. Hand,” Intelligent Data Analysis”, Springer
7.	Paul Zikopoulos, Chris Eaton, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw Hill.
8.	Mark Gardner, “Beginning R: The Statistical Programming Language”, Wrox Publication.
9.	Pete Warden, Big Data Glossary, O’Reilly.
10.	Glenn J. Myatt, Making Sense of Data, John Wiley & Sons.
11.	Peter Bühlmann, PetrosDrineas, Michael Kane, Mark van der Laan, "Handbook of Big Data", CRC Press.
12.	Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer.
13.	Colleen Mccue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Elsevier.
14.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer.
15.	Jiawei Han, MichelineKamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	√	√	√	√									√	√
CO2	√	√											√	√
CO3	√	√	√										√	√
CO4	√	√	√	√									√	√
CO5	√	√	√		√	√							√	√

Open Elective Subject List -1

BCE-O530	Advance Operating System
BCE-O531	Functional Programming Principles with Scala
BET-O532	Signals and Systems
BCE-O533	Business Economics and Financial Analysis
BCE-O534	Introduction to AI
BCE-0535	Linux and Shell Programming

Course Code: BCE-O530
Course Name: ADVANCE OPERATING SYSTEM

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Concept of Operating System
Objectives:	● To learn the fundamentals of Operating Systems ● To gain knowledge on Distributed operating system concepts that includes architecture, Mutual exclusion algorithms, Deadlock detection algorithms and agreement protocols ● To gain insight on the distributed resource management components viz. the algorithms for implementation of distributed shared memory, recovery and commit protocols ● To know the components and management aspects of Real time, Mobile operating systems

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Advance Operating Systems:** Functions and services of operating systems, Processes and Threads - Process Scheduling Deadlocks: Detection, Prevention and Recovery – Models of Resources – Memory Management Techniques, types of advanced operating systems (NOS, DOS, Multiprocessor OS, Mobile OS, RTOS, Cloud OS).	**08**	PO1/ PO2/	PSO1/ PSO2
Module-2	**Distributed Operating Systems:** Issues in Distributed Operating System – Architecture – Communication Primitives –Lamport's Logical clocks – Causal Ordering of Messages – Distributed Mutual Exclusion Algorithms – Centralized and Distributed Deadlock Detection Algorithms – Agreement Protocols.	**08**	PO1/ PO3	PSO1/ PSO2
Module-3	**Distributed Resource Management:** Distributed File Systems – Design Issues - Distributed Shared Memory – Algorithms for Implementing Distributed Shared memory–Issues in Load Distributing – Scheduling Algorithms – Synchronous and Asynchronous Check Pointing and Recovery – Fault Tolerance – Two-Phase Commit Protocol – Nonblocking Commit Protocol – Security and Protection.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	**Multiprocessor Operating System:** Introduction, Basic multiprocessor system architectures, design issues, Threads, Process synchronization: the test and set instruction, the swap instruction, implementation of the process wait Processor scheduling: Issues, Co-scheduling, Smart scheduling, Affinity Based scheduling.	**08**	PO1/ PO2/ PO4/ PO12	PSO1/ PSO2
Module-5	**Real Time And Mobile Operating Systems:** Basic Model of Real Time Systems - Characteristics-Applications of Real Time Systems –Real Time Task Scheduling - Handling Resource Sharing - Mobile Operating Systems –Micro Kernel Design - Client Server Resource Access – Processes and Threads - Memory Management - File system.	**08**	PO1/ PO2/ PO3/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Discuss the various synchronization, scheduling and memory management issues ● Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system ● Discuss the various resource management techniques for distributed systems ● Identify the different features of real time and mobile operating systems ● Install and use available open-source kernel

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	MukeshSinghal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems – Distributed, Database, and Multiprocessor Operating Systems", Tata McGraw-Hill, 2001.
2.	Abraham Silberschatz; Peter Baer Galvin; Greg Gagne, "Operating System Concepts", Seventh Edition, John Wiley & Sons, 2004.
3.	Daniel P Bovet and Marco Cesati, "Understanding the Linux kernel", 3rd edition, O'Reilly, 2005.
4.	Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
5.	Neil Smyth, "iPhone iOS 4 Development Essentials – Xcode", Fourth Edition, Payload media, 2011.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√		√										√	√
CO3	√	√	√										√	√
CO4	√	√		√								√	√	√
CO5	√	√	√									√	√	√

Course Code: BCE-O531
Course Name: FUNCTIONAL PROGRAMMING PRINCIPLES WITH SCALA

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Proficiency with Java or C# is ideal, but experience with other languages such as C/C++, Python, Javascript or Ruby
Objectives:	● Understand the principles of functional programming ● Write purely functional programs, using recursion, pattern matching, and higher-order functions ● Design immutable data structures ● Combine functional programming with objects and classes

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Functional Programming overview with Scala – Basic types and operations, classes and objects, functional objects, functions and closure, composition and inheritance	**07**	PO1/ PO2	PSO1/ PSO2
Module-2	Singletons, Factories, and Builders Singletons and Null Objects, Builders	**07**	PO1/ PO3	PSO1/ PSO2
Module-3	Recursive structures Recursion, optimization and tail recursion, persistent data structures	**07**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	Understanding Lazy Sequences, The proxy pattern, Lazy evaluation, Infinite sequences – Scala streams, Recursive streams	**07**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-5	Functions as first-class values: Currying, The decorator pattern	**06**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-6	Higher Order Functions: The strategy design pattern, Functors, Monads, FlatMap, Monoids	**06**	PO1/ PO2/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Understand the principles of functional programming ● Write purely functional programs, using recursion ● Pattern matching, and higher-order functions ● Combine functional programming with objects and classes ● Design immutable data structures

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Functional Programming in Scala Paul Chiusano and RunarBjarnasonSeptember 2014, ISBN 9781617290657
2.	Programming in Scala, 3rd Edition, Martin odersky

CO-PO/PSO MAPPING														
Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√		√										√	√
CO3	√	√	√										√	√
CO4	√	√		√									√	√
CO5	√	√	√	√									√	√

Course Code: BET-O532
Course Name: SIGNALS AND SYSTEMS

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Inclination to learn mathematics, basic knowledge of differential equations and difference equations, electrical circuits and networks.
Objectives:	● Understand the concepts of continuous time and discrete time systems. ● Analyse systems in complex frequency domain. ● Understand sampling theorem and its implications.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Signals and Systems: Continuous-time and discrete-time Signals, Transformations of the Independent Variable, Exponential and Sinusoidal Signals, Continuous-Time and Discrete-Time LTI Systems and their properties, convolution sum and convolution integrals, Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.	**08**	PO1/PO2	PSO1/PSO2
Module-2	Fourier Series and Fourier Transform: The response of LTI Systems to Complex Exponentials, Fourier Series Representation of Continuous-time Periodic Signals and their Properties, Continuous time and discrete time Fourier Transforms and their properties, System Characterized by Linear Constant Coefficient Differential equations and Difference equations.	**08**	PO1/PO2	PSO1/PSO2
Module-3	Time and Frequency Characterization of Signals and Systems: Magnitude Phase Representation of the Fourier Transform, Magnitude Phase Representation of the Frequency response of LTI systems, Time Domain and Frequency Domain aspects of Non ideal filters, First Order and Second Order Continuous Time and Discrete time Systems.	**08**	PO1/PO2/PO3	PSO1/PSO2
Module-4	Sampling and Laplace Transform: Signal representation by samples, sampling theorem, Impulse train sampling, sampling of discrete time signals, discrete time processing of continuous time signals. Laplace Transform, Region of convergence, inverse Laplace Transform, Analysis and characterization of LTI System, Block diagram representation, Unilateral Laplace transform.	**08**	PO1/PO2/PO3/PO4	PSO1/PSO2
Module-5	Z-Transform: Z-Transform, Region of convergence, Inverse Z-transform, analysis and characterization of LTI system, Block diagram representation, Unilateral Z-transform. Random variable, random process correlation functions, Signals and systems as seen in everyday life, and in various branches of engineering and science.	**08**	PO1/PO2/PO3/PO4	PSO1/PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Analyze different types of signals ● Represent continuous and discrete systems in time and frequency domain using different ● transforms ● Investigate whether the system is stable ● Sampling and reconstruction of a signal

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	V. Oppenheim, A.S. Willsky and S. Hamid Nawab, 'signals & System', Pearson Education, Second Edition, 2003.
2.	Roberts, "Signals and Systems" Tata McGraw Hills.
3.	P. Ramesh Babu, R. Ananda Natarajan,"Signals and Systems", SCITECH Publications.
4.	Charles L. Phillips, John M.PARR and EVEA. RISKIN, "Signals, Systems and Transforms", PEARSON Education, Third Edition.
5.	Chen 'Signals & Systems, Oxford University, Press.

Course Code: BCE-O533
Course Name: BUSINESS ECONOMICS AND FINANCIAL ANALYSIS

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	None
Objectives:	• To learn the basic Business types, impact of the Economy on Business and Firms specifically. • To analyze the Business from the Financial Perspective.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction to Business and Economics:** **Business**: Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance. **Economics:** Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply in Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Demand and Supply Analysis:** **Elasticity of Demand:** Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting. **Supply Analysis:** Determinants of Supply, Supply Function & Law of Supply.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**Production, Cost, Market Structures & Pricing:** **Production Analysis:** Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions. **Cost analysis**: Types of Costs, Short run and long run Cost Functions. **Market Structures**: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition. **Pricing:** Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis.	**08**	PO1/ PO3	PSO1/ PSO2
Module-4	**Financial Accounting:** Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements,	**08**	PO1/ PO2	PSO1/ PSO2

	Preparation of Final Accounts.			
Module-5	**Financial Analysis through Ratios:** Concept of Ratio Analysis, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios (simple problems). Introduction to Fund Flow and Cash Flow Analysis (simple problems).	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• The students will understand the various Forms of Business and the impact of economic variables on the Business. • The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt. • The students can study the firm's financial position by analysing the Financial Statements of a Company.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	D.D. Chaturvedi, S.L. Gupta, Business Economics - Theory and Applications, International
2.	Book House Pvt. Ltd. 2013.
3.	Dhanesh K Khatri, Financial Accounting, Tata McGraw Hill, 2011.
4.	Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata McGraw Hill Education Pvt. Ltd. 2012.
5.	Paresh Shah, Financial Accounting for Management 2e, Oxford Press, 2015.
6.	S.N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√		√										√	√
CO3	√	√	√										√	√

