NEW HORIZON COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA
New Horizon Knowledge Park, Ring Road, Bellandur Post, Bengaluru 560 103

Department of Master of Computer Applications

**Third & Fourth Semester MCA
Scheme & Syllabus**

ACADEMIC YEAR 2021-22

	CONTENTS	
1.	Vision, Mission of the College and Department	3-4
2.	Program Educational Objectives (PEO), Program Specific Objectives & PEO to Mission Statement Mapping	5-6
3.	Program Outcomes (PO) with Graduate Attributes	7
4.	Mapping of POs with PEOs	8
5.	MCA Program Credit Structure	9
	SCHEME	
6.	Scheme of Third Semester MCA	10
7.	Scheme of Fourth Semester MCA	12
8.	**SYLLABUS OF THIRD SEMESTER MCA**	
	a) DESIGN AND ANALYSIS OF ALGORITHMS	14
	b) MACHINE LEARNING TECHNIQUES	17
	c) ELECTIVE - 3	21-35
	d) ELECTIVE - 4	36-52
	e) ELECTIVE - 5	53-70
	f) PYTHON PROGRAMMING LAB	71
	g) BIGDATA ANALYTICS LAB	74
	h) MINI PROJECT(IOT/CLOUD/PYTHON/ML)	78
9.	**SYLLABUS OF FOURTH SEMESTER MCA**	
	a) INDUSTRY INTERNSHIP / PROJECT	83
	b) RESEARCH / TECHNICAL SEMINAR	87
	c) ELECTIVE - 6	89-106

NEW HORIZON COLLEGE OF ENGINEERING

VISION

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

MISSION

To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research and innovation among faculty members and students.
To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.
To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

QUALITY POLICY

To provide educational services of the highest quality both curricular and co-curricular to enable students integrate skills and serve the industry and society equally well at global level.

VALUES

- Academic Freedom
- Integrity
- Inclusiveness
- Innovation
- Professionalism
- Social Responsibility

DEPARTMENT OF MCA

VISION

To emerge as a department of eminence in the field of Computer Applications in serving the Information Technology Industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

MISSION

To strengthen the theoretical, practical and ethical aspects of the learning while inculcating a culture of research, innovation and practical applications amongst faculty and students.

To encourage long-term interactions between the department and the IT Industry through rich involvement of the Industry in the design of the curriculum and its hands-on implementation.

To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

QUALITY POLICY

To provide services of the highest quality both curricular and co-curricular, so that our students can integrate their skills and serve the industry and society equally well at the global level.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1 Pursue and excel in the field of Computer Applications and contribute to academia, industry and research.

PEO2 Deliver software solutions that are socially relevant and adopt quickly to emerging technologies.

PEO3 Demonstrate professional behavior by understanding ethical and communication skills to engage in lifelong learning.

PROGRAM SPECIFIC OUTCOME (PSOs)

PSO1
Ability to design, develop, implement computer programs and apply the knowledge in various domains to identify research gaps and to provide solutions to new ideas and innovations.

PSO2
Work and communicate effectively with professionals in various fields and pursue lifelong professional development in computing.

PEO to Mission Statement Mapping
Correlation: 3-High, 2-Medium, 1-Low

Mission Statements	PEO1	PEO2	PEO3
To strengthen the theoretical, practical and ethical aspects of the learning while inculcating a culture of research, innovation and practical applications amongst faculty and students.	3	3	3
To encourage long-term interactions between the department and the IT Industry through rich involvement of the Industry in the design of the curriculum and its hands-on implementation.	3	2	3
To strengthen and mould students in professional, ethical, social and environ -mental dimensions by encouraging parti -cipation in co-curricular and extra -curricular activities.	3	3	3

Program Outcomes (PO) with Graduate Attributes

PROGRAMME OUTCOMES (POs)

PO1 **Computational Knowledge:** Apply computing knowledge, mathematical knowledge and domain knowledge to create and develop new models for real world applications.

PO2 **Problem Analysis:** Identify, formulate, review research literature and analyze complex problems using principles of mathematics, computing sciences and relevant domains.

PO3 **Design / Development of Solutions:** Design, implement, test and maintain solutions for systems, components or processes that meet specific needs with consideration for public health safety, societal and environmental issues.

PO4 **Conduct investigations of complex Computing problems:** Use Research–based knowledge to analyze and interpret data to obtain viable conclusions.

PO5 **Modern Tool Usage:** Use modern tools, techniques and skills to solve complex and critical computing problems with an understanding of their limitations.

PO6 **Professional Ethics:** Understand and apply ethical principles, cyber regulations and commit to professional computing practice and responsibilities.

PO7 **Life-long Learning:** Recognize the importance of self-learning for continual development as a computing professional.

PO8 **Project management and finance:** Demonstrate the management principles for managing projects as an individual, as a member and as a leader in a team under multidisciplinary environments.

PO9 **Communication Efficacy:** Recognize the importance of communication within the computing community and the society at large.

PO10 Societal and Environmental Concern: Understand and assess the local and global influence of software solutions and responsibilities related to professional computing practice.

PO11 Individual and Team Work: Deliver effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.

PO12 Innovation and Entrepreneurship: Adopt standardized computer application practices with innovative ideas to succeed as an employee or an entrepreneur.

Mapping of POs to PEOs

PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	3	3	3	2	1	3	2	2	3	3
PEO2	3	3	3	2	3	2	1	3	2	3	3	3
PEO3	2	2	3	2	2	3	3	2	2	3	2	2

Correlation: 3- High, 2-Medium, 1-Low

NEW HORIZON COLLEGE OF ENGINEERING

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Accredited by **NAAC** with 'A' Grade. Accredited bay NBA
The Trust is a Recipient of Prestigious Rajyotsava State Award 2012 Conferred by the Government of Karnataka.
Awarded Outstanding Technical Education Institiute in Karnataka.

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
MCA DEGREE CURRICULUM – CREDIT DISTRIBUTION TABLE
ACADEMIC YEAR 2021-2022: SEMESTER I TO IV

SEMESTER	CORE	ELECTIVE	MINI PROJECT / PROJECT WORK	SEMINAR	TOTAL CREDITS
I	25	0	0	0	25
II	17	6	2	0	25
III	11	12	2	0	25
IV	0	2	21	2	25
TOTAL	53	20	25	2	100
% of Distribution	53%	20%	25%	2%	100%
% of Requirement	40-55	20-35	20-35	02-10	

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
SCHEME OF THIRD SEMESTER MCA PROGRAM

S NO	COURSE CODE	COURSE	B O S	CREDIT DISTRIBUTION				OVERALL CREDITS	CONTACT HOURS WEEKLY	MARKS		
				L	T	P	S			CIE	SEE	TOTAL
1	20MCA31A	DESIGN AND ANALYSIS OF ALGORITHMS	MCA	4	0	0	0	4	4	50	50	100
2	20MCA32A	MACHINE LEARNING TECHNIQUES	MCA	4	0	0	0	4	4	50	50	100
3	20MCA33XA	ELECTIVE - 3	MCA	4	0	0	0	4	4	50	50	100
4	20MCA34XA	ELECTIVE - 4	MCA	4	0	0	0	4	4	50	50	100
5	20MCA35XA	ELECTIVE - 5	MCA	4	0	0	0	4	4	50	50	100
7	20MCAL36A	PYTHON PROGRAMMING LAB	MCA	0	0	1.5	0	1.5	3	25	25	50
8	20MCAL37A	BIGDATA ANALYTICS LAB	MCA	0	0	1.5	0	1.5	3	25	25	50
9	20MCA38A	MINI PROJECT (IOT/CLOUD/PYTHON/ML)	MCA	0	0	2	0	2	4	25	25	50
		TOTAL		20	0	5	0	25	30	325	325	650
L -Lecture (1 hour), T- Tutorial (2 hours), P-Practical (2 hours)												

		ELECTIVE - 3 (AI TRACK)						
SNO	**COURSE CODE**	**COURSE**	**BOS**	**CREDIT DISTRIBUTION**				**TOTAL**
				L	**T**	**P**	**S**	
1	20MCA331A	DATA SCIENCE	MCA	4	0	0	0	4
2	20MCA332A	DEEP LEARNING	MCA	4	0	0	0	4
3	20MCA333A	REINFORCEMENT LEARNING	MCA	4	0	0	0	4
4	20MCA334A	NEURAL NETWORKS	MCA	4	0	0	0	4
5	20MCA335A	ARTIFICIAL INTELLIGENCE	MCA	4	0	0	0	4

		ELECTIVE - 4 (COMPUTING SERVICES & MULTIMEDIA TRACK)						
SNO	**COURSE CODE**	**COURSE**	**BOS**	**CREDIT DISTRIBUTION**				**TOTAL**
				L	**T**	**P**	**S**	
1	20MCA341A	CLOUD COMPUTING	MCA	4	0	0	0	4
2	20MCA342A	GRID AND HIGH PERFORMANCE COMPUTING	MCA	4	0	0	0	4
3	20MCA343A	MICROSERVICES ARCHITECTURE	MCA	4	0	0	0	4
4	20MCA344A	SOCIAL MEDIA ANALYTICS	MCA	4	0	0	0	4
5	20MCA345A	AUGMENTED REALITY AND VIRTUAL REALITY	MCA	4	0	0	0	4