Course Code: BCE-O544
Course Name: INTRODUCTION TO AI

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Probability and statistics, Automata and languages
Objectives:	● Provide the most fundamental knowledge to the students so that they can understand what the AI is. ● eliminate theoretic proofs and formal notations as far as possible, so that the students can get the full picture of AI easily. ● Students who become interested in AI may go on to the graduate school for further study.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction:** Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Applications of Artificial Intelligence, Intelligent Agents, Structure of Intelligent Agents. Computer vision, Natural Language Processing.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Introduction to Search**: Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning.	**08**	PO2/ PO3	PSO1/ PSO2
Module-3	**Knowledge Representation & Reasoning**: Propositional logic, Theory of first order logic, Inference in First order logic, Forward & Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.	**08**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-4	**Machine Learning**: Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data - Naive Bayes models. **Expert System:** Existing Systems (DENDRAL, MYCIN) domain exploration Meta Knowledge, Self-Explaining System	**08**	PO2/ PO3	PSO1/ PSO2
Module-5	**Capstone Project:** Choose a real-world Problem and develop an AI solution end-to-end, Build the AI Model / Use API, Create a User Interface: Web App / Android App/iOS App, Deploy AI App, Documentation: Problem, model, results, future scope, Live demo.	**08**	PO1/ PO3/ PO4	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Understand AI's fundamental concepts and methods ● Acquire knowledge of modern AI tools, including Deep Learning framework TensorFlow and Deep Learning capabilities of RapidMiner. ● Learn how to apply AI-based methods to solving practical business problems ● Understand implications of AI for business strategies ● Examine where the AI technologies are heading within the next few years.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Rich & Knight, Artificial Intelligence
2.	Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education
3.	Charnick, Introduction to A.I., Addision Wesley
4.	Winston, LISP, Addision Wesley
5.	Marcellous, Expert System Programming, PHI
6.	Elamie, Artificial Intelligence, Academic Press
7.	Lioyed, Foundation of Logic Processing, Springer Verlag

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√	√									√	√
CO4	√	√		√									√	√
CO5	√	√	√	√									√	√

Course Code: BCE-O535
Course Name: LINUX AND SHELL PROGRAMMING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	None
Objectives:	• Essential ideas behind the open-source operating system approach to programming. • Knowledge of Linux and shell script helps to understand the backbone of cybersecurity. • learn basic Linux commands, Shell scripting, File structure and management, Processes, Inter process communication, Socket programming. • work on LINUX / UBUNTU platform to gain hands-on experience on LINUX and Shell programming

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction to LINUX and LINUX utilities:** A brief history of LINUX, architecture of LINUX, features of LINUX, introduction to vi editor. Linux commands-PATH,man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip, file handling utilities, security by file permissions, process utilities, disk utilities, networking commands, unlink, du, df, mount, umount, find, unmask, ulimit, ps, w, finger, arp, ftp, telnet, rlogin. Text Processing utilities and backup utilities , tail, head , sort, nl, uniq, grep, egrep, fgrep, cut, paste, join, tee, pg, comm, cmp, diff, tr, awk, cpio.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Introduction to Shells:** Linux Session, Standard Streams, Redirection, Pipes, Tee Command, Command Execution, Command-Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Options, Shell/Environment Customization. **Filters:** Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters, Files with Duplicate Lines, Count Characters, Words or Lines, Comparing Files.	**08**	PO2/ PO3	PSO1/ PSO2
Module-3	**Grep:** Operation, grep Family, Searching for File Content. Sed: Scripts, Operation, Addresses, commands, Applications, grep and sed. **Unix File Structure:** Introduction to UNIX file system, inode (Index Node), file descriptors, system calls and device drivers.File Management: File Structures, System Calls for File **Management –** create, open, close, read, write, lseek, link, symlink, unlink, stat, fstat, lstat, chmod, chown, Directory API – opendir, readdir, closedir, mkdir, rmdir,umask.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	**Process And Signals:** Process, process identifiers, process structure: process table, viewing processes, system processes, process scheduling, starting new **Processes:** waiting for a process, zombie processes,	**08**	PO1/ PO3/ PO12	PSO1/ PSO2

	orphan process, fork, vfork, exit, wait, waitpid, exec, signals functions, unreliable signals, interrupted system calls, kill, raise, alarm, pause, abort, system, sleep functions, signal sets.File locking: creating lock files, locking regions, use of read and write with locking, competing locks, other lock commands, deadlocks.			
Module-5	**Inter Process Communication:** Pipe, process pipes, the pipe call, parent and child processes, and named pipes: fifos, semaphores: semget, semop, semctl, message **Queues:**msgget, msgsnd, msgrcv, msgctl, shared memory: shmget, shmat, shmdt, shmctl, ipc status commands. Introduction to Sockets: Socket, socket connections - socket attributes, socket addresses, socket, connect, bind, listen, accept, socket communications. **Laboratory Experiments:**Students will use LINUX / UBUNTU to gain hands-on experience on LINUX and Shell programming.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Use various Linux commands that are used to manipulate system operations at admin level • Write Shell Programming using Linux commands. write Shell Programming using Linux commands. • Design and write application to manipulate internal kernel level Linux File System.

Suggested books:

S. No.	Name of Authors /Books /Publisher
1.	M. Ebrahim and A Mallett, Mastering Linux Shell Scripting: A Practical Guide to Linux Command-Line, Bash Scripting, and She (2 ed.), Packt Publication, 2018. ISBN 978- 1788990554
2.	R. Blum and C. Bresnahan, Linux Command Line and Shell Scripting Bible (3 ed.), Wiley, 2016. ISBN 978-1118983843
3.	R. Love, Linux System Programming (2 ed.), O'Reilly, 2013. ISBN 978-1449339531
4.	W.R. Stevens, Advanced Programming in the UNIX Environment (2 ed.), Pearson Education, 2017. ISBN 978-9332575905
5.	W.R. Stevens, UNIX Network Programming (3 ed.), PHI Publications, 2017. ISBN 978- 8120307490

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√									√	√	√

Course Code: BCE-C621
Course Name: DISTRIBUTED SYSTEMS

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	Familiarity with the design and analysis of sequential algorithms, knowledge of basic computer organization and elementary operating systems concepts are required.
Objectives:	• To understand the foundations of distributed systems. • To learn issues related to clock Synchronization and the need for global state in distributed systems. • To learn distributed mutual exclusion and deadlock detection algorithms. • To understand the significance of agreement, fault tolerance and recovery protocols in Distributed Systems. • To learn the characteristics of peer-to-peer and distributed shared memory systems.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Characterization of Distributed Systems-Introduction-Examples-Resource Sharing and the Web-Challenges. System Models-Architectural-Fundamental. Inter process Communication- Introduction-API for Internet Protocols-External data representation and marshalling--Client-server Communication-Group communication- Case study: Inter process Communication in UNIX.Transparency in Distributed Systems (Access, Location, Migration, etc.)	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	Distributed Objects and Remote Invocation-Introduction-Communication between distributed objects-Remote procedure calls-Events and notifications-Case study: Java RMI. Operating System Support-Introduction-OS layer-Protection-Processes and threads- Communication and invocation OS architecture.Sockets and Streams,Quorum-based Protocol	**08**	PO2/ PO3	PSO1/ PSO2
Module-3	Distributed File Systems-Introduction-File service architecture-Case Study: Sun Network File System-Enhancements and further developments. Name Services-Introduction-Name Services and the Domain Name System-Directory. Services-Case Study: Global Name Service.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	Time and Global States-Introduction-Clocks, events and process states-Synchronizing physical clocks-Logical time and logical clocks-Global States-Distributed debugging. Coordination and Agreement-Introduction-Distributed mutual exclusion-Elections-Multicast Communication-Consensus and related problems. Authentication in distributed systems: Protocols based on symmetric cryptosystems, Protocols based on asymmetric cryptosystems, Password-based authentication, and Authentication protocol failures.	**08**	PO1/ PO3/ PO12	PSO1/ PSO2

Module-5	Distributed Shared Memory-Introduction-Design and implementation issues-Sequential consistency and Ivy case study Release consistency and Munin case study-Other consistency models. CORBA Case Study-Introduction-CORBA RMI-CORBA services,Cloud-Native Distributed Systems (Containers, Kubernetes), Microservices Architecture in Distributed Systems, Middleware and Message Queues (Kafka, RabbitMQ)	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understanding of Distributed architecture, CORBA, RMI. • Understanding reliable services to geographically dispersed users. The focus is networks, server architecture, protocols, security, resiliency, and scalability. • Illustrate distributed file system, time and global state. • Understand properties of key algorithms used in concurrent systems such as mutual exclusion. Its focus is the application of formal techniques.

Suggested books:

S. No.	Name of Authors /Books /Publisher
1.	George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.
2.	A.tS. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2006.
3.	M.L.Liu, “Distributed Computing Principles and Applications”, Pearson Addison Wesley, 2004.
4.	MukeshSinghal, “Advanced Concepts In Operating Systems”, McGrawHill Series in Computer Science, 1994.
5.	Nancy A. Lynch, "Distributed Algorithms", The Morgan Kaufmann Series in Data Management System, Morgan Kaufmann Publishers, 2000.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√									√	√	√
CO4	√	√										√	√	√

Course Code: BCE-C625
Course Name: Theory of Computation: Classical to Quantum Models

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	Math's Problems on Set Theory, Relations, Operations
Objectives:	• Introduce concepts in automata theory and theory of computation • Identify different formal language classes and their relationships • Design grammars and recognizers for different formal languages • Prove or disprove theorems in automata theory using its properties • Determine the decidability and intractability of computational problems

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Regular Languages:** Finite State systems – Basic Definitions – Finite Automation – DFA & NFA – Finite Automaton with e-moves – Regular Expression – Equivalence of NFA and DFA – Equivalence of NFA's with and without e-moves – Equivalence of finite Automaton and regular expressions. Melay and Moore Machine.	**06**	PO1/ PO2	PSO1/ PSO2
Module-2	**Context Free Languages:** Context Free Grammars – Derivations and Languages – Relationship between derivation and derivation trees – ambiguity – simplification of CFG –Derivation trees, sentential forms, right most and left most derivation. Greiback Normal form – Chomsky normal forms – Problems related to CNF and GNF.	**06**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**Pushdown Automata:** Definitions – Moves – Instantaneous descriptions – Deterministic pushdown automata – Pushdown automata and CFL. Designing of PDA. Acceptance by final state, acceptance by null store.	**06**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-4	**Turing Machines:** Turing machines – Computable Languages and functions – Turing Machine constructions – Storage in finite control – multiple tracks – checking of symbols – subroutines – two way infinite tape, Types of Turing machines.	**06**	PO1/ PO2/ PO3/	PSO1/ PSO2
Module-5	**Undecidability:** Chomsky hierarchy of languages, linear bounded automata and context Sensitive language, LR(0) grammar, decidability of problems, Universal Turing Machine, undecidability of posts. Correspondence problem, Turing reducibility, Definition of P and NP problems, NP complete and NP hard problems.	**06**	PO1/ PO2/ PO4/ PO12	PSO1/ PSO2
Module-6	Introduction to Quantum Models of Computation, What is Quantum Computing, Qubits vs Bits: A simple comparison, Basic Concepts: Superposition, entanglement, Quantum Finite Automata (QFA): What changes from DFA/NFA, Quantum Turing Machines: Theoretical extension of classical TM, Quantum vs Classical Models: Comparison of power, limitations,	**10**	PO1/ PO2/ PO4/ PO12	PSO1/ PSO2

	Real-world relevance: Case Study			
Total No. of Hours		**40**		

Learning Outcomes:	• Classify machines by their power to recognize languages. • Employ finite state machines to solve problems in computing. • Explain deterministic and non-deterministic machines. • Comprehend the hierarchy of problems arising in the computer sciences.

Suggested books:

S. No.	Name of Authors /Books /Publisher
1.	"Introduction to Automata Theory Languages and Computation". Hopcroft H.E. and Ullman J. D. Pearson Education
2.	Introduction to Theory of Computation –Sipser 2nd edition Thomson
3.	Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
4.	Introduction to languages and the Theory of Computation, John C Martin, TMH
5.	"Elements of Theory of Computation", Lewis H.P. & Papadimitriou C.H. Pearson /PHI.
6.	4 Theory of Computer Science – Automata languages and computation -Mishra and Chandrashekaran, 2nd edition, PHI

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√									√	√	√
CO4	√	√	√	√								√	√	√

Course Code: BET-C620
Course Name: Embedded Systems and IoT Applications

MM: 100 **Time: 3 Hr.** **L T P** **3 1 0**	**Sessional:30** **ESE:70** **Credit :4**

Prerequisites:	Microprocessor & interfacing
Objectives:	1. Understand the Fundamentals of Embedded Systems. 2. Develop Programming Skills for Embedded Systems. 3. To explore serial, parallel, and wireless communication protocols. 4. To develop skills for real-world peripheral interfacing. 5. Understanding of IoT and its applications
Course Coordinator	Mr. ANUJ KUMAR SHARMA

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08)long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	*Module-1*	Embedded systems and its applications, Embedded Operating system, Design parameters of an embedded system and its significance, design life cycle, tools introduction, hardware and software partitioning and co-design. Open collector outputs Tristate outputs I/O sinking and Sourcing, PLD's, Watchdog Timers, Hardware design and development.	**06**	PO1/ PO2/ PO3	PSO1/ PSO2/..
UNIT-2	*Module-2*	Microcontroller families and classifications (8-bit, 16-bit, 32-bit), 8051 Microcontroller, AVR Microcontroller, Features of ATmega328 used in Arduino, PIC Microcontrollers, ARM Cortex-M Series (e.g., STM32), ESP32 / ESP8266 (Wi-Fi-enabled microcontrollers), Programming via Arduino IDE and ESP-IDF.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2/..
UNIT-3	*Module-3*	Introduction to Microcontrollers and Micoprocessors, Embedded versus external memory devices, CISC and RISC processors, Harvard and Von Neumann Architectures. 8051 Microcontrollers-Assembly language, architecture, registers, Addressing modes, Instruction set, I/O ports and memory organization Interrupts Timer/counter and serial communication.	**12**	PO2/ PO3/ PO4/	PSO1/ PSO2/..
UNIT-4	*Module-4*	Communication basics, Microprocessor Interfacing I/O Addressing, Direct memory access, Arbitration, multilevel bus architecture, Serial protocols, Parallel protocols and wireless	**10**	PO2/ PO4/ PO5	PSO1/ PSO2/..

		protocols. Real world Interfacing: LCD, Stepping Motor, ADC, DAC, LED, Push Buttons, Key board, Latch Interconnection, PPI.			
UNIT-5	*Module-5*	Introduction to Internet of Things (IoT), components of an IoT system including sensors, actuators, microcontrollers, and cloud platforms; IoT system architecture, overview of IoT communication models such as device-to-device, device-to-cloud, and gateway-based communication; IoT communication technologies including Wi-Fi for local high-speed connections, Bluetooth Low Energy (BLE) for short-range low-power communication, Zigbee for mesh networking, LoRaWAN for long-range low-power applications, and NB-IoT for cellular-based IoT solutions.	**04**	PO2/ PO4/ PO5	PSO1/ PSO2/..
Total No. of Hours			**40**		

Learning Outcomes:	After completing this course, the student will be able to 1. **Explain** the fundamentals of embedded systems and their applications in real-world scenarios. 2. **Develop** basic embedded programs using 8051, AVR (ATmega328), PIC, ARM Cortex-M, and ESP32/ESP8266 microcontrollers. 3. **Describe** the structure and functions of a Real-Time Operating System (RTOS), including tasks, semaphores, shared data, queues, and mailboxes. 4. **Compare** serial, parallel, and wireless communication protocols for use in embedded applications. 5. **Interface** real-world devices (LCD, stepper motors, ADC/DAC, LEDs, push buttons, keyboards) with microcontrollers.

Suggested books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	Muhammad Ali Mazidi and Janice Gillispie "***The 8051 Microcontroller and embedded systems***" ISBN: 978-0131194021	1999
2.	Tony Givargis Frank Vahid "***Embedded System Design: A Unified Hardware / Software Introduction",*** IV, McGraw-Hill, ISBN-9780071371766	2006
3.	Kenneth Hintz, Daniel Tabak "***Microcontrollers (Architecture, Implementation & Programming)***" Tata McGraw-Hill,	2005
4.	Sampath Kr "***Microcontrollers & Embedded Systems 2nd Edition***" KatsonBooks	206

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	Learning Outcome 1	Learning Outcome 2	Learning Outcome 3	Learning Outcome 4	Learning Outcome 5
PO1	Y	N	Y	Y	Y
PO2	Y	Y	N	Y	Y
PO3	Y	N	Y	Y	Y
PO4	N	Y	N	N	Y
PO5	Y	N	Y	Y	Y
PO6	Y	Y	N	Y	Y
PO7	N	N	N	N	Y
PO8	Y	Y	N	Y	Y
PO9	Y	N	Y	N	Y
PO10	Y	Y	N	Y	Y
PO11	Y	N	N	Y	Y
PO12	Y	Y	N	Y	Y

	Learning Outcome 1	Learning Outcome 2	Learning Outcome 3	Learning Outcome 4	Learning Outcome 5
PSO1	N	Y	N	N	N
PSO2	Y	N	Y	Y	N
PSO3	Y	N	Y	Y	N
PSO4	N	N	Y	Y	Y

Course Code: BCE-M002
Course Name: INTELLECTUAL PROPERTY RIGHTS

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	**None**
Objectives:	• Understanding and practicing the professional ethics for young engineers. • Understanding of patent law, and how patents are prosecuted and enforced. • Understanding of the importance of intellectual property laws in modern engineering and the related ethical considerations involved.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Engineering Ethics:** Senses of 'Engineering Ethics'; variety of moral issues, types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, consensus and controversy, Models of Professional Roles, theories about right action, Self-interest, customs and religion, uses of ethical theories.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Patents:** Introduction to Patents, Patentable Subject Matter, Novelty, Non-Obviousness, The Patenting Process, Novelty, Infringement, & Searching, Patent Applications, Claim Drafting, Patent Prosecution, Design Patents, Business Method Patents, Foreign Patent Protection, Computer-Related Inventions, Patent Enforcement; Technical Design-Around.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	Copyrights: Introduction to Copyright, Subject matter of Copyright, Rights of the owners of the copyright, Authorship – ownership & licensing and assignment of Copyrighted work, Registration of Copyright & Authorities, Copyrights for Technology Protection.	**08**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-4	**Intellectual Property Rights:** IP Law Overview, Mask Works, Trade Secrets, Trademarks, Engineers & Scientists as Expert Witnesses.	**08**	PO1/ PO2	PSO1/ PSO2
Module-5	**Enforcement of Intellectual Property Right:** Infringement of intellectual property right, UNFAIR COMPETITION: relationship between unfair competition and intellectual property law. misappropriation right of publicity. false advertising.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand about the professional ethics, • Understand the patent laws and importance of intellectual property laws in modern engineering. • Some important topics include: senses of 'engineering ethics', introduction to patents, subject matter of copyright, ip law overview.

Suggested books:

S. No.	Name of Authors /Books /Publisher
1.	H B Rockman, Intellectual Property Law for Engineers and Scientists (1ed.), IEEE Press, 2004**,** ISBN st 978-0471449980.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√		√	√									√	√

Course Code: BCE-C661
Course Name: DISTRIBUTED SYSTEMS LAB

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	• To understand the fundamentals of distributed systems. • To understand implementation of mutual exclusion, different clock, locking algorithm. • To implement Remote Procedure Call, chat server, Remote Method Invocation and termination detection algorithms.

NOTE:	1. Minimum of 5 experiments have to be conducted. 2. In practical examination the student shall be required to perform one experiment. 3. A teacher shall be assigned 20 students for daily practical work in the laboratory. 4. No batch for practical class shall consist of more than 20 students. 5. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students. 6. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean.

LIST OF EXPERIMENTS	**No. of Hours**	**POs mapped**	**PSOs mapped**
1. Program to implement non token based algorithm for Mutual Exclusion 2. Program to implement Lamport's Logical Clock 3. Program to implement edge chasing distributed deadlock detection algorithm. 4. Program to implement locking algorithm. 5. Program to implement Remote Method Invocation. 6. Program to implement Remote Procedure Call. 7. Program to implement Chat Server. 8. Program to implement termination detection	**03**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2

Learning Outcomes:	• To understand and learn fundamentals of mutual exclusion in distributed systems. • Apply and understand implementation of Lamport's clock, deadlock detection and different locking algorithm. • Identify and implement concept of Remote Procedure Call, Remote Method Invocation and termination detection algorithms.

CO-PO/PSO MAPPING

Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√			√									√	√

Course Code: BET-C662
Course Name: EMBEDDED SYSTEMS AND IOT APPLICATIONS LAB

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	Students will perform Microcontrollers interfacing with LED, Seven segment display, LCD, Keypad, ADC, DAC etc. Experiments.
Course Coordinator	Mr.Anuj Sharma

NOTE:	1. Minimum of 8 experiments have to be conducted. 2. The programs have to be tested on 8051/89C51 Development board/equivalent using Embedded C Language/Assembly Language on Keil IDE or Equivalent 3. In practical examination the student shall be required to perform one experiment. 4. A teacher shall be assigned 20 students for daily practical work in laboratory. 5. No batch for practical class shall consist of more than 20 students. 6. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students. 7. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean.

LIST OF EXPERIMENTS	No. of Hours	POs mapped	PSOs mapped
1. Program to interface LCD data pins to port P1 and display a message on it. 2. Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD. 3. Program to interface seven segment display unit. 4. Program to interface LED display unit 5. Program to toggle all the bits of Port P1 continuously with 250 mS delay. 6. Program to toggle only the bit P1.5 continuously with some delay. Use Timer 0, mode 1 to create delay. 7. Program to interface ADC0808 8. Program to clear 16 RAM locations starting at RAM address 60H 9. Mini Project based on IoT	**03**	PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO9 PO12	PSO1 PSO2

Learning Outcomes:	• Understanding the Program to interface LCD data pins to port P1 and display a message on it. • Understanding the Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD. • Design program to clear 16 RAM locations starting at RAM address 60H. • Design Program to toggle all the bits of Port P1 continuously with 250 mS delay • Students will be able to design IoT Applications.