		ELECTIVE-5 (RECENT TRENDS TRACK)						
SNO	**COURSE CODE**	**COURSE**	**BOS**	**CREDIT DISTRIBUTION**				**TOTAL**
				L	**T**	**P**	**S**	
1	20MCA351A	INTERNET OF EVERYTHING	MCA	4	0	0	0	4
2	20MCA352A	MOBILE APPLICATION DEVELOPMENT	MCA	4	0	0	0	4
3	20MCA353A	BLOCKCHAIN TECHNOLOGIES	MCA	4	0	0	0	4
4	20MCA354A	FULL STACK DEVELOPMENT TOOLS	MCA	4	0	0	0	4
5	20MCA355A	COMPUTER VISION	MCA	4	0	0	0	4

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
SCHEME OF FOURTH SEMESTER MCA PROGRAM

S NO	COURSE CODE	COURSE	B O S	CREDIT DISTRIBUTION				OVERALL CREDITS	CONTACT HOURS WEEKLY	MARKS		
				L	T	P	S			CIE	SEE	TOTAL
1	20MCA41A	INDUSTRY INTERNSHIP / PROJECT WORK	MCA	0	0	21	0	21	-	150	150	300
2	20MCA42A	RESEARCH / TECHNICAL SEMINAR	MCA	0	0	0	2	2	-	25	25	50
3	20MCA43XA	ELECTIVE - 6	MCA	2	0	0	0	2	2	25	25	50
		TOTAL		2	0	21	2	25	2	200	200	400
	L -Lecture (1 hour), T- Tutorial (2 hours), P-Practical (2 hours)											

ELECTIVE - 6 (INNOVATION AND MANAGEMENT TRACK)								
SNO	COURSE CODE	COURSE	BOS	CREDIT DISTRIBUTION				TOTAL
				L	T	P	S	
1	20MCA431A	DESIGN THINKING	MCA	2	0	0	0	2
2	20MCA432A	RESEARCH METHODOLOGY & IPR	MCA	2	0	0	0	2
3	20MCA433A	ENTREPRENEURSHIP AND INNOVATION MANAGEMENT	MCA	2	0	0	0	2
4	20MCA434A	PROFESSIONAL ETHICS	MCA	2	0	0	0	2
5	20MCA435A	ECONOMICS FOR SOFTWARE ENGINEERS	MCA	2	0	0	0	2

THIRD SEMESTER

MCA SYLLABUS

2-YEAR PROGRAM

DESIGN AND ANALYSIS OF ALGORITHMS

Course Code   : 20MCA31A   Credits : 04

L:T:P:S   : 4:0:0:0   **CIE Marks** : 50

Exam Hours   :3   **SEE Marks** : 50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Summarize the paradigms and approaches used to design and analyze algorithms by categorizing problems based on the popular domains.
CO2	Discuss Brute Force, Divide & conquer algorithms and measure their performance.
CO3	Classify the different Decrease and conquer algorithms and discuss space and time tradeoffs technique.
CO4	Characterize the features of various graphical problems with the help of a suitable technique.
CO5	Evaluate the limitations of algorithm by categorizing the problems such as P, NP or NP Complete.
CO6	Apply Backtracking and Branch & Bound techniques to solve different problems and analyze their performance.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	-	-	-		-	-	-	-	-	3	3
CO2	2	3	3	2	-	-	2	-	-	-	2	-	3	3
CO3	2	3	3	2	-	-	2	-	-	-	2	-	3	3
CO4	2	3	3	2	-	-	2	-	-	-	2	-	3	3
CO5	2	3	3	-	-	-	2	-	-	-	2	-	3	3
CO6	2	3	3	-	-	-	2	-	-	-	2	-	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Introduction:** Notion of Algorithm, Fundamentals o f Algorithmic Problem Solving, Important Problem Types, Basics of data structures. **Fundamentals of the Analysis of Algorithm Efficiency:** Analysis Framework, Asymptotic Notations and Basic efficiency classes, Mathematical analysis of Recursive and Non-recursive algorithms, Examples.	9	CO1
2	**Brute Force:** Selection Sort, Bubble sort, String Matching, Exhaustive Search. **Divide and Conquer:** Merge sort, Quick sort, Binary Search, Binary tree traversals and related properties, Multiplication of large integers.	9	CO2
3	**Decrease and Conquer:** Insertion Sort, Depth-First and Breadth-First Search, Topological sorting, Algorithms for Generating Combinatorial Objects, Decrease by a constant factor algorithms. **Space and Time Tradeoffs:** Sorting by Counting, Input Enhancement in String Matching using Horspool's Algorithm, Hashing, B-Trees.	9	CO3
4	**Dynamic Programming:** Computing a binomial coefficient, Warshall's and Floyd's algorithms, Knapsack Problem. **Greedy Technique:** Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees.	9	CO4
5	**Limitations of algorithm power:** Introduction, Lower bound arguments, Decision trees, P, NP and NP-complete problems. **Coping with the limitations of algorithm power:** Backtracking, n-queens problem, Hamiltonian Circuit problem, Subset-Sum problem. Branch-and-Bound - Knapsack problem, Travelling Salesman Problem, Assignment problem.	9	CO5, CO6

Text Books:

1. Algorithms: Design and Analysis, Sushil C. Dimri, Preeti Malik, Mangey Ram, De Gruyter Publications, 2021, ISBN: 9783110693751.
2. Introduction to the Design and Analysis of Algorithms, Anany Levitin, Pearson Education, 3rd Edition, 2012, ISBN: 978013231681.
3. Fundamentals of Computer Algorithms, Horowitz E., Sahani S., Rajasekharan S, Galgotia Publications, 2nd Edition, ISBN: 9788175152571.

Reference Books:

1. Design and Analysis of Algorithms, Sandeep Sen, Amit Kumar, Cambridge University Press, 2019, ISBN: 978110849682.
2. Design and Analysis of Algorithms, Parag H. Dave, Pearson Education, 2007, ISBN: 9788177585957.
3. Introduction to Algorithms, Thomas H. Cormen, Charles E.Leiserson, Ronal L.Rivest, Clifford Stein, MIT Press, 2001, ISBN: 9780262032933.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	5	5
Understand	5	5	3
Apply	5	3	2
Analyze	5	2	-
Evaluate	2	-	-
Create	3	-	-

SEE - Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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MACHINE LEARNING TECHNIQUES

Course Code	:20MCA32A	**Credits**	:04
L:T:P:S	:4:0:0:0	**CIE Marks**	:50
Exam Hours	:3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss and identify the practical applications of Machine Learning (ML) and types of ML approaches.
CO2	Apply suitable ML algorithms using standard datasets.
CO3	Analyze the usage of supervised and unsupervised ML algorithms.
CO4	Develop simple scripts using R tool.
CO5	Evaluate the performance of classification and clustering algorithms using standard datasets.
CO6	Construct the ML algorithms using R tool.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	-	-	-	2	-	-	1	-	1	3	3
CO2	1	2	3	-	-	-	-	-	-	-	-	-	3	3
CO3	1	2	3	2	-	-	-	-	-	-	-	-	3	3
CO4	2	2	1	-	2	-	-	-	-	-	-	-	3	3
CO5	1	2	3	2	2	-	-	-	-	-	-	1	3	3
CO6	2	2	3	2	3	-	-	-	-	-	-	1	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Introduction to Machine Learning:** Definition of Learning, Need of ML, Types of learning, Origins of ML, Uses and abuses of ML, Ethical considerations, How Machines learn?, Abstraction and knowledge representation, Generalization, Assessing the success of learning, Steps to apply ML to data, Choosing a ML algorithm, the input data, types of ML algorithms, Matching data to an appropriate algorithm, ML Models, Applications of ML.	9	CO1
2	**Machine Learning Algorithms-I:** Neural Networks-Representation– Perceptron– Multilayer Networks and Back Propagation Algorithms, Decision Tree, Bayesian Method – Naïve Bayes Classification, Instance Based Learning–K-Nearest Neighbor.	9	CO2
3	**Machine Learning Algorithms II:** Regression-Linear Regression, Logistic Regression, Support Vector Machine, Clustering, Genetic Algorithms and Genetic Programming.	9	CO3
4	**Introduction to R:** R Environment, R Packages and Libraries, Basics of R, Managing and Understanding Data, Reading Data into Data frames, Lists, Data handling, Statistical functions & Graphics, Writing Functions, Control Statements, Loops, Strings, Data Interfaces, Charts and Graphs.	9	CO4
5	**Machine Learning Techniques Implementation Using R:** Implementation techniques of algorithms using R with standard datasets - Neural Network, Decision Tree, Naïve Bayes, KNN, Regression, K-Means Clustering, Time Series Analysis.	9	CO5 CO6

Text Books:
1. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson Education India, 2019, ISBN: 9789353067373.
2. Mathematics and Programming for Machine Learning with R, By William B. Claster, CRC Press, Taylor & Francis, 2020, ISBN: 978-1-00-0196979.
3. Machine Learning, Tom M Mitchel, McGraw Hill Education, 2013, ISBN: 978-1-25-909695.
4. R for Everyone, Advanced Analytics and Graphics, Jared P Lander, Pearson Publication, 2015, ISBN: 978-93-325-3924-2.