Course Code: BCE-P663
Course Name: PROJECT

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	• Study and identify the problem area by studying and reviewing research papers. • Implement the skills of software engineering and software project management. • Improve upon the communication and presentation skills

NOTE:	

PROJECT DETAILS	**No. of Hours**	**POs mapped**	**PSOs mapped**
Each student shall be assigned a Minor Project by departmental committee. The student shall be required to perform his project work under the supervision of the supervisor(s). There shall be a seminar on the project work of the student to be evaluated by a departmental committee chaired by H.O.D. The student shall be required to submit his project report in the form of dissertation 15 days before the end of VII semester. The student shall be required to submit three copies of the project work with a certificate from the supervisor(s) that the work is an authentic record of the work performed by him. The report shall be forwarded by H.O.D. The report of the project work shall be evaluated by the external examiner(s). The same external examiner(s) shall hold the viva-voce examination. ** - Marks for the project work shall be awarded jointly by the external and internal examiners after viva-voce examination. *** - There shall be a seminar on the project work of the student to be evaluated by the departmental committee chaired by H.O.D.	**03**	PO1/ PO2/ PO3/ PO4/ PO5/ PO9/ PO10/ PO11/ PO12	PSO1/ PSO2

Learning Outcomes:	• Students will get knowledge of problem identification and use their skills for team building and project development. • develop a solution for any real-world problem. • Students will get equipped with knowledge of latest/upcoming problems and solutions. • Students will also be able to improve skills for project planning, implementation and communication.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Ford, Neal, Matthew McCullough and Nathaniel Schutta, Presentation patterns:Techniques for crafting better presentations (1 ed.), Addison- Wesley, 2012. ISBN 978-0321820808.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√						√	√	√		√	√
CO3	√	√	√	√	√				√	√	√	√	√	√
CO4	√	√		√	√				√	√	√	√	√	√
CO5	√	√	√	√	√				√	√	√	√	√	√

Course Code: BCE-S670
Course Name: SEMINAR ON LATEST TECHNOLOGIES

MM: 50 **Time: 3 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	● Develop speech preparation and presentation techniques, audience awareness and self-awareness along with the cultivation of self-confidence. ● Demonstrate the ability to present scientific material in visual, written and oral form including the formulation of an effective presentation on a topic in the Computer Science domain. ● Demonstrate an ability to listen to a scientific presentation with the discussion of the strengths and weaknesses of a speaker's presentation.

NOTE:	

SEMINAR DETAILS	**No. of Hours**	**POs mapped**	**PSOs mapped**
Importance of seminars/presentations in undergraduate studies. Introduction presentation with extemporaneous delivery approach (include information on likes/dislikes, hobbies, family, career goals, etc.) Experiencing the problems of talking in front of people, Understanding body Language. Considerations when preparing an oral presentation - audience, purpose, organization, flow, style. Presentation delivery approaches, Importance of visual aids, Designing effective presentations. Demonstration/How-To Speech - valuable information to the audience by demonstrating a process via visual aid. Informative speech/Speech of Explanation - original concept, policy, idea, or person, location or event to inform the audience about it via visual aids. Persuasive Speech - establish a problem with references and offering a solution via visual aids. Language of presentations: Explaining the title, outline, and summary, Explaining the background, problem, materials, methods, and processes, Explaining and discussing data in the form of figures and tables, Understanding and answering questions from the audience and Final presentations.	**03**	PO1/ PO2/ PO3/ PO9/ PO10/ PO11	PSO1/ PSO2

Learning Outcomes:	• Students would be able to improve their presentation skills and work towards enhancing their self-confidence. • This course helps the students to explore a domain of computer science and exploit their interest to demonstrate the ability to present scientific material in visual, written and oral form.

Suggested books:

S. No.	**Name of Authors /Books /Publisher/Year**
1.	Ford, Neal, Matthew McCullough and Nathaniel Schutta, Presentation patterns: Techniques for crafting better presentations (1 ed.), Addison- Wesley, 2012. ISBN 978-0321820808.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√						√	√	√		√	√

Program Elective Subject List- II

BCE-P624	Machine Learning - 2
BCE-P615	Advance Database Management System
BCE-P616	Software Project Management
BET-P617	Digital Signal Processing
BCE-P618	High Performance Computer Architecture
BCE-P619	Full Stack Web Development
BCE-P620	Data Analytics -2
BCE-P621	Cyber Forensics
BCE-P622	Augmented Reality and Virtual Reality

Course Code: BCE-P624
Course Name: MACHINE LEARNING –II

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Knowledge of basic machine learning concept**,** Understanding ofBasic Programming Concept and Mathematics (probability and statistics).
Objectives:	• To learn the fundamentals of Advanced Machine Learning. • To understand basic components of an intelligence system for regression & classification problems. • To explore applications and implementation of advanced machine learning. • To understand different types of machine learning algorithms, framework and tools. • To learn how to use machine learning models to solve real world problems.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Brief Recap of Fundamentals of Introduction to regression and classification problems, Linear regression in One Variable: Introduction, Gradient Descent Algorithm, Gradient Descent Implementation, Gradient Descent Update Rule for Regression, Data Preparation, Scoring, Surface Plots and Contours, Visualizing Loss function and Gradient Descent Trajectory. Linear regression in multiple variables: Gradient Descent for Multiple Variables, Features and Polynomial Regression.	**08**	PO1/ PO2	PSO1 /PSO2
Module-2	Introduction to Logistic Regression: Why use logistic regression? (Binary/Multi-class Classification), Sigmoid Function & Decision Boundary, Applications(Spam Detection, Medical Diagnosis) Cost Function (Log Loss), Gradient Descent Optimization Evaluation Metrics: Confusion Matrix, Precision, Recall, F1-Score, ROC Curve & AUC, Overfitting in Logistic Regression, Multiclass Classification (One-vs-Rest, Softmax)	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	Principal Component Analysis Problem Formulation, PCA Algorithms, K Nearest Neighbors: Distance Metrics, 1-NN algorithm, K-NN algorithm, Weighted KNN algorithm, Issues with high dimensions, high data scarcity and computational complexity, Classification using KNN.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-4	K-Means Clustering: Intro to Clustering, Intro to Hierarchical Clustering, DBSCAN. Decision Trees and Random Forests: Intro to Decision Trees, Decision Trees implementation, Decision Forests Visualization using, Random Forests Ensembles.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2

Module-5	Introduction and Implementation of Support Vector Machine (SVM). Project Task - End-to-End Machine learning Model Development – Housing Price Prediction, Stock Price Prediction, MNIST Digit Classification, any other.	**08**	PO1/ PO2/ PO3/ PO4/ PO5	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• List various approaches of Advanced Machine Learning and its various tools, framework, data Repositories and datasets. • Explain various types of Machine Learning algorithms and machine learning tasks. • Identify feature extraction & selection methods, different data types and data pre-processing methods involved in machine learning. • Analyze regression & classification problems and various regression classification algorithms • Compare various performance metrics for evaluation of Machine Learning Algorithms.

Suggested books:

S. No.	Name of Authors /Books /Publisher
1.	Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller and Sarah Guido, O'Reilly, 2016.
2.	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, AurelienGeron, O'Reilly, 2017.
3.	Elements of Machine Learning, Pat Langley Morgan Kaufmann Publishers, Inc. 1995.
4.	Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Peter Flach, Cambridge University Press, 2012.
5.	Pattern recognition and machine learning by Christopher Bishop, Springer Verlag, 2006.
6.	Machine Learning, Tom Mitchell, McGraw Hill, 1997.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	√	√	√	√									√	√
CO2	√	√	√	√									√	√
CO3	√	√	√		√								√	√
CO4	√	√	√	√									√	√
CO5	√	√	√	√	√								√	√

Course Code: BCE-P615
Course Name: ADVANCE DATABASE MANAGEMENT SYSTEM

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic concept of DBMS
Objectives:	• To understand the basic concepts and terminology related to DBMS and Relational Database Design • To the design and implement Distributed Databases. • To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Formal review of relational database and FDs Implication, Closure, its correctness	**06**	PO1/ PO2	PSO1/ PSO2
Module-2	3NF and BCNF, Decomposition and synthesis approaches, Review of SQL99, Basics of query processing, external sorting, file scans	**10**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	Processing of joins, materialized vs. pipelined processing, query transformation rules, DB transactions, ACID properties, interleaved executions, schedules, serializability	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-4	Correctness of interleaved execution, Locking and management of locks, 2PL, deadlocks, multiple level granularity, CC on B+ trees, Optimistic CC	**08**	PO1/ PO2/ PO3/ PO12	PSO1/ PSO2
Module-5	T/O based techniques, multi-version approaches, Comparison of CC methods, dynamic databases, Failure classification, recovery algorithm, XML and relational databases	**08**	PO3/ PO4/ PO5/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand the basic concepts and terminology related to DBMS and Relational Database Design. • Design and implement Distributed Databases. • Understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports. • Analyze the complex queries including full outer joins, self-join, sub queries, and set theoretic queries. • Knowhow of the file organization, Query Optimization, Transaction management, and database administration techniques.

Suggested books:

S. No.	Name of Authors /Books /Publisher
1.	R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill. 2004.
2.	Silberschatz, H. Korth, S. Sudarshan, Database system concepts, 5/e, McGraw Hill. 2008.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√	√	√							√	√	√
CO4	√	√		√	√							√	√	√
CO5	√	√	√	√	√							√	√	√

Course Code: BCE-P616
Course Name: SOFTWARE PROJECT MANAGEMENT

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	None
Objectives:	• To understand the Software Project Planning and Evaluation techniques. • To plan and manage projects at each stage of the software development life cycle (SDLC). • To learn about the activity planning and risk management principles. • To manage software projects and control software deliverables. • To develop skills to manage the various phases involved in project management and people management. • To deliver successful software projects that support organization's strategic goals.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Review of software engineering concepts:** Managed Using Phased Lifecycle, Perform Continuous Validation, Maintained Disciplined Product Control, Use Modern Programming Practices (MPP), Maintain Clear Accountability for Results, Features of Good Software, Quality Requirement in Different Application Areas	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Software Process**: Software Process Definition: Software Process Models, Life Cycle Models, Waterfall Life Cycle Model, Incremental Life Cycle Model, Spiral Life Cycle Model Evolutionary Development Life Cycle Model, Prototyping Life Cycle Model Or Throwaway Prototyping, Object Oriented Life Cycle Model, Winwin Spiral Life Cycle Model, Rational Unified Process, System Engineering, Software Specification, Software design and implementation, Software validation, Software evolution, Tools and Techniques for Process Modeling, Static modeling, Dynamic modeling.	**08**	PO1/ PO2/ PO3/ PO4/ PO5	PSO1/ PSO2
Module-3	**Introduction to Project Management**: Introduction of project, Activities by software project. Feasibility study, Planning, Project execution, Methodologies, Ways of categorizing software projects, Stakeholders, Setting objectives, project success and failures, Management, Principles of Project management, Principles of Project management, Initiation, Planning, execution, closure	**08**	PO1/ PO3/ PO7	PSO1/ PSO2
Module-4	**Software Project Planning:** Introduction ,Projects and Activities, Sequencing and Scheduling Activities, Formulating a Network Model, Forward Pass and Backward Pass, Identifying the critical path , Shortening the Project Duration, Activity-on-Arrow Networks, Work Breakdown Structure, Generating the WBS, Criteria for completeness in the WBS, Estimating Activity Resources Requirements , Cost Estimation techniques, Joint Project Planning Session , Project Management Plan , Scope Management and	**08**	PO2/ PO5/ PO9/ PO11	PSO1/ PSO2

	Schedule Management, Cost Management and Quality Management, Human Resource and communication Management			
Module-5	**Project Economics**: Project Costing, Example for Project Costing, Software Project Estimation, Work Breakdown Structure (WBS), Measuring Effort for a Project, SLOC- Technique, Function Point (FP) Technique, Project Scheduling and Tracking Techniques, COSMIC Full Function Points, Task Network and Scheduling Methods, Monitoring and Control Progress, Risk Concept and Risk Management, Software Metrics and Project Management	**08**	PO8/ PO9/ PO10/ PO11	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand Project Management principles while developing software. • Gain extensive knowledge about the basic project management concepts, framework and the process models. • Obtain adequate knowledge about software process models and software effort estimation techniques. • Estimate the risks involved in various project activities. • Define the checkpoints, project reporting structure, project progress and tracking mechanisms using project management principles. • Learn staff selection process and the issues related to people management

Suggested books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi	2012
2.	Robert K. Wysocki ―Effective Software Project Management – Wiley Publication	2011
3.	Walker Royce: ―Software Project Management- Addison-Wesley	1998
4.	Gopalaswamy Ramesh, ―Managing Global Software Projects – McGraw Hill Education (India), Fourteenth Reprint	2013

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√								√		√	√
CO3	√	√	√	√	√				√	√	√	√	√	√
CO4	√	√		√	√				√	√	√	√	√	√
CO5	√	√	√	√	√		√	√	√	√	√	√	√	√

Course Code: BCE-P617
Course Name: DIGITAL SIGNAL PROCESSING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Fourier Analysis
Objectives:	• Understand the concepts of Digital signals with the help of DFT and Z transform etc. • Analyze systems in complex frequency domain. • Understand various digital filtering technique and their implications.
Course Coordinator	Mr.Shiv Kumar

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Discrete Fourier Transform:** Frequency Domain Sampling: The Discrete Fourier Transform Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals. The Discrete Fourier Transform (DFT). The DFT as a linear Transformation. Relationship of the DFT to Other Transforms. Properties of the DFT. Periodicity, Linearity, and Symmetry Properties. Multiplication of two DFTs and Circular Convolution. Additional DFT Properties. Frequency analysis of signals using the DFT.	**08**		
Module-2	**Efficient Computation of DFT:** Efficient Computation of the DFT: FFT Algorithms, Direct Computation of the DFT. Radix-2 FFT algorithms. Efficient computation of the DFT of two real sequences, computations, efficient computation of the DFT of a 2NPointreal sequences, Gortezel Algorithm, Chirp Z-transform algorithm.	**08**		
Module-3	**Basic IIR Filter Structures:** Direct forms (I & II), cascade and parallel realizations. Signal flow graph, Transposed structure, Basic FIR filter structures-. Direct form structure, frequency sampling structure, Lattice structure, Linear phase FIR structure. FIR structures.	**08**		
Module-4	**Symmetric and Anti-symmetric:** FIR Filters, Design of Linear-Phase FIR Filters Using Windows, Design of Linear-Phase FIR Filters by the Frequency Sampling Method, Design of FIR, Equi-ripple filter design Differentiators. Design of Hilbert Transformers.	**08**		
Module-5	**Design of IIR Filters from Analog Filters:** IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance. IIR Filter Design by the Bilinear Transformation. The Matched-z Transformation, Characteristics of Commonly Used Analog Filters. Application of above technique to the design of Butterworth &Chebyshev filters. Introduction to STFT, wavelets multirate Signal Processing architecture of DSP processor and application.	**08**		
Total No. of Hours		**40**		

Learning Outcomes:	• Represent signals mathematically in continuous and discrete time and frequency domain • Get the response of an LSI system to different signals • Design of different types of digital filters for various applications

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Proakis, J.G &Manolakis, D.G., "Digital Signal Processing: Principles Algorithms and Applications", Prentice Hall (India).
2.	Sanjit K. Mitra, "Digital Signal Processing", Third Edition, TMH, 2005.
3.	Oppenheim A.V. & Schafer, Ronald W., "Digital Signal Processing", Pearson Education.

Course Code: BCE-P618
Course Name: HIGH PERFORMANCE COMPUTER ARCHITECTURE

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Knowledge of computer architecture
Objectives:	• The objective of this course is to learn how to improve the quality of the programs that you write for execution on high performance computer systems. • The course discusses the various activities that happen during program execution, and how they are managed by the hardware (architectural features) and system software (operating systems, run-time systems).

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Parallel Computer Models:** Computing states, Multiprocessors and Multicomputer, Multivector and SIMD Computers, Conditions of parallelism, Program Partitioning and scheduling, Program flow mechanisms, System interconnect architecture	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Principles of Scalable Performance and Processor Hierarchy:** Performance Metrics and Measures, Parallel processing applications, Speedup Performance Laws, Scalability Analysis and Approaches, Advanced Processor and Memory Hierarchy Technology, Distributed Shared Memory	**08**	PO1/ PO2/ PO4/ PO5	PSO1/ PSO2
Module-3	**Requirement and general issues of High-Performance Computing:** Dependable Clustered Computing, Meta computing: Harnessing Informal Supercomputers, Specifying Resources and Services in Meta computing Systems, Load Balancing Over Networks, Job and Resource Management Systems	**08**	PO1/ PO3/ PO5	PSO1/ PSO2
Module-4	**Parallel Models and High-Performance Languages:** Scheduling Parallel Jobs on Clusters, Parallel Programming Models, Parallel and High-Performance programming languages, Dependence Analysis of Data arrays	**08**	PO1/ PO2/ PO4/ PO5/ PO11	PSO1/ PSO2
Module-5	**Advance Computing**: Introduction to Petascale computing, Optical Computing, Quantum computing and its issues.	**08**	PO1/ PO3/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Comprehend various High-Performance Computing (HPC) system architectures • Identify design issues related to the architectural characteristics and performance of HPC systems • Design and implement compute intensive applications on HPC platform

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Kai Hwang,Advance Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill International Editions
2.	Buyya, Rajkumar, High Performance Cluster Computing: Programming and Applications, Pearson Education
3.	Georg Hager and Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√								√		√	√
CO3	√	√	√	√	√						√	√	√	√

Course Code: BCE-P619
Course Name: FULL STACK WEB DEVELOPMENT

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Academic level web application knowledge
Objectives:	• Enable participants to develop a complete web application from the scratch that includes Front-end, Back-end and Data-exchange technologies • Build strong foundations (ex: OOPS) in entry level engineers thereby making them job ready as per industry requirements. Enable them to learn new technologies by applying foundation paradigms • By the end of the program participants will be become an industry-ready engineer who can be readily deployed in a project.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Fundamental of web development** **Understanding browser internals:** Rendering engine, Parsing - HTML parsing, CSS parsing, Render tree, Layouting, Painting, Engine's thread - Event loops, CPU, GPU, Memory, and multi-process architecture. **Building basic web apps using HTML, CSS &Javascript** **HTML -** HTML Basics, HTML Forms, HTML APIs. **CSS -** Selectors, Box model, positioning, Pseudo-class, specificity, Animations. **Javascript -** Fundamental, Object, Arrays, Functions, Events, Scope, Hoisting, Errors, this keyword, ES6, Conditions, Iterations, Debugging, Promises, Synchronous & Asynchronous flow.	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Server side of web development** **Understanding NodeJs -** Fundamental, Modules, File System, NPM, Events, Callbacks, Global namespace, Garbage collection, NPM registry, HTTP server. **Building REST APIs using ExpressJs -** Creating Basic Server, JSON, Middleware, Synchronous, Asynchronous, Dynamic Routes, Static Files, Template Engine, Streams, Error handling, MVC pattern.	**08**	PO1/ PO3/ PO5	PSO1/ PSO2
Module-3	**Storage in depth** **Understanding Browser storage -** LocalStorage, Session Storage, Cookies, IndexedDB, Web SQL, Cache. **Storing application data in MongoDB -** Fundamental, Create Database, Create Collections, Insert, Find, Query, Delete, Drop, Update, Join, Using Mongoose.	**08**	PO1/ PO3/ PO5/ PO11	PSO1/ PSO2
Module-4	**Web security** **Understanding authentication & authorization -** Understanding basics of security, Access control, OAuth, Encryption, multi-factor authentication. **Vulnerabilities in Web Apps-** Cross-Site Scripting (XSS), SQL Injection, Cross-Site Request Forgery, Denial of Service (DoS), Transport Layer Security (TLS)/ Secure Socket Layer (SSL), Server-side JavaScript Injection (SSJI)	**08**	PO1/ PO2/ PO4/ PO5	PSO1/ PSO2

Module-5	**Advanced web development** **Building dynamic apps using ReactJs-** ReactJs fundamentals, LifeCycle, Hooks, JSX, Component, State, Props, Synthetic events. **Web application performance -** Measuring performance, Performance metrics - (FCP, LCP, FMP, TTI, FP), Improving Performance - (Assets Compressions, CDN, Caching, Lazy load, BundleSize, SSR, Prefetching).	**08**	PO1/ PO5/ PO11/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand Structure and implement HTML/CSS. • Understand visualizations in accordance with UI/UX theories. • Develop a fully functioning website and deploy on a web server. • Derive information from data and implement data into applications. • Implement a RESTful backend API for storing and retrieving data via AJAX calls.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Jennifer Robbins, "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics".
2.	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites".
3.	Kyle Simpson, "You Don't Know JS: Up & Going"
4.	Matt Zandstra, "PHP Objects, Patterns, and Practice, Second Edition"
5.	Leonard Richardson, "RESTful Web APIs: Services for a Changing World"

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√								√		√	√
CO3	√	√	√	√	√							√	√	√
CO4	√	√		√	√							√	√	√
CO5	√	√	√	√	√							√	√	√