Reference Books:
1. Machine Learning in Action, Peter Harrington, Manning Publications, 2012, ISBN: 978-1617290183.
2. Machine Learning, An Algorithmic Perspective, Stephen Marsland, CRC Press, 2009 ISBN: 978-1-4200-6718-7.
3. Understanding Machine Learning: From Theory to Algorithms, Shai Shalev-Shwartz, Shai Ben- David, 2014, ISBN: 978-1-107-05713-5.

CIE- Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	10
Remember	5	3	2
Understand	4	3	2
Apply	4	3	2
Analyze	4	2	2
Evaluate	4	2	2
Create	4	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

****

ELECTIVE - 3 (AI TRACK)

DATA SCIENCE

Course Code	: **20MCA331A**	**Credits**	:**04**
L:T:P:S	:**4:0:0:0**	**CIE Marks**	:**50**
Exam Hours	: **3**	**SEE Marks**	:**50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basics of Data Science (DS) and programming packages, stages in data pre-processing.
CO2	Use basic mathematics in DS applications.
CO3	Apply advanced statistics in DS applications.
CO4	Illustrate data manipulation concepts in Python.
CO5	Identify visualization of categorical and numerical data using software packages.
CO6	Formulate the customization of visualization outputs.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	2	-	-	-	-	-	-	-	-	3	3
CO2	3	2	1	-	-	-	-	-	-	-	-	2	3	3
CO3	2	2	-	2	-	-	-	2	-	-	-	-	3	3
CO4	2	-	2	-	2	-	-	1	-	-	-	-	3	3
CO5	1	2	1	-	2	-	-	-	-	-	-	-	3	3
CO6	1	2	1	1	2	-	-	-	-	-	-	-	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Data Science Introduction:** Basic terminologies, Venn diagram, Programming – Prebuilt Python modules: pandas, sci-kit learn, seaborn, numpy/scipy, requests (to mine data from the web), Beautiful soup (for web-html parsing), Types of Data – Structured versus Unstructured, Quantitative versus Qualitative data, Data pre-processing – example programs, Four levels of data and mathematical operations, other measures on all levels of data, Five Steps of DS and Basics of data exploration, Elementary case studies.	9	CO1
2	**Basic Mathematics for data science:** Vectors and Matrices, Arithmetic symbols, Graphs, Logarithms/exponents and Set theory. Linear Algebra – Matrix multiplication. **Introduction to Probability:** Basic definitions, Bayesian versus Frequentist, Compound events, Rules of probability, Advanced Probability – Bayes theorem, Applications, Random variables.	9	CO2
3	**Basic Statistics:** Statistics, Obtaining sample data, Sampling data, Statistical measures – center, variation and relativeness. **Advanced Statistics:** Sampling distributions, Confidence levels, Hypothesis tests – Conducting a test, One sample t-tests, Type-I and Type-II errors. Hypothesis test for categorical variables – Chi-Square goodness of fit test, Chi-Square test for association/independence.	9	CO3
4	**High Performance Packages:** Introduction to Numpy – Data types in Python, Basics of Numpy arrays, Computation on Numpy arrays – Universal functions, Aggregations, Broadcasting, Comparisons, Masks and Boolean logic, Fancy Indexing, Sorting arrays, Numpy's structured arrays. **Data manipulation:** Pandas objects, Data Indexing and selection, Operating on data in pandas, Handling missing data, Hierarchical Indexing, concat and append, merge and join, aggregation and grouping, pivot tables, vectorized string operations, working with time series, high-performance pandas – eval() and query().	9	CO4

| 5 | **Visualization Packages:** Introduction to Matplotlib – Importing, Setting styles, Displaying plots – Simple line plots, scatter plots. Visualizing errors, Density and Contour plots, Histograms, Binnings and Density, Customizing plot legends, Customizing colorbars, Multiple subplots, Text and Annotation, 3D plotting in Matplotlib. | 9 | CO5, CO6 |

Text Books:
1. Principles of Data Science, Sinan Ozdemir, Packt, 2016, ISBN: 978-1-78588-791-8.
2. Python Data Science Handbook, Jake VanderPlas, O'Reilly, 2017, ISBN: 978-93-5213-491-5.

Reference Books:
1. An Introduction to Data Science, Jeffrey S Saltz, Jeffrey Morgan Stanton, SAGE, 2017, ISBN: 978-1506377537.
2. Python Data Science – Essentials, Alberto Boschetti and Luca Massaron, Packt Publishers, 2015, ISBN: 978-1-78953-786-4.
3. Data Science from Scratch, Joel Grus, O'Reilly publishers, 2019, ISBN: 978-9352138326.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	5	3	-
Create	-	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

****

DEEP LEARNING

Course Code	: **20MCA332A**	**Credits**	**:04**
L:T:P:S	: **4:0:0:0**	**CIE Marks**	**:50**
Exam Hours	: **3**	**SEE Marks**	**:50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the applied mathematical concepts in the basics of machine learning.
CO2	Discuss Feedforward networks and build deep learning models.
CO3	Design deep learning models for improved performance over traditional models.
CO4	Apply deep learning concepts in research for advanced feature engineering applications.
CO5	Use deep learning concepts in advanced research problems.
CO6	Develop deep learning models across vivid domain applications.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	2	-	-	-	-	-	-	-	-	3	3
CO2	3	-	1	-	-	-	-	-	-	-	-	2	3	3
CO3	2	-	-	2	-	-	-	2	-	-	-	-	3	3
CO4	2	-	-	-	2	-	-	-	-	-	-	-	3	3
CO5	1	2	1	-	2	-	-	-	-	-	-	-	3	3
CO6	1	2	1	-	2	-	-	-	-	-	-	-	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Applied Math and Machine learning basics:** Linear Algebra, Probability and Information Theory, Numerical Computation, Learning Algorithms, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Challenges motivating deep learning.	9	CO1
2	**Modern Practices on Deep Networks-1: Deep Feedforward Networks:** Gradient-based Learning, Architectural Design, Back-Propagation and other differentiation algorithms, Regularization for Deep Learning, Optimization for Training Deep Models.	9	CO2
3	**Modern Practices on Deep Networks-2:** Convolutional Networks, **Sequence Modeling:** Recurrent and Recursive Nets, Recurrent Neural Networks, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, Echo State Networks, Applications.	9	CO3
4	**Deep Learning Research-1:** Linear Factor Models, Representation Learning: Greedy Layer-Wise Unsupervised Pre-training, Transfer learning and domain adaptation, Semi-supervised disentangling of casual factors, Structured Probabilistic Models for Deep Learning.	9	CO4
5	**Deep Learning Research-2:** Monte Carlo Methods, Confronting the partition function, Deep Generative Models: Boltzmann machines, Restricted Boltzmann machines, Deep belief networks, Deep Boltzmann machines, Convolutional Boltzmann machines, Other Boltzmann machines, Back propagation through random operations, Evaluating Generative Models.	9	CO5, CO6

Text Books:

1. Deep Learning from Scratch: Building with Python from First Principles, Seth Weidman, Shroff/O'Reilly, First edition, 2019, ISBN: 978-0352139026.
2. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, An MIT Press book, 2016, ISBN: 9780262035613.

Reference Books:

1. Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Publishers, First Edition, 2017, ISBN-13: 978-9352136049.
2. Deep learning with Python, Francois Chollet, Manning Publications, First Edition, 2017, ISBN: 978-1617294433.
3. Tensor Flow Deep Learning Cookbook, Antonio Gulli, Amita Kapoor, Packt Publications, 2017, ISBN: 9781788293594.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	3	3	-
Create	2	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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REINFORCEMENT LEARNING

Course Code	: **20MCA333A**	**Credits**	**:04**
L:T:P:S	**:4:0:0:0**	**CIE Marks**	**:50**
Exam Hours	**: 3**	**SEE Marks**	**:50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the fundamental ideas of modern Reinforcement Learning (RL).
CO2	Distinguish between on-policy and off-policy by solving problems using dynamic programming techniques and Monte-Carlo methods.
CO3	Predict the optimal values for a given signal.
CO4	Develop an intuitive learning for the prediction and approximation of RL.
CO5	Evaluate the predictions and hypothesis of Neuroscience.
CO6	Analyse real-time applications and case studies in RL.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	2	-	-	-	-	-	-	1	-	-	2	2
CO2	-	-	2	-	-	-	-	-	-	1	-	-	3	2
CO3	1	-	2	-	-	-	-	-	-	1	-	-	3	2
CO4	-	-	2	-	-	-	-	-	-	-	-	-	3	2
CO5	-	3	2	-	-	-	-	-	-	-	-	2	3	2
CO6	-	3	2	2	2	-	-	1	-	-	-	2	3	2

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Reinforcement Problem:** Introduction, Elements of Reinforcement Learning (RL), History, Evaluative feedback. **Finite Markovian Decision Processes (MDP)**: Goals and rewards, Returns, Policies and Value functions, Optimality criterion in MDPs.	**9**	**CO1**
2	**Dynamic Programming (DP):** Policy Evaluation, Policy Improvement, Value iteration, Asynchronous DP, Efficiency. **Monte Carlo Methods:** Policy Evaluation, Policy Improvement, On-policy and off- policy Monte Carlo controls, Incremental implementation.	**9**	**CO2**
3	**Temporal Difference Learning (TD):** TD prediction, Optimality, Sarsa, Q-Learning, TD-Traces Games. **n-step Bootstrapping**: Prediction, Sara, off-policy.	**9**	**CO3**
4	**Function Approximation**: Value prediction and control, Gradient Descent methods, Linear methods. On-policy control with Approximation.	**9**	**CO4**
5	**Neuroscience:** Basics, Reward Prediction, error Hypothesis, Experimental support, Collective RL, Model-based methods, Applications and Case Studies.	**9**	**CO5, CO6**

Text Books:
1. Reinforcement Learning: An Introduction, Sutton R. S. and Barto A. G., MIT Press, 2018, ISBN: 9780262039246.
2. Algorithms for Reinforcement Learning, Csaba Szepesvári, Morgan & Claypool Publications, 2010, ISBN: 9781608454921.

Reference Books:
1. Deep Reinforcement Learning in Action, Alexander Zai, Brandon Brown, Manning Publications, 2020, ISBN: 9781617295430.
2. Pattern Recognition and Machine Learning, Christopher Bishop, Springer publications, 2016, ISBN: 9781493938438.
3. Machine Learning - A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012, ISBN: 9780262018029.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	5	3
Understand	5	5	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	3	-	-
Create	2	-	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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NEURAL NETWORKS

Course Code : 20MCA334A	**Credits** :04
L:T:P:S :4:0:0:0	**CIE Marks** :50
Exam Hours : 3	**SEE Marks** :50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand Neural Network (NN) development, architecture, algorithm and operations.
CO2	Apply NN for pattern classification and association problems.
CO3	Design a competition-based NN.
CO4	Evaluate the Adaptive Resonance theory and Back Propagation method.
CO5	Apply NN for constraint optimization problems.
CO6	Create probabilistic Neural Networks.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	1	-	-	-	-	-	-	-	-	-	3	3
CO2	2	-	1	-	-	-	-	-	-	-	-	2	3	3
CO3	1	2	3	-	-	-	-	-	-	-	-	-	3	3
CO4	-	-	1	-	-	-	-	-	-	-	-	-	3	3
CO5	1	-	1	-	-	-	-	-	-	-	-	2	3	3
CO6	1	-	3	-	-	-	-	-	-	-	-	-	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Neural Net:** ANN, BNN, Signal Processing, Control, Pattern Recognition, Medicine, Speech Production and Recognition, Architectures, Setting the Weights, Common Activation Functions, Development of Neural Networks, McCulloch-Pitt Neuron – Architecture, Algorithm and applications.	9	CO1
2	**Simple Neural Nets for Pattern Classification:** General Architecture, Biases and Thresholds, Linear Separability, Data Representation, HebbNet, Perceptron. **Pattern Association:** Training Algorithms and Pattern Association, Hetero-associative Memory Neural Network, Auto-associative Net, Iterative Auto-associative Net, BAM.	9	CO2
3	**Neural Networks based on competition:** Fixed-weight competitive nets, Kohonen Self-Organizing Maps, Learning Vector Quantization, Counter Propagation.	9	CO3
4	**Adaptive Resonance Theory:** Introduction, ART1 and ART2. **Back Propagation Neural Net**: Standard Back propagation, Variations, Theoretical results.	9	CO4
5	**Other Neural Nets:** Fixed Weight Nets for Constrained Optimization – Boltzmann Machine, Continuous, Hopfield Net, Gaussian Machine, Cauchy Machine. **Learning Nets:** Modified Hebbian, Boltzmann Machine with Learning, Boltzmann Machine with Learning, Simple Recurrent Net, Back propagation in Time. **Adaptive Architectures**: Probabilistic Neural Net.	9	CO5, CO6

Text Books:
1. Neural Networks and Learning machines, Simon O. Haykin, Pearson India, 3rd Edition, 2016, ISBN: 978-9332570313.
2. Fundamentals of Neural Networks – Architectures, Algorithms and Applications, Laurence Fausett, Pearson Education, 2008, 3rd Impression, ISBN: 978-81-317-0053-2.

Reference Books:

1. Make Your Own Neural Network, Tariq Rashid, Create Space Independent Publishing Platform, 2016, ISBN: 9781530826605.
2. Machine Learning with Neural Networks: An In-depth Visual Introduction with Python: Make Your Own Neural Network in Python: A Simple Guide on Machine Learning with Neural Networks, Michael Taylor , Mark Koning, Blue Windmill Media, 2017, ISBN: 978-1549869136.

Assessment Pattern
CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	3	3	-
Create	2	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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ARTIFICIAL INTELLIGENCE

Course Code	: 20MCA335A	**Credits**	:04
L:T:P:S	:4:0:0:0	**CIE Marks**	:50
Exam Hours	: 3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the basic concepts of Artificial Intelligence (AI) and searching techniques.
CO2	Summarize different logic to represent knowledge, reasoning patterns to derive the proof.
CO3	Illustrate statistical reasoning for incomplete and uncertain Information using Bayes theorem.
CO4	Examine different AI techniques for planning and learning.
CO5	Demonstrate the fundamentals of conceptual dependency, game playing and design scripts.
CO6	Evaluate different phases of natural language processing and connectionist models.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	-	1	-	-	-	-	-	2	3
CO2	1	3	2	1	-	-	1	-	-	-	-	-	2	3
CO3	-	-	2	1	-	-	1	-	-	-	-	-	2	3
CO4	-	-	2	1	-	-	-	2	-	-	-	-	2	3
CO5	2	1	2	1	-	-	-	-	-	-	-	-	2	3
CO6	1	1	1	1	-	-	-	-	-	-	-	2	2	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Introduction and Search techniques:** Foundations of Artificial Intelligence (AI), Problem solving strategies, Problem definition and characteristics, Spaces and search, Heuristic search technique–Generate and test, Hill climbing, Best first search, problem reduction.	9	CO1
2	**Knowledge Representation:** Knowledge-based agents, the wumpus world as an example, Logic. **Propositional logic** – Reasoning patterns, Agents, Syntax and semantics of first – order logic, Its usage, Knowledge engineering.	9	CO2
3	**Reasoning with Uncertainty & Probabilistic Reasoning:** Symbolic Reasoning under Uncertainty, Non-monotonic reasoning, Implementation of BFS and DFS. **Statistical reasoning –** Bayes theorem and Bayesian networks.	9	CO3
4	**Weak Slot and Filter Structures**: Semantic nets and frames, Strong slot-and-filler structures-conceptual dependency, scripts and Cyc. **Learning**: Forms of learning, Inductive learning, Learning decision trees, Ensemble learning.	9	CO4
5	**Game playing:** The mini-max search procedure, adding alpha–beta cut-offs additional refinements, iterative deepening and reference on specific games. **Planning:** Blocks world, Components of a planning system, Goal stack planning, Nonlinear planning using constraint posting, Hierarchical planning and Reactive systems.	9	CO5, CO6

Text Books:

1. Artificial Intelligence, Ela Kumar, Dreamtech Press, 2020, ISBN: 978-9389795134.

2. Artificial Intelligence, E. Rich, K. Knight & S.B. Nair, 3/e, McGraw-Hill, 2017, ISBN: 978-0-07-008770-5.

3. Artificial Intelligence: A Modern Approach, Stuart Rusell, Peter Norving, Pearson Education, 3rd Edition, 2015, ISBN: 978-9332543515.

Reference Books:

1. Introduction to Artificial Intelligence and Expert Systems, DanW. Patterson–Prentice Hall of India.
2. Artificial Intelligence: Structures and Strategies for complex problem Solving, G.Luger, 4th Edition, Pearson Education, 2002.
3. Artificial Intelligence and Expert Systems Development by DW Rolston – McGraw Hill.

Assessment Pattern

CIE - Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	3	3	-
Create	2	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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ELECTIVE - 4 (COMPUTING SERVICES & MULTIMEDIA TRACK)

CLOUD COMPUTING

Course Code   : 20MCA341A   **Credits** :04

L:T:P:S   : 4:0:0:0   **CIE Marks** :50

Exam Hours   : 3   **SEE Marks** :50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the system models for Distributed and Cloud Computing.
CO2	Analyse various service models and the architectural design of a cloud.
CO3	Examine the public cloud platforms and security strategies.
CO4	Distinguish the features of cloud platforms.
CO5	Develop applications using cloud-enabled programming models.
CO6	Examine emerging cloud software environments.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	2	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	3	3
CO3	-	-	-	2	-	-	2	-	1	-	-	2	3	3
CO4	-	-	-	2	-	-	-	-	-	-	-	-	3	3
CO5	3	3	3	-	2	-	-	2	-	-	1	2	3	3
CO6	3	3	-	-	2	-	2	-	-		-	2	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Distributed System Models and Enabling Technologies:** Scalable Computing Service over the Internet: Age of Internet Computing, scalable computing Trends & New Paradigms, Internet of Things and Cyber-Physical Systems. System Models for Distributed and Cloud Computing: Clusters of Cooperative Computers, Grid Computing Infrastructures, Peer-to-Peer Network Families, Cloud Computing over the Internet. **Software Environments for Distributed Systems and Clouds**: Service-Oriented Architecture (SOA), Trends towards Distributed Operating Systems, Parallel & Distributed Programming Models.	9	CO1
2	**Performance, Security, and Energy-Efficiency**: Performance Metrics & Scalability Analysis, Fault-Tolerance & System Availability, Network Threats and Data Integrity, Energy- Efficiency in Distributed Computing. **Cloud Platform Architecture over Virtualized Data Centres** Cloud computing and Service Models: Public, Private, and Hybrid Clouds, Cloud Ecosystem and Enabling Technologies, Infrastructure as a Service (IaaS), Platform and Software as a Service (Paas, SaaS). Architectural Design of Compute and Storage Clouds: A Generic Cloud architecture Design, Layered Cloud Architectural development, Virtualization Support and Disaster Recovery, Architectural Design Challenges. **Hands on:** *Creating a word document and store on the cloud.*	9	CO2