Course Code: BCE-P620
Course Name: DATA ANALYTICS-2

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic knowledge of data structure and data analytics.
Objectives:	• To provide an overview of an exciting growing field of big data analytics. • To introduce the tools required to manage and analyze big data like Hadoop, NoSqlMapReduce. • To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability. • To enable students to have skills that will help them to solve complex real-world problems in for decision support.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Supervised Learning with Regression and Classification Techniques:** Bias-Variance Dichotomy, Linear and Quadratic Discriminant Analysis, Classification and Regression Trees, Ensemble Methods: Random Forest, Neural Networks, Deep Learning.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Machine Learning:** Introduction and Concepts: Ridge Regression; Lasso Regression; and K-Nearest Neighbours, Regression and Classification.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	**Introduction to R**: - R graphical user interfaces, data import and export, attribute and data types, descriptive statistics, exploratory data analysis, visualization before analysis, 08 analytics for unstructured data.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-4	**Classification:** Decision Trees – Attribute Selection Measures and Tree Pruning; Bayesian and Rule-based Classification; Model Evaluation and Selection; Cross-Validation; Classification Accuracy; Bayesian Belief Networks; Classification by Backpropagation; and Support Vector Machine.	**08**	PO1/ PO2/ PO3/ PO4/ PO11	PSO1/ PSO2
Module-5	**Business Analytics:** Predictive Analysis (Regression and Correlation, Logistic Regression, InSample and Out-of-Sample Predictions), Prescriptive Analytics (Optimization and Simulation with Multiple Objectives).	**08**	PO1/ PO2/ PO3/ PO4/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Apply R tool for developing real time applications. • Gain the principle concepts and foundational understanding of data analytics. • Understanding of the statistical procedures most often used by practicing engineers. • Demonstrate the business analytical techniques used in decision making. • Understand item sets, classification, clustering and machine learning techniques.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press.
2.	Bill Franks, Taming the Big Data Tidal wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & Sons.
3.	Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
4.	David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big Data Analytics”, EMC Education Series, John Wiley
5.	Frank J Ohlhorst, “Big Data Analytics: Turning Big Data into Big Money”, Wiley and SAS Business Series
6.	Michael Berthold, David J. Hand,” Intelligent Data Analysis”, Springer
7.	Paul Zikopoulos, Chris Eaton, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw Hill.
8.	Mark Gardner, “Beginning R: The Statistical Programming Language”, Wrox Publication.
9.	Pete Warden, Big Data Glossary, O’Reilly.
10.	Glenn J. Myatt, Making Sense of Data, John Wiley & Sons.
11.	Pete Warden, Big Data Glossary, O’Reilly.
12.	Peter Bühlmann, PetrosDrineas, Michael Kane, Mark van der Laan, "Handbook of Big Data", CRC Press.
13.	Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer.
14.	Colleen Mccue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Elsevier.
15.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer.
16.	Jiawei Han, MichelineKamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√								√		√	√
CO3	√	√	√	√								√	√	√
CO4	√	√		√								√	√	√
CO5	√	√	√	√								√	√	√

Course Code: BCE-P621
Course Name: CYBER FORENSICS

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Network Security
Objectives:	• To study computer forensics • To know about mobile device forensics. • To know about tools of forensics

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction of Cybercrime:** Types, The Internet spawn's crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	Initial Response and forensic duplication, Initial Response & Volatile Data Collection from Windows system -Initial Response & Volatile Data Collection from Unix system – Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic. Duplicate/Qualified Forensic Duplicate of a Hard Drive	**08**	PO2/ PO11	PSO1/ PSO2
Module-3	**Forensics analysis and validation**: Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, performing remote acquisitions **Network Forensics:** Network forensics overview, performing live acquisitions, developing standard procedures for network forensics, using network tools, examining the honeynet project.	**08**	PO1/ PO3/ PO11	PSO1/ PSO2
Module-4	**Current Forensic tools:** evaluating computer forensic tool needs, computer forensics software tools, computer forensics hardware tools, validating and testing forensics software E-Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools. **Cell phone and mobile device forensics**: Understanding mobile device forensics, understanding acquisition procedures for cell phones and mobile devices.	**08**	PO1/ PO3	PSO1/ PSO2
Module-5	**Working with Windows and DOS Systems**: understanding file systems, exploring Microsoft File Structures, Examining NTFS disks, Understanding whole disk encryption, windows registry, Microsoft startup tasks, MS-DOS startup tasks, virtual machines.	**08**	PO11	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Students will understand the usage of computers in forensic, and how to use various forensic tools for a wide variety of investigations. • It gives an opportunity to students to continue their zeal in research in computer forensics

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill,2006.
2.	Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi.
3.	Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning
4.	Real Digital Forensics by Keith J. Jones, Richard Bejtiich, Curtis W. Rose, Addison- Wesley Pearson Education
5.	Forensic Compiling, A Tractitioneris Guide by Tony Sammes and Brian Jenkinson, Springer International edition.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√								√		√	√

Course Code: BCE-P622
Course Name: AUGMENTED REALITY AND VIRTUAL REALITY

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	● Intermediate programming ability in C# or other object-oriented languages ● Familiarity with 3D game engines or strong desire to learn ● Basic linear algebra
Objectives:	This course is to introduce students with the fundamentals of augmented reality (AR), and how to build an AR experience using ARCore. This course will address the use of AR in smart phones, Google AR. AR for shopping and retail. AR for business. AR for social media. AR for gaming. AR for education. AR for healthcare This course helps to identify different types of AR experiences using ARKit (Apple's Augmented Reality SDK for iOS). This course will cover different software and hardware tools and platforms used in the AR landscape. It will also cover popular use cases for AR and How AR experiences work.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction -** The history of augmented reality. AR today: smart phones. Standalone. Google AR. AR for shopping and retail. AR for business. AR for social media. AR for gaming. AR for education. AR for healthcare. AR for non-profits, The similarities and differences between AR and VR.	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Placing and positioning assets -** Scale and the size of assets. Occlusion. Lighting for increased realism. Solid augmented assets. Context awareness. Tracking in AR. Outside-in tracking. Inside-out tracking. Motion tracking. Environmental understanding: feature points and plane-finding. Light estimation. Anchors. Interface issues	**08**	PO1/ PO3	PSO1/ PSO2
Module-3	**Introduction to ARKit** (Apple's Augmented Reality SDK for iOS), Hardware supported features, ARKit Unique Features: World Maps, Object Detection, Environment Probes. Fundamental Concepts: Motion Tracking, Environmental Understanding, Light Estimation, Plane Detection., ARKit Features: Face Tracking, Image Tracking. 3D Body Tracking, AR Foundation: Lightweight Render pipeline, Camera image API, AR object scaling. Head mounted AR, Environmental Mapping.	**08**	PO1/ PO3/ PO4	PSO1/ PSO2
Module-4	**Interaction in VR:** 3D Interaction Design in Virtual Reality, Natural Interaction, Magic Interaction, Active and Passive Interaction, Affordances, VR Interaction Theory, Standard HMDs, Other Devices, Interaction Scripts.	**08**	PO2/ PO3/ PO12	PSO1/ PSO2
Module-5	**Moving around in VR:** Introduction to Navigation in VR, Real Walking, Redirected Walking,Walk-in-Place, Virtual Navigation, Teleporting, Teleportation, Travel in VR, Implementing Walk in Place, Movement in VR.	**08**	PO4/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• How to identify different types of AR experiences. • Tools and platforms used in the AR landscape. • Popular use cases for AR and How AR experiences work.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	MichealLanhan, Learn ARCore - Fundamentals of Google ARCore (1 ed.), Packet Publishing Limited, 2018. ISBN 978-1788830409.
2.	Paul Mealy, Virtual & Augmented Reality for Dummies (1 ed.), Wiley Publishers, 2018. ISBN 978-1119481348.
3.	Michael Wohl, The 360° Video Handbook: A step-by-step guide to creating video for virtual reality (VR) (1 ed.), Michael Wohl, 2017. ISBN 978-0692904282.
4.	Steven M. LaValle, Virtual Reality, Cambridge University Press, 2019.E Book Link: http://vr.cs.ui
5.	Luke Ahearn, 3D Game Textures (3 ed.), CRC Focal Press, 2011. ISBN 978-0240820774.
6.	Heather Maxwell Chandler, Game Production Handbook (3 ed.), Jones & Bartlett, 2013. ISBN 978-1449688097.
7.	Jason Gregory, Jeff Lander and Matt Whiting, Game Engine Architecture (3 ed.), A K Peters/CRC Press, 2018. ISBN 978-1138035454.
8.	Allen Sherrod, Ultimate 3D Game Engine Design & Architecture (1 ed.), Charles River Media game development, 2009. ISBN 978-1111055660.
9.	Steven M. LaValle, Virtual Reality (1 ed.), Cambridge University Press, 2019. ISBN 978-0521862059.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√	√								√	√	√

Open Elective –II

BCE-O630	Applied AI
BET-O631	Digital Image Processing
BCE-O632	Industrial Economics and Business Administration
BCE-O633	Introduction to Data Science and Design Thinking
BCE-O634	Data Mining
BCE-O635	Natural Language Processing
BCE-O636	E-commerce & Social Media Analysis
BCE-O647	Java based Object Oriented Programming **
BCE-O667	Java based Object Oriented Programming lab**

Course Code: BCE-O630
Course Name: APPLIED AI

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Some exposure to formal languages, logic and programming
Objectives:	This course will help the students to understand the fundamentals of AI techniques. They will learn the concepts of intelligent systems for pattern recognition and statistical reasoning, develop smart applications using AI, understand computational mathematics for learning and data analysis, explore the algorithms for heuristic search and state space search. An introduction to machine learning, deep learning etc. will also be provided.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Introduction of AI: The AI basics, AI Problems, the core assumptions of AI, the need of AI over the traditional methods, the AI Techniques, the level of the Model, Criteria for success and failure of the models, Artificial intelligence fundamentals, Machine learning, Human languages technologies, Distributed systems: paradigms and models for AI, Intelligent systems for pattern recognition, Smart applications using AI, Computational mathematics for learning and data analysis.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	Algorithms for Heuristic search and State space search, Defining problem as state space search, Production Systems, Production Characteristics, Production System Characteristics, And issues in the design of search programs, Additional problems. Generate-and-test, Hill climbing, Best-first search, Problem reduction, Constraint satisfaction, Means-ends analysis.	**08**	PO1/ PO2/ PO3	PSO1/ PSO2
Module-3	Application of AI in Natural language processing, Introduction, syntactic processing, semantic analysis, discourse and pragmatic processing, spell checking, Measures of WordNet similarity, Sentiment analysis and opinions on the web.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-4	Exploring sub-discipline of AI: Machine Learning, Supervised learning, Unsupervised learning, Reinforcement learning, Classification problems, Regression problems, Clustering problems, Introduction to neural networks and deep learning.	**08**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2
Module-5	Statistical Reasoning: Probability and Bays' Theorem, Certainty Factors and Rule-Base Systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic. AI for knowledge representation, rule-based knowledge representation, procedural and declarative knowledge, Logic programming, Forward and backward reasoning. Introduction to Prolog: Syntax and numeric function, Basic list manipulation functions in Prolog, functions, predicates and conditional, Input, Output and local variables, Iteration and recursion.	**08**	PO1/ PO2/ PO3/ PO4/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Understand the need for Artificial Intelligence and the limitations of conventional methods. • Design, Develop, and Implementation of various AI methods in Prolog, and in Python for prediction, regression, classification, clustering, Searching, and decision-making problems. • Demonstrate the ideas behind selection of various AI methods and their use.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Nils J. Nilsson, Artificial Intelligence: A New Synthesis (1 ed.), Morgan-Kaufmann, 1998. ISBN 978-1558605350.
2.	Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3 ed.), Pearson, 2010. ISBN 978-0136042594.
3.	Bishop, Christopher M, Pattern Recognition and Machine Learning (1 ed.), Springer, 2006. ISBN 978-1493938438.
4.	Daniel Jurafsky and James H. Martin, Speech & language processing (2 ed.), Pearson Education India, 2000. ISBN 978-0131873216.
5.	Shalev-Shwartz, Shai, and Shai Ben-David, Understanding machine learning: From theory to algorithms (3 ed.), Cambridge university press, 2014. ISBN 978-1107512825.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√	√									√	√
CO3	√	√	√	√								√	√	√