3	**Public Cloud Platforms:** GAE, AWS, and Azure: Smart Cloud, Public Clouds and Service Offerings, Google App Engine (GAE), Amazon Web Service (AWS), Microsoft Windows Azure. **Inter-cloud Resource Management:** Extended Cloud Computing Services, Resource Provisioning and Platform Deployment. **Cloud Security and Trust management:** Cloud Security Defence Strategies, Distributed Intrusion/ Anomaly Detection, Data and Software Protection Techniques. **Hands on:** *Creating an account in AWS and working with AWS, Launching an Instance with AMI.*	9	CO3
4	**Cloud Programming and Software Environments:** Features of Cloud and Grid Platforms: Cloud Capabilities and Platform Features, Traditional Features Common to Grids and Clouds, Data Features and Databases, Programming and Runtime Support. Parallel and Distributed Programming Paradigms: Parallel Computing and Programming Paradigms, Map Reduce, Twister and Iterative Map Reduce, Hadoop Library from Apache. **Hands on:** *Install a C compiler on the virtual machine and execute sample programs.*	9	CO4
5	**Programming the Google App Engine:** Google File System(GFS), Big table, Google's NOSQL system, Chubby, Google's Distributed Lock service. Programming on Amazon AWS and Microsoft Azure, Programming on Amazon EC2, Amazon Simple Storage Service S3, Amazon Elastic Block Store EBS and Simple DB, Microsoft Azure programming support. **Emerging Cloud Software Environments:** Open Source Eucalyptus and Nimbus, Open Nebula, Sector / Sphere, and Open Stack. **Hands on:** *Installation and working of GAE.*	9	CO5, CO6

Text Books:
1. Cloud Computing: Master the Concepts, Architecture and Applications with Real-world Examples and Case Studies, Kamal Kant Hiran, 1st Edition, BPB Publications, 2019, ISBN:9789388511407.
2. Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dungaree, and Geoffrey Fox, MK Publisher, 2012, ISBN: 978-0-12-385880-1.

Reference Books:

1. Cloud Computing for Dummies: Judith S. Hurwitz, Daniel Kirsch, 2nd Edition, 2020, ISBN: 978-0-470-484-8.
2. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, MK Publications, 2013, ISBN: 978-0-12-411454-8.
3. Cloud Computing, A Practical Approach, Anthony T. Volte,Toby J. Volte, Robert Elsenpeter, McGraw Hill, 2010, ISBN: 978-0-07-162695-8.
4. Cloud Computing, Dr. Kumar Sourabh, 2nd Edition, Willey, India, 2012, ISBN: 9788126536030.
5. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Media Inc., 2009, ISBN: 9780596156367.

Assessment Pattern

CIE – Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	5	3	-
Create	-	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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GRID AND HIGH PERFORMANCE COMPUTING

Course Code	: 20MCA342A	**Credits**	:04
L:T:P:S	: 4:0:0:0	**CIE Marks**	:50
Exam Hours	: 3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Summarize the fundamentals of grid computing.
CO2	Illustrate the architectural considerations for grid computing.
CO3	Create and demonstrate the working of a grid environment.
CO4	Relate the architectures for achieving parallelism in cluster computing.
CO5	Analyze the resource management systems in high performance computing.
CO6	Design scheduling algorithms for load sharing and balancing.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	3	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO4	2	2	-	-	-	-	-	-	-	1	-	1	3	3
CO5	2	2	3	3	-	-	-	-	-	1	-	1	3	3
CO6	3	2	-	-	-	-	-	-	-	1	-	1	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Grid Fundamentals:** Grid computing, Benefits: Exploiting under-utilized resources, Parallel CPU capacity, Virtual resources and virtual organizations for collaboration, Access to additional resources, Resource balancing, Reliability and management. Grid terms and concepts – Types of resources, Jobs and applications, Scheduling, reservation and scavenging, Grid software components. Grid user roles – A user's perspective – Enrolling, Logging, Querying, configuring, monitoring and reserving resources, Using a grid: Planning, Installation, Managing enrolment, Certificate authority and resource management.	9	CO1
2	**Grid architecture considerations:** Standards for grid environments – OGSA, OGSI, OGSA-DAI, GridFTP, WSRF, Web services related standards. **Application considerations:** General application considerations, CPU-intensive application considerations, Data considerations. **Security:** Introduction to grid security – Grid security requirements, CPU-intensive application considerations. **Design** – Building Grid architecture, Grid architecture models, Grid topologies, Phases and activities, A conceptual architecture, Web services resource framework – Resource state management using Grid services, WSRF fundamentals, WS-Resource Framework specifications, WSRF references.	9	CO2
3	**Creating a grid environment with Globus Toolkit 4:** Globus Toolkit 4 components – Common runtime components, Security components, Data Management components, Monitoring and Discovery services, Execution management. **Globus toolkit 4 installations and configuration, Grid demonstration application, Case study on IBM software portfolio**.	9	CO3

4	**Cluster Computing:** Introduction to Cluster Computing, Scalable Parallel Computer Architectures, Cluster Computer and its Architecture, Classifications, Components for Clusters, Cluster Middleware and Single System Image, Resource Management and Scheduling, Programming Environments and Tools, Applications, Representative Cluster Systems, Heterogeneous Clusters, Security, Resource Sharing, Locality, Dependability, Cluster Architectures, Detecting and Masking Faults, Recovering from Faults, Condor, Evolution of Meta-computing.	9	CO4
5	**Load Sharing and Balancing:** Evolution, Job and Resource Management Systems, State-of-the-Art in RMS and Job, Rigid Jobs with Process Migration, Communication-Based Scheduling, Batch Scheduling, Fault Tolerance, Scheduling Problem for Network Computing, Algorithm - ISH, MCP and ETF, Dynamic Load Balancing, Mapping and Scheduling, Task Granularity and Partitioning, Static and Dynamic Scheduling.	9	CO5, CO6

Text Books:

1. Introduction to Grid Computing, Magoules, Frederic; Pan, Jie; Tan, Kiat-An; Kumar, Abhinit, CRC Press; 1st Edition , 23rd Oct 2019, ISBN: 978-0367385828.
2. Introduction to Grid Computing, Bart Jacob, Michael Brown, Kentaro Fukui, Nihar Trivedi, 2005, 1st Edition, IBM Redbooks, ISBN: 0738494003.
3. High Performance Cluster Computing: Architectures and Systems, R. Buyya, Volume 1, Pearson Education, 2008.

Reference Books:

1. The Grid: Blueprint for a New Computing Infrastructure, Foster and C. Kesselman, Morgan Kaufmann, Elsevier, 2004.
2. Grid Computing, D. Janakiram, Tata McGraw-Hill, 2005.
3. Mastering Cloud Computing Foundations and Applications Programming, R. Buyya, C. Vecchiola and S. T. Selvi, Morgan Kaufmann, Elsevier, 2013.

Assessment Pattern

CIE- Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	5	3	-
Create	-	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

****

MICROSERVICES ARCHITECTURE

Course Code	: 20MCA343A	**Credits**	:04
L:T:P:S	: 4:0:0:0	**CIE Marks**	:50
Exam Hours	: 3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand Microservices and its various approaches.
CO2	Discuss the fundamentals to design a Microservices system.
CO3	Summarize the various aspects, limitations and boundaries of Microservices system.
CO4	Examine the solution architectures and infrastructure required to deploy Microservices.
CO5	Design a solution architecture for Microservices.
CO6	Compose various aspects adapted for Microservices in practice.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	1	-	-	3	3
CO2	1	-	-	-	-	-	-	-	-	1	-	1	3	3
CO3	1	-	-	-	-	-	-	-	-	1	-	1	3	3
CO4	1	2	-	1	-	-	-	-	-	1	-	1	3	3
CO5	1	-	3	1	-	-	-	-	-	1	-	1	3	3
CO6	1	-	3	1	-	-	-	-	-	1	-	1	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**The Microservices:** Understanding Microservices, Adapting Microservices, The speed of change, The safety of change, At scale, In harmony. **Microservices value preposition:** Microservice architecture benefits, Deriving a business value, Defining a goal-oriented and Layered approach, Applying the goal-oriented and Layered approach.	9	CO1
2	**Designing Microservice Systems:** The systems approach to Microservices, Service, Solution, Process and Tools, Organization, Culture, Embracing change. **A Microservices Design Process:** Set optimization goals, Development principles, Sketch the system design, Implement, Observe and Adjust, the Microservices system designer.	9	CO2
3	**Establishing a Foundation:** Goals and Principles, Platforms, Culture. **Service Design**: Microservice Boundaries, API Design for Microservices, Data and Microservices, Distributed Transactions and Sagas, Asynchronous Message Passing and Microservices, Dealing with Dependencies.	9	CO3
4	**System Design and Operations:** Independent Deployability, Docker and Microservices, The role of service discovery, Need for an API Gateway, Monitoring and Alerting.	9	CO4
5	**Adopting Microservices in Practice:** Solution Architecture guidance, Organizational guidance, Culture guidance, Tools and Process guidance, Service guidance.	9	CO5, CO6

Text Books:
1. Microservices: A practical guide, Principles, Concepts and Recipes, Eberhard Wolff, Manning Publications, 2nd Edition, 2019, ISBN: 9781617296505.

2. Microservice Architecture Aligning Principles, Practices and Culture, Irakli Nadareishvili, Ronnie Mitra, Matt McLarty, and Mike Amundsen, O'Reilly Publishers, 2016, ISBN: 978-149-195-9794.

Reference Books:
1. Building Microservices: Designing Fine-Grained Systems, Sam Newman, O'Reilly, 2015, ISBN: 9781491950357.
2. Production-Ready Microservices, Susan J Fowler, O'Reilly, 2016, ISBN: 9781491965979.
3. Service-Oriented Architecture: Analysis and Design for Services and Microservices, Thomas Erl, 2016, ISBN: 978013358587.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	3	2	2
Evaluate	2	2	-
Create	5	3	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	5
Evaluate	5
Create	10

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SOCIAL MEDIA ANALYTICS

Course Code	: 20MCA344A	**Credits**	:04
L:T:P:S	: 4:0:0:0	**CIE Marks**	:50
Exam Hours	: 3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the subset of available data to focus on analysis.
CO2	Demonstrate the activities that assist in transforming raw data into insights.
CO3	Analyze various perspectives of insights to derive higher accuracy.
CO4	Evaluate the information interpretation as a social analytic process.
CO5	Organize information gathered from consumer to filter & find right data.
CO6	Formulate the common visualizations techniques.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	1	-	-	-	-	-	1	3	3
CO2	-	-	-	-	-	-	-	-	-	-	-	1	3	3
CO3	-	3	-	2	-	-	-	-	-	-	-	1	3	3
CO4	-	2	-	2	-	1	-	-	-	-	1	1	3	3
CO5	-	-	3	1	-	1	-	-	-	-	1	1	3	3
CO6	2	1	-	1	-	-	-	-	-	-	1	1	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Data Identification:** Data, Subset of content, Attributes of data, Regular expressions and right subset of people, Predictive versus Descriptive, Sentiment, Structured data versus Unstructured data, Big data and Identifying data in social media outlets.	9	CO1
2	**Data Analysis - I:** Four dimensions of analysis taxonomy, Domain of analysis, Velocity of data, Validating the hypothesis, Discovering themes and topics, Using iterative methods. Stream computing, IBM Infosphere streams, SPL applications, Directed graphs, SSM examples, Value derived from a conference using real-time analytics.	9	CO2
3	**Data Analysis - II:** Ad-Hoc analysis, Example of Ad-Hoc analysis, Data Integrity, Responding to leads identified in social media, Support for deep analysis in analytics software. **Enterprise Social Network:** Social collaboration, Memory of organization, Enterprise graph and details of implementation.	9	CO3
4	**Information Interpretation:** Finding the right data, Communication, Choosing filter words, Customizing and Modifying tools, Using right tools, Analyzing consumer reaction during hurricane study.	9	CO4
5	**Visualization as an aid to analytics**: Common visualizations – Pie, Bar, Line, Scatter plots. Common pitfalls – Information overload, Unintended consequences of using 3D, Using colour, Visually representing unstructured data. **Case study:** IBM Amplify - Data Identification, Data Analysis and Information Interpretation and conclusions.	9	CO5, CO6

Text Books:
1. Creating Value With Social Media Analytics, Gohar F. Khan, Create Space Independent Publishing Platform, 2018, ISBN: 9781977543974.
2. Social Media Analytics, Mathew Ganis, Avinash Kohirkar, IBM Press, 2016, ISBN: 978-0-13-389256-7.
3. Seven Layers of Social Media Analytics: Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine and Location Data, Gohar F. Khan, Amazon Digital Services, 2015, ISBN: 978-1507823300.

Reference Books:
1. Learning Social Media Analytics with R, Raghav Bali, Dipanjan Sarkar, Tushar Sharma, Packt Publishing, 2017, ISBN: 9781787127524.
2. Social Media Analytics, Marshall Sponder, Mc-Graw Hill Publishers, 2011, ISBN: 9780071768627.

Assessment Pattern

CIE – Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	2	3	-
Create	3	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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AUGMENTED REALITY AND VIRTUAL REALITY

Course Code	**: 20MCA345A**	**Credits**	**:04**
L:T:P:S	**: 4:0:0:0**	**CIE Marks**	**:50**
Exam Hours	**: 3**	**SEE Marks**	**:50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the design modalities across digital realities.
CO2	Demonstrate the making of 3D Art.
CO3	Examine the augmented and virtual reality toolkits.
CO4	Design ML visualization in augmented reality (AR) and virtual reality (VR).
CO5	Develop an AR/VR health ecosystem.
CO6	Analyze the case studies in AR/VR.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	3	3
CO2	2	-	-	-	-	-	-	-	-	-	-	-	3	3
CO3	-	2	-	-	3	-	-	-	-	-	-	-	3	3
CO4	2	-	2	-	-	-	-	-	-	-	-	-	3	3
CO5	2	-	1	2	-	-	-	-	-	-	-	-	3	3
CO6	-	3	2	2	-	-	-	-	-	-	-	-	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**How humans interact with computers:** Common term definitions, Introduction, Modalities through the ages, New Modalities, The current state, current controllers, Hand tracking and hand pose recognition. **Designing for our senses, not our devices**: Envisioning a future, Sensory technology explained, Sensory design, Five sensory principles, Adobe's AR.	9	CO1
2	**Virtual reality for art:** A more natural way of making 3D Art, VR for animation. **3D Art Optimization:** Introduction, Draw calls, Using VR tools for creating 3D Art, Acquiring 3D models versus making them from scratch. **Hardware, SLAM, Tracking:** History of AR, Selecting an AR platform, Mapping, Platforms, Other development considerations, AR cloud.	9	CO2
3	**Virtual Reality and Augmented reality - Cross Platform theory:** understanding 3D graphics, Portability lessons from video game design, Simplifying the controller Input. **Virtual Reality toolkit (VRTK) - Open source framework for the community:** History, future, success of VRTK, VR & AR development best practices.	9	CO3
4	**Data and Machine learning visualization design and development in spatial computing:** Introduction, Understanding the data visualization, principles for data and machine learning visualization in spatial computing, Working of data and machine learning visualization in spatial computing, animation, failures in data visualization design, Good data visualization, Character AI and Behaviours.	9	CO4
5	**Virtual and augmented reality health technology ecosystem:** VR/AR health technology application design, Standard UX, Five key principles of AR and VR for sports, The next evolution of sports experience, VR enterprise training use cases.	9	CO5, CO6

Text Books:
1. Creating augmented & virtual realities, Erin Pangillinan, Steve Lukas, Vasanth Mohan, O'Reillly Media, Inc. 2019, ISBN: 9781492044192.
2. Augmented Reality for Developers, Jonathan Linowes, 2017, Packt Publishers, ISBN: 978-1787286436.

Reference Books:
1. Virtual & Augmented Reality for Dummies, Paul Mealy, 2018, ISBN: 978-1-119-48134-8.
2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Steve Aukstakalnis, Addison-Wesley Professional, 2016, ISBN: 9780134094328.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	5	3	-
Create	-	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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ELECTIVE – 5 (RECENT TRENDS TRACK)