Course Code: BCE-O631
Course Name: DIGITAL IMAGE PROCESSING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Data compression, MATLAB
Objectives:	• To provide an idea of image, video. • To provide the visualization of relationships between spatial and frequency.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Digital Image Fundamentals-**Elements of visual perception, image sensing andacquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.	**08**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Image Enhancements and Filtering-** Gray level transformations, histogramequalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.	**08**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-3	**Image Compression:** Image compression fundamentals; Coding Redundancy, Spatial and Temporal redundancy, Compression models; Lossy& Lossless, Huffman coding, bit plane coding, Transform coding, Predictive coding, Wavelet coding, Lossy Predictive coding Still image compression standards–JPEG and JPEG-2000.	**08**	PO1/ PO4	PSO1/ PSO2
Module-4	**Basic Steps of Video Processing:** Analog Video, Digital Video, Time Varying Image Formation models; Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.	**08**	PO1/ PO3	PSO1/ PSO2
Module-5	2-D Motion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding. Video Segmentation-Temporal segmentation–shot boundary detection, hard-cuts and soft-cuts; spatial segmentation–motion-based; Video object detection and tracking.	**08**	PO1/ PO2/ PO3/ PO11/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• The students shall be able to develop new state of the art image and video processing method. • Process these images for the enhancement of certain properties or for optimized use of the resources.

	• Develop algorithms for image compression and coding.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008
2.	Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition 2004
3.	Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition 2015

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√								√		√	√
CO3	√	√	√	√								√	√	√

Course Code: BCE-O632
Course Name: INDUSTRIAL ECONOMICS AND BUSINESS ADMINISTRATION

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	None.
Objectives:	● To learn the basics of Industrial Economics and Business Administration. ● To acquaint the participants with the concepts and techniques used in economic theory and to enable them to apply this knowledge in business decision making and administration. ● To explain the use of Industrial Economics and Business Administration in current job scenario. ● To practical knowledge of Industrial Economics and Business Administration. ● To learn what is the use of Industrial Economics and Business Administration in practical life and busines. ● Students develop basic skills for the job market. ● Provide an authentic opportunity for students to develop teamwork and leadership skills.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Industrial Economics:** Definition of Industrial Economics, The Structure, Conduct,Elasticity of demand and supply, Demand forecasting methods, Consumption laws, Types of competition, Break even analysis, National income accounting, Trends in Industrialization in India, Economies of scale, Production Planning and control.	**09**	PO1/PO2	PSO1/PSO2
Module-2	**Money, Banking and Financial Management:** Theories of Measurement of Concentration, Nature and functions of money, Functions of commercial and central banks, Credit creation in the banks, Balance of payment and trade, Foreign Exchange, Exchange control, Devaluation and Revaluation, Sources of Industrial Finance, Principles of accounting, Balance sheet & P & L A/C, Cash flow statement.	**09**	PO1/PO2	PSO1/PSO2
Module-3	**Principles of Management:** Managerial functions - Planning, Organizing Leading & Controlling.	**07**	PO1/PO2	PSO1/PSO2
Module-4	**Marketing Management:** Concept of marketing management, P's of marketing, Product life cycle, Market segmentation.	**07**	PO1/PO2	PSO1/PSO2
Module-5	**Personnel Management and Industrial Psychology:** Concept and importance of Personnel Management recruitment and selection, Training and development, Job evaluation, Fatigue, Accidents - causes and prevention, Nature of Industrial relations, Industrial disputes, Quality of work life.	**08**	PO1/PO2	PSO1/PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Develop a strong understanding of the Industrial Economics and Business Administration and how it can be applied for business purpose to treat problems in diseases. • Emphasis is given to changes in the nature of business firms in the context of globalization. • Learn to research and understand the unique needs of specific challenges in Industrial Economics and Business Administration. • Develop the willingness to take a risk and the ability to deal with failure.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Dewtt. K.K., Modern Economic Theory" S. Chand, & Co (r) Ltd (r) 1999.
2.	Robbins (r) P. Stephen, Coutter Mary, 'Management' PHI 1998.
3.	Kotler Philip, 'Marketing Management', PHI latest edition.
4.	Nair N.G.,LathaNair,Personnel Management and Industrial Relations', S.Chand&Co 1999.
5.	Singh S.P. "Industrial Economics & Management" AITBS, New Delhi, 2006
6.	Kooutsnnis, 'Modern Economic Theory', PHI, 1996.
7.	Maheswari S.N., 'An Introduction to Accountancy' Vikas Publishing House 1999.
8.	Koontz Harold, O Donnel Cyril, WeihirchHeniz, 'Management', TMH-1983.
9.	MonoppanArun, Sayadain S (r) Mirza, 'Personnel Management', TMH 1997 Edn.

Course Code: BCE-O633
Course Name: INTRODUCTION TO DATA SCIENCE AND DESIGN THINKING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Elementary programming knowledge
Objectives:	● An understanding of problems solvable with data science and an ability to attack them from a statistical perspective. ● An understanding of when to use supervised and unsupervised statistical learning methods on labeled and unlabeled data-rich problems. ● The ability to create data analytical pipelines and applications in Python. ● Familiarity with the Python data science ecosystem and the various tools needed to continue developing as a data scientist. ● To learn the basics of design thinking and good design concepts ● To explore design thinking applications in computer science ● To understand design-based issues of product and services ● Demonstrate the value of developing a local network and assist students in making lasting connections with the business community. ● Students develop a portfolio of work to set them apart in the job market. ● Provide an authentic opportunity for students to develop teamwork and leadership skills.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction to Data Science –**Evolution of Data Science – Data Science Roles – Stages in a Data Science Project – Applications of Data Science in various fields – Data Security Issues.	**09**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Data Collection Strategies –**Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization.	**09**	PO2/ PO4/ PO5	PSO1/ PSO2
Module-3	Descriptive Statistics – Mean, Standard Deviation, Skewness and Kurtosis – Box Plots – Pivot Table – Heat Map – Correlation Statistics – ANOVA.	**07**	PO1/ PO2/ PO3/ PO5	PSO1/ PSO2
Module-4	**Introduction to Design Thinking:**Definition of design thinking, good design and bad design, importance of design thinking, applications of design thinking. Stages of Design thinking: Empathize, Define, Ideate, Prototype, Test and Implement. The evolution of technology using design thinking, innovative examples of design thinking - Life Saving Dot, Embrace Incubator, Project Bloks, Pillpack, Aarambh Desk.	**07**	PO1/ PO3/ PO4/ PO5/ PO11	PSO1/ PSO2
Module-5	**Case Studies, Design for Specific Culture:**Case studies of Zip line, Tesla, AirBNB, The body Shop, Patagonia, Ben & Jerry's, 23 and Me, War child, Warby Parker and Toms Shoes.	**08**	PO4/ PO5/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• Demonstrate proficiency with statistical analysis of data. • Demonstrate skill in data management. • Apply data science concepts and methods to solve problems in real-world. • Develop a strong understanding of the design process • Learn how to create physical prototypes / a visual representation of an idea

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Saltz, Jeffrey S., and Jeffrey M. Stanton. *An introduction to data science*. Sage Publications, 2017.
2.	JojoMoolayil, "Smarter Decisions: The Intersection of IoT and Data Science", PACKT, 2016.
3.	Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015.
4.	Luchs, Michael G. "A brief introduction to design thinking." *Design thinking: New product development essentials from the PDMA* (2015): 1-12.
5.	Suyash Bhardwaj, "*10 Amazing Stories of Design Thinking that Shaped the Future: Learning Through Design Thinking*", Amazon, 2023. ISBN - 978-93-5906-723-0
6.	David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big data Analytics", EMC 2013
7.	Raj, Pethuru, "Handbook of Research on Cloud Infrastructures for Big Data Analytics", IGI Global.
8.	Cross, Nigel. *Design thinking: Understanding how designers think and work*. Berg, 2011.
9.	Meinel, Christoph, and Larry Leifer. "Design thinking research." *Design thinking research*. Springer, Berlin, Heidelberg, 2012. 1-11.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√								√		√	√
CO3	√	√	√	√								√	√	√
CO4	√	√		√	√							√	√	√
CO5	√	√	√	√	√							√	√	√

Course Code: BCE-O634
Course Name: DATA MINING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Knowledge of Database Management Systems and probability & statistics
Objectives:	● It presents methods for mining frequent patterns, associations, and correlations. ● It then describes methods for data classification and prediction, and data–clustering ● approaches. ● It covers mining various types of data stores such as spatial, textual, multimedia, streams.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Data Mining:** Data–Types of Data–, Data Mining Functionalities– Interestingness Patterns– Classification of Data Mining systems– Data mining Task primitives –Integration of Data mining system with a Data warehouse–Major issues in Data Mining–Data Preprocessing.	**09**	PO1/ PO2/ PO12	PSO1/ PSO2
Module-2	**Association Rule Mining:** Mining Frequent Patterns–Associations and correlations – Mining Methods– Mining Various kinds of Association Rules–Correlation Analysis– Constraint based Association mining. Graph Pattern Mining, SPM.	**09**	PO1/ PO2	PSO1/ PSO2
Module-3	**Classification:** Classification and Prediction **–** Basic concepts–Decision tree induction–Bayesian classification, Rule–based classification, Lazy learner.	**07**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-4	**Clustering and Applications:** Cluster analysis–Types of Data in Cluster Analysis–Categorization of Major Clustering Methods– Partitioning Methods, Hierarchical Methods– Density–Based Methods, Grid–Based Methods, Outlier Analysis.	**07**	PO1/ PO3/ PO5	PSO1/ PSO2
Module-5	**Advanced Concepts:** Basic concepts in Mining data streams–Mining Time–series data—Mining sequence patterns in Transactional databases– Mining Object–Spatial– Multimedia–Text and Web data – Spatial Data mining– Multimedia Data mining–Text Mining– Mining the World Wide Web.	**08**	PO5/ PO12	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Ability to understand the types of the data to be mined and present a general classification of tasks and primitives to integrate a data mining system. ● Apply preprocessing methods for any given raw data. ● Extract interesting patterns from large amounts of data. ● Discover the role played by data mining in various fields. ● Choose and employ suitable data mining algorithms to build analytical applications

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Data Mining – Concepts and Techniques – Jiawei Han &MichelineKamber, 3rd Edition Elsevier.