INTERNET OF EVERYTHING

Course Code	**: 20MCA351A**	**Credits**	**:04**
L:T:P:S	**: 4:0:0:0**	**CIE Marks**	**:50**
Exam Hours	**: 3**	**SEE Marks**	**:50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the working of Wireless Sensor Networks and Internet of Things.
CO2	Distinguish the various IOT protocols, design and their standardization challenges in IOT levels and deployment templates.
CO3	Illustrate the various IIOT applications.
CO4	Examine the IOT system management and design methodology.
CO5	Evaluate the Physical Devices and Endpoints of IOT.
CO6	Develop controlling and interfacing applications using Raspberry PI.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	2	-	-	-	-	-	-	-	-	1	3	3
CO2	1	-	2	-	-	-	-	-	-	-	-	1	3	3
CO3	2	2	-	2	-	-	-	-	-	-	-	1	3	3
CO4	2	3	2	2	2	-	-	1	-	-	-	1	3	3
CO5	2	2	1	2	2	-	-	-	-	-	-	2	3	3
CO6	3	2	3	2	3	-	-	1	-	-	-	2	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Overview of Wireless sensor Networks:** Introduction, Brief Historical Survey of Sensor Networks, Background of Sensor Network Technology, Ad-hoc Networks. **Basic Wireless Sensor Technology:** Introduction, Sensor Node Technology Sensor Taxonomy, WN Operating Environment, WN Trends, Wireless Network Standards: IEEE 802.15.4, ZigBee, IEE 1451. **IOT**: Introduction to Internet of Things, Definition & Characteristics, Physical Design, Things in IOT, IOT Protocols, Logical design of IOT, IOT functional blocks, IOT communication models, IOT APIs. IOT Networking Considerations and Challenges.	9	CO1
2	**IoT enabling Technologies:** Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols, Embedded Systems. IoT Levels and Deployment Templates - IoT level-1, IoT level-2, IoT level-3, IoT level-4, IoT level-5, IoT level-6, Modern Applications of IoT.	9	CO2
3	**Industrial IoTs**–Home Automation-Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors, Cities-Smart Parking, Smart Lighting, Roads, Structural Health Monitoring, Surveillance, Emergency Response, Environment- Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection, Energy-Smart Grids, Renewable Energy Systems, Prognostics. Retail- Inventory Management, Smart Payments, Smart Vending Machines, Logistics-Route Generation & scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics, Agriculture - Smart irrigation, Green House Control, Industry-Machine Diagnosis & Prognosis, Indoor Air Quality Monitoring, Health and Lifestyle-Health & Fitness Monitoring, Wearable Electronics.	9	CO3

4	**IoT and M2M** – Introduction, M2M-Difference between IoT & M2M, SDN and NFV for IoT- Software Defined Networking, Network Function Virtualization. **IoT System Management with NETCONF**-YANG-Need for IoT System Management , SNMP-Limitations of SNMP, Network Operator Requirements, NETCONF, YANG. Cheat sheets – SDN, NETCONF, YANG. **IoT Platform Design Methodology** - IoT Design Methodology.	9	CO4
5	**Raspberry PI programming – Commands.** **IoT Physical Devices and Endpoints-** Basic building blocks of IoT, Exemplary Device - Raspberry PI, Raspberry PI-Interfaces- serial, SPI, I2C. **Programming Raspberry PI with Python -** Controlling LED with Raspberry PI, Interfacing an LED and Switch with Raspberry PI, Interfacing a Light Sensor(LDR) with Raspberry PI.	9	CO5, CO6

Text Books:
1. The Internet of Things – What everyone needs to know, Scott J. Shackelford, Oxford University Press, 2020, ISBN: 978-0-190-943837.
2. Internet of Things–A Hands – on Approach, Arshdeep Bahgaand Vijay Madisetti, Universities Press, 2015.
3. Wireless Sensor Network, Kazem Sohraby, Daniel Minoli, Taieb Znati Pub: Wiley, 2007, ISBN: 978-0-471-74300-2.

Reference Books:

1. Gen2: API Features and Arduino Projects for Linux Programmers, Manoel Carlos Ramon, Intel ® Galileo and Intel ® Galileo, Apress, 2014.
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly, 2014.
3. Internet of Things with the Arduino Yun, Marco Schwartz, Packt, 2014.
4. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, JanHoller, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, , 1st Edition, Academic Press, 2014.

Assessment Pattern

CIE - Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	2	2
Understand	5	2	2
Apply	5	4	2
Analyze	5	2	2
Evaluate	5	2	2
Create	-	3	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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MOBILE APPLICATION DEVELOPMENT

Course Code   : 20MCA352A   **Credits :04**

L:T:P:S   : 4:0:0:0   **CIE Marks :50**

Exam Hours   : 3   **SEE Marks :50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the basics of Android for mobile apps.
CO2	Summarize the architecture and design apps using Android SDK.
CO3	Develop apps using data storage, file sharing and inter-process communication concepts.
CO4	Create mobile apps using interface sensors and Bluetooth connectivity.
CO5	Design mobile apps using multimedia graphics and animations.
CO6	Deploy and monetize mobile apps.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	-	1	-	-	-	-	-	-	3	3
CO2	1	2	2	1	2	1	-	-	-	-	-	-	3	3
CO3	2	2	2	-	2	-	-	-	-	2	-	-	3	3
CO4	2	2	2	-	2	-	-	-	-	-	-	1	3	3
CO5	2	2	2	-	2	-	-	-	2	-	-	1	3	3
CO6	2	2	2	-	2	-	-	3	-	-	2	1	3	3

	SYLLABUS		
Module	**Contents of the Module**	**Hours**	**COs**
1	**INTRODUCTION TO ANDROID:** Android architecture, Android Studio-Project Structure, User Interface, Gradle build system, Debug and profile tools, Android Emulator, AVD in Android Studio, Hardware device, Basic Building blocks – Activities, Services, Broadcast Receivers & Content providers, UI Components- Views & notifications, Components for communication - Intents & Intent Filters. **Hands-On:** Using Android SDK display Hello world in android.	9	CO1
2	**APPLICATION STRUCTURE AND BASIC UI DESIGN:** Activity, Lifecycle, View, View groups, Layouts, Basic controls of screen- Managing orientation, Using basic view- Textview, Button, Edit text box, checkbox and radio button, Event handling for views, Recycler view, Adapter and view holder, Alert dialog, Toast, Datepicker, Timepicker. **Hands-On:** 1. Design and implement a single screen app that displays information about a small business. eg. Restaurant, Book shop etc. Your design must include: • Business name • Photo of business • Contact information 2. Design and develop a Mobile App for smart phones - Unit Converter using Android Studio. 3. Design and develop a Mobile App for smart phones - Currency Converter.	9	CO2

3	**INTENTS, SERVICE AND NOTIFICATION:** Concept of Intents, Implicit and Explicit intent, Service, Overview of services in Android, Implementing a Service, Service lifecycle, Broadcast Receiver, Notification. **Hands-On:** 1. Design an app for Tourist spot with the following three activities: Welcome page, display highlights of tourist spot and webpage of the tourist spot. 2. Design Android app "play music" in the background.	**9**	**CO3**
4	**DATA STORAGE AND INTER PROCESS COMMUNICATION:** Content Provider, Shared Preferences, Preferences activity, File access, SQLite database, Threads, AsyncTask. **Hands-On:** 1. Design and develop a Mobile App "The Expense Manager" for smart phones using Android. The app should store all the expenses in a file. 2. Design and develop Health Monitoring App using Android. The app will store the blood pressure, blood group and glucose level of a patient in SQLite database.	**9**	**CO4**
5	**ADVANCED ANDROID APP DEPLOYMENT:** Sending SMS using app, Building apps with Location-based services and Google maps, Building app with Camera, Preparing for publishing – Signing & Versioning of apps, Using Google Play to distribute & monetize, Best practices for security and privacy. **Hands-On:** 1. Develop an Android app to display Map of your college locality. 2. Develop an Android app to alert SMS to one given phone number.	**9**	**CO5, CO6**

Text Books:
1. Learn Android Studio 4, Efficient Java-Based Android Apps Development, Ted Hagos, Apress, 2020, ISBN: 978-1-484-259368.
2. Professional Android2 Application Development, RetoMeier, Wiley, 1st Edition, 2012, ISBN: 9788126525898.

Reference Books:

1. Professional Android4 Application Development, RetoMeier, Wrox, 2012.
2. Beginning iOS6 Development: Exploring the iOSS DK, DavidMark, Jack Nutting, Jeff La Mouche, and Fredric Olsson, Apress, 2013.
3. Android in Practice, Charlie Collins, Michael Galpin and Matthias Kappler, DreamTech, 2012.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	25	15	10
Remember	2	3	3
Understand	3	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	5	3	-
Create	5	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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BLOCKCHAIN TECHNOLOGIES

Course Code	: **20MCA353A**	**Credits**	:**04**
L:T:P:S	: **4:0:0:0**	**CIE Marks**	:**50**
Exam Hours	: **3**	**SEE Marks**	:**50**

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the fundamentals of Blockchain Technologies.
CO2	Apply various cryptographic mechanisms in Blockchain.
CO3	Design smart contracts for B2C applications.
CO4	Characterize Ethereum environment and wallets.
CO5	Formulate Ethereum network and the development scenario.
CO6	Develop test cases for smart contracts.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	-	-	-	-	-	-	1	-	3	3
CO2	1	2	2	-	3	-	-	-	-	-	1	-	3	3
CO3	2	2	2	-	3	-	-	-	-	-	1	-	3	3
CO4	2	2	2	-	-	-	-	-	-	-	1	-	3	3
CO5	2	2	2	-	-	-	-	-	-	-	1	-	3	3
CO6	2	2	2	2	-	-	-	-	-	-	1	-	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Fundamentals of Blockchain:** History of Blockchain, Distributed ledgers, Problems with distributed ledger, Blockchain popularity, Pros and Cons of Blockchain, Use case of Blockchain, The problem of trust, Trust through consensus, Consensus models and mining, Types of Blockchain platforms, Crypto currencies, P2P applications, Genesis Block, Blockchain wallets, Decentralized applications. **Hands-On** • Installation Metamask • Getting free Ethers • Explore mining and live transactions • Explore Past transactions and blocks • Blockchain Demo	9	CO1
2	**Blockchain Cryptography:** Understanding digital signatures, Encryption, Decryption, Types of encryption, Stream Ciphers, Block Ciphers, Encryption Algorithms, Elliptical curve cryptography, Public and private keys in Block chain, Transaction Signing, Hashing, Merkle Trees. **Hands-On** • Encryption and Decryption using SHA/MD5 • Public and private keys	9	CO2
3	**Smart Contract Programming with Solidity:** A smart contract, Lifecycle of Smart Contract, need of smart contracts, Smart contracts in B2C applications (Business to consumer), Smart contracts in B2B applications (Business to Business). **Solidity Programming:** Solidity - Introduction, Need and features, Types, Structures, Control Flow and Smart contract structure. **Hands-On** • Interacting with smart contracts • Writing a basic smart contract • Compiling a smart contract • Deploying a smart contract • Debugging smart contract code	9	CO3