2.	Data Mining Introductory and Advanced topics – Margaret H Dunham, PEA.
3.	Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005.

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√	√									√	√
CO4	√	√		√	√								√	√
CO5	√	√	√	√	√							√	√	√

Course Code: BCE-O635
Course Name: NATURAL LANGUAGE PROCESSING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Fundamentals of machine learning& linear algebra.
Objectives:	• To understand fundamentals and current trends & systems in natural language processing. • Tocomprehend the fundamentals syntax, semantics and pragmatics of the language. • To be able to identify the implication of pragmatics for natural language understanding. • To understand existing methods for statistical approaches to machine translation.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Introduction, Ambiguity in language, Segmentation, Stemming, Tokenization, Representation of word, Sentence, Word embedding, Word Senses, Linguistic Structure: Dependency Parsing.	**09**	PO1/ PO2	PSO1/ PSO2
Module-2	Word Window Classification, Neural Networks for text, N-gram Language Models, Perplexity, Hidden Markov Models, Viterbi algorithm, Recurrent Neural network, Vanishing Gradients and exploding gradient.	**09**	PO1/ PO2/ PO4/ PO5	PSO1/ PSO2
Module-3	LSTM (Long sort term memory), GRU (Gated recurrent Unit), Part of speech tagging, BERT, XLnet.	**07**	PO1/ PO3	PSO1/ PSO2
Module-4	Statically Machine Translation, Neural Machine Translation, Seq2Seq Modelling, Attention, Question Answering Bot.	**07**	PO1/ PO3/ PO4/ PO5	PSO1/ PSO2
Module-5	1D-CNN for NLP, Sub-word Models, Contextual Representations, Transformers, Self-Attention for Generative Models, Natural Language Generation, Neural Machine Translation.	**08**	PO4/ PO5	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	• To understand natural language processing and importance of word representation. • Apply deep learning to solve natural language problems such as language modelling, machine translation, POS tagging, Seq2Seq generation. • Solve NLP problem in Indian context (Indian languages).

Studio Work / Laboratory Experiments	The laboratory of Natural Language Processing is designed to provide a practical exposure to the students about the concepts and topics taught in the classroom sessions.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Daniel Jurafsky and James H. Martin, Speech and Language processing an introduction to Natural Language Processing, Computational Linguis (2 ed.), Prentice Hall, 2008. ISBN 978-0131873216.
2.	Steven Bird, Ewan Klein and Edward Lopper, Natural Language Processing with Python (2 ed.), O'Reilly, 2009. ISBN 978-0596516499.
3.	Siddiqui and Tiwari, Natural Language Processing and Information Retrieval (1 ed.), Oxford University Press, 2008. ISBN 978-0195692327.
4.	Nitin Indurkhya, Fred J. Damerau and Fred J. Damerau, Handbook of Natural Language Processing (2 ed.), Taylor and Francis, 2010. ISBN 978-1420085921.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√			√								√	√
CO2	√	√	√										√	√
CO3	√	√	√	√									√	√

Course Code: BCE-O636
Course Name: E-COMMERCE & SOCIAL MEDIA ANALYSIS

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic knowledge commerce and internet.
Objectives:	● Understand fundamentals of E-commerce. ● Understand the method of Social Media Analytics and its impact on an organization's business. ● Learn to apply marketing fundamentals using digital media or the internet.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	Introduction to ecommerce: ecommerce analysis, digital economy ecommerce and development, ecommerce processes and use of data analytics, online vs offline retail and role of technology, benefits of ecommerce analysis, using the measurement plan, reporting vs analysis, analysis preparation; understanding customers: traffic source analysis, multi-channel analysis, customer profile analysis; understanding shopping behavior: enhanced ecommerce overview, on-site merchandising analysis, shopping behavior analysis, checkout analysis.	**09**	PO1/ PO2	PSO1/ PSO2
Module-2	Introduction to social media analytics: the role and structure of social media conversations, methods for and implications of gathering data, unlocking values from social data, social media monitoring vs listening, key metrics for analyzing data, methods for identifying trends in social data, the theory of social networks, methods for creating and interpreting data visualizations, social media crisis management.	**09**	PO1/ PO3	PSO1/ PSO2
Module-3	Ecommerce analysis: click stream analytics-basic concepts in web analytics, case study customer segmentation, conversion modelling, market basket analysis for recommendation engine, predicting fashion adoption; Machine learning and Big Data.	**07**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-4	Understanding Web Analytics: Purpose, History, Goals & objectives, Web Analytic tools & Methods. Web Analytics Mistakes and Pitfalls. Search Engine Optimization: Meaning, Common SEO techniques, Understanding Search Engines, basics of Keyword search, Google rankings, Link Building, Steps to optimize website.	**07**	PO1/ PO3/ PO4	PSO1/ PSO2
Module-5	Social Media Analytics tools: Buffer, ViralWoot, Google Analytics, Cyfe, TweetReach, IBM Watson Personality Insight, Social Rank; Application of Social Media Monitoring, role of social media in innovation, The Customer Profile: Your Brand's Secret Weapons, Methods for creating and interpreting data visualization.	**08**	PO2/ PO4	PSO1/ PSO2
Total No. of Hours		**40**		

Learning Outcomes:	● Understand e-commerce applications. ● Understand customer shopping behavior. ● Understand social media and e-commerce analytics.

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Gary P Schneider, Electronic commerce, Thomson learning & James T Peny Cambridge USA, 2001. ISBN 978-0538469241.
2.	William Stallings and Lawrie Brown, Computer Security: Principles and Practice (3 ed.), Pearson, 2014. ISBN 978-0133773927.
3.	Fundamentals of Digital Marketing by Punit Singh Bhatia, Pearson
4.	Judah Phillips, Ecommerce Analytics: Analyze and Improve the Impact of Your Digital Strategy, Publisher: PH Professional Business, 2016. ISBN 9780134177281.
5.	Marketing 4.0: Moving from Traditional to Digital by Philip Kotler, Publisher Wiley.
6.	The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Campaigns by Ian Dodson, Wiley Publisher

CO-PO/PSO MAPPING

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√		√									√	√

Course Code: BCE-O647
Course Name: JAVA BASED OBJECT ORIENTED PROGRAMMING

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic knowledge of programming(C/C++) and concept of algorithm development.
Objectives:	● To acquire programming skills in core Java and Python. ● To acquire Object Oriented Skills in Java. ● To solve simple problems using the fundamental syntax and semantics of Java & Python. ● To learn how to use lists, tuples, and dictionaries in Python programs.

NOTE:	The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Module	Course Content	No. of Hours	POs mapped	PSOs mapped
Module-1	**Introduction:** Features of Java byte code, data types, variables, declaring variables, arrays, operators, control statements, type conversion and casting, compiling and running of simple Java program. **Classes and Objects:** Concepts of classes and objects, class fundamentals Declaring objects, assigning object reference variables, introducing methods, constructors, usage of static with data and methods, usage of final with data, access control, this key word, overloading methods and constructors, parameter passing – call by value, nested classes and inner classes, exploring the String class.	**08**	PO1/ PO2	PSO1/ PSO2
Module-2	**Inheritance:** Basic concepts, member access rules, usage of super key word, forms of inheritance, method overriding, abstract classes, dynamic method dispatch, using final with inheritance, the Object class. **Packages and Interfaces:** Defining, Creating and Accessing a Package, understanding class path, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces.	**08**	PO1/ PO3	PSO1/ PSO2
Module-3	**Exception Handling and Multithreading:** Concepts of Exception handling, types of exceptions, usage of try, catch, throw, throws and finally keywords, Built-in exceptions, creating own exception sub classes, Concepts of Multithreading, thread life cycle, creating multiple threads using Thread class, Runnable interface, Synchronization.	**08**	PO1/ PO4	PSO1/ PSO2
Module-4	**Event Handling:** Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes	**08**	PO1/ PO2/ PO4	PSO1/ PSO2
Module-5	JDBC: The connectivity Model, JDBC/ODBC Bridge, java.sql package, connectivity to remote Database, navigating through multiple rows retrieved from a database, selection, insertion, updating and deletion in database using JDBC.	**08**	PO1/ PO3	PSO1/ PSO2

Total No. of Hours	**40**		

Learning Outcomes:	● Describe the features of Java & Python. ● Design classes with object-oriented features in Java ● Describe advanced features of Java like exception handling, multithreading etc. ● Write programs in JAVA and Python featuring its core capabilities

Suggested books:

S. No.	Name of Authors /Books /Publisher/Year
1.	Herbert schildt (2010), The complete reference, 7th edition, Tata Mc graw Hill, New Delhi.
2.	Y. Daniel Liang (2010), Introduction to Java programming, 7th edition, Pearson education, India.
3.	Python Programming: A Modern Approach, VamsiKurama, Pearson.
4.	Learning Python, Mark Lutz, Orielly.
5.	Herbert Schildt, The Complete Reference Java J2SE 5th Edition, TMH Publishing Company Ltd.
6.	Head First Java, O'rielly publications.
7.	J. Nino, F. A. Hosch (2002), An Introduction to programming and OO design using Java, John Wiley & sons, New Jersey.
8.	Think Python, Allen Downey, Green Tea Press.
9.	Core Python Programming, W.Chun, Pearson.

CO-PO/PSO MAPPING														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√											√	√
CO2	√	√	√										√	√
CO3	√	√	√	√									√	√
CO4	√	√		√									√	√

Course Code: BCE-C667
Course Name: JAVA BASED OBJECT ORIENTED PROGRAMMING LAB

MM: 50 **Time: 2 Hr.** **L T P** **0 0 2**	**Sessional: 15** **ESE: 35** **Credit: 01**

Objectives:	• To understand the fundamental concepts of Java &Python programming language. • To implement OOPs concepts and Multithreading fundamentals in core Java and Python. • To apply programming skills to demonstrate different concepts of java like event handling, database connectivity and servlets.

NOTE:	1. In practical examination the student shall be required to perform one experiment. 2. A teacher shall be assigned 20 students for daily practical work in the laboratory. 3. No batch for practical class shall consist of more than 20 students. 4. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students. 5. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean.

LIST OF EXPERIMENTS	**No. of Hours**	**POs mapped**	**PSOs mapped**
1. Classes and Objects: Programs to illustrate the concept of object and classes. 2. Inheritance packages and interface: Programs to illustrate the concepts of Inheritance, packages and interfaces. 3. Multithreading: programs to illustrate concepts of multithreading in Java. 4. Event Handling: programs in Java to handle Mouse and Keyboard events. 5. Java Database Connectivity: Programs to connect, control and manipulate database.	**02**	PO1/ PO2/ PO3/ PO4	PSO1/ PSO2

Learning Outcomes:	• Apply fundamental syntax and semantics of Java & Python programming language. • Become able to implement OOPs and interface concepts in core Java. • Develop reusable code to demonstrate different fundamentals of java like event handling, database connectivity and servlets.

CO-PO/PSO MAPPING

Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√	√	√									√	√
CO2	√	√	√										√	√
CO3	√	√	√	√									√	√