4	**Fundamentals of Ethereum:** History of Ethereum, Ethereum Concepts and Terminology, Ethereum Virtual Machine, Ethereum Releases, Ethereum Networks, Ethereum Wallets, Ethereum currency and units (ether, gwei, wei), Gas, Types of Ethereum Accounts, Ethereum Blockchain Explorers, Ether Faucets, Ethereum clients. **Hands-On** • Creating Ethereum wallets • Creating Ethereum accounts • Transaction between Ethereum accounts • Exploring Ethereum mining and transactions	9	CO4
5	**Ethereum Infrastructure Development and Testing:** Introduction to geth client, interacting with Ethereum network using geth, Ethereum development tools, Setting up the development environment. **Hands-On** • Installing Ethereum Clients • Basic geth Node Administration • Mining with geth • Writing unit tests for smart contract functions • Testing deployments.	9	CO5, CO6

Text Books:

1. Blockchain By Example, A Developer's Guide to Creating Decentralized Applications Using Bitcoin, Ethereum, and Hyperledger, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, Packt Publishing, 2018, ISBN: 9781788473910.

2. Blockchain for dummies, Tiana Laurence, John Wiley & Sons, Inc., 2019, ISBN: 978-1-119-55501-8

Reference Books:

1. Beginning Blockchain, A beginner's guide to building blockchain solutions, Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, 2018, Apress, ISBN: 9781484234440.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	25	15	10
Remember	-	-	-
Understand	5	2	5
Apply	5	3	3
Analyze	5	5	2
Evaluate	5	5	-
Create	5	-	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	50
Remember	5
Understand	5
Apply	10
Analyze	10
Evaluate	10
Create	10

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FULL STACK DEVELOPMENT TOOLS

Course Code	: 20MCA354A	**Credits**	:04
L:T:P:S	: 4:0:0:0	**CIE Marks**	:50
Exam Hours	: 3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Summarize in-depth understanding of server-side scripting language essentials.
CO2	Investigate the functions and evaluate expressions.
CO3	Examine arrays and functions required for web development.
CO4	Investigate the functions required for form validation, session handling techniques and database access.
CO5	Examine the Object-Oriented features in PHP.
CO6	Evaluate the interface and serialization procedures in PHP.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	2	-	-	-	-	-	-	1	3	3
CO2	-	-	3	-	2	-	-	-	-	-	-	1	3	3
CO3	2	-	3	-	2	1	-	-	-	-	-	1	3	3
CO4	2	-	3	-	2	1	-	-	-	-	-	1	3	3
CO5	2	2	3	3	2	1	-	-	-	-	-	1	3	3
CO6	2	3	3	3	2	1	-	-	-	-	-	1	3	3

	SYLLABUS		
Module	**Contents of the Module**	**Hours**	**COs**
1	**Introduction to PHP5:** A brief history of PHP, Language Basics: Lexical Structure, Comments, Literals, Identifiers, Keywords, Data Types, Expressions and operators, Casting, Strings and String Functions, logical operators, Flow-Control Statements, embedding PHP in Web pages.	**9**	CO1
2	**PHP Functions:** Defining a Functions, Variable Scope, Passing Parameters by Value, Passing Parameters by Reference, Default Parameters, Variable Parameters, Missing Parameters, Type Hinting, Return Values, Anonymous Functions, Regular Expressions and Pattern matching.	**9**	CO2
3	**Arrays:** Indexed Versus Associative Arrays, Multidimensional Arrays, Array Methods, Converting between Arrays and variables. **Web Techniques:** HTTP Basics, Variables, Server Information, processing Forms- Methods, Parameters, Self-processing pages, Sticky Forms, Multi-valued Parameters, Sticky Multi-valued Parameters, File Uploads.	**9**	CO3
4	**Form Validation& Session Handling:** Setting Response headers- Different Content Types, Redirections, Expiration, Authentication. Maintaining State- Cookies, Sessions, Combining Cookies and Sessions. SSL. **Databases:** Using MySQL with PHP: DML & DDL commands, connecting to database, Selecting database and issuing command, Using PHP to Access a Database, Relational Databases and SQL- PHP Data Objects.	**9**	CO4
5	**Objects:** Objects, Terminology, creating an object, Accessing properties and Methods, Declaring a Class- Declaring Methods, Declaring Properties, Declaring Constants, Inheritance, Interfaces, traits, Abstract Methods, Constructors, Destructors, Anonymous Classes, Introspection- Examining Classes, Examining an Object, Serialization.	**9**	CO5, CO6

Text Books:

1. Learning PHP, MySQL & JavaScript With jQuery, CSS & HTML, Robin Nixon, O'Reilly Media, Inc., 4th Edition, 2015, ISBN: 978-93-5213-015-3.
2. Web Content Management: Systems, Features, and Best Practices, Deane Barker, O'Reilly Media, 1st Edition, 2016, ISBN: 978-1-4919-0812-9.
3. Beginning Drupal 8, Todd Tomlinson, Apress Publishing Company, 1st Edition, 2015, ISBN: 978-1-4302-6580-1.

Reference Books:

1. Learning PHP and MySQL, Michele E. Davis & Jon A. Philips, O'REILLY, 2009, ISBN: 978059551650.
2. Professional LAMP: Linux, Apache, MySQL, and PHP5 Web Development, Jason Gerner, Elizabeth Naramore, Morgan Owens, Wiley Publishing Inc, 2006, ISBN: 978-0-7645-9723-7.
3. Setting up LAMP: Getting Linux, Apache, MySQL, and PHP working together, Eric Rosebrock, Eric Filson, SYBEX, 2006, ISBN: 9780782151121.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy Marks	Tests	Assignments	Quizzes
	25	15	10
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	3	2	2
Evaluate	2	3	-
Create	5	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	50
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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COMPUTER VISION

Course Code	: 20MCA355A	**Credits**	:04
L:T:P:S	: 4:0:0:0	**CIE Marks**	:50
Exam Hours	: 3	**SEE Marks**	:50

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the essential concepts of OpenCV API.
CO2	Discuss the user interface capabilities and image processing techniques required for computer vision applications.
CO3	Examine the various problem handling methods in image segmentation and transformations.
CO4	Investigate the interesting 2D features and object detection problem in computer vision.
CO5	Illustrate motion and tracking in computer vision applications.
CO6	Formulate machine learning and GPU-based acceleration in computer vision.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	2	2	-	2	-	-	1	-	1	3	3
CO2	1	2	3	2	2	-	-	-	-	-	-	1	3	3
CO3	1	2	3	2	2	-	-	-	-	-	-	-	3	3
CO4	2	2	3	1	2	-	-	-	-	-	-	-	3	3
CO5	1	2	3	2	1	-	-	-	-	-	-	-	3	3
CO6	2	2	3	1	3	-	-	-	-	-	-	-	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Introduction to OpenCV:** Setting up OpenCV, compiled versus precompiled library, Configuring OpenCV, Building and Installing the library, API concepts and basic data types, Reading/writing images and videos, Reading and Playing a video file, Live input from a camera.	9	CO1
2	**Graphical User Interfaces:** Highgui module, text and drawing, selecting regions, using Qt-based functions. **Image Processing:** pixel-level access and common operations, Image histogram, Brightness and contrast modeling, Histogram matching and LUT, Conversion from RGB to colour spaces, Filtering with the retina model.	9	CO2
3	**Arithmetic and geometrical transforms:** Arithmetic transform, Geometrical transforms, Image Segmentation, Thresholding, Contours and connected components, Flood fill, Watershed segmentation, Grabcut.	9	CO3
4	**Focusing on the Interesting 2D features:** Interest points, Feature detectors, Feature descriptor extractors, Descriptor matches, Matching the SURF descriptors, Matching the AKAZE descriptors. **Object detection:** Definition, Detecting objects with OpenCV, **Cascades:** using Object detection with OpenCV, Training your own cascade, Latent SVM, Scene text detection.	9	CO4
5	**Motion:** Reading video sequences, The Lucas-Kanade optical flow, The Gunnar-Farnback optical flow, The mean-shift tracker, The Camshift tracker, The motion templates, The background subtraction technique, Image alignment. **Machine Learning:** KNN classifier, Radom forest classifier and SVM. **GPU**: Definition, Setting up OpenCV with CUDA, GPU based program.	9	CO5, CO6

Text Books:
1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer, 2020, ISBN: 978-3-030-34371-2.
2. OpenCV Essentials Illustrated Edition, Oscar Deniz Suarez, Packt, 2014, ISBN: 9781783984244.
3. Computer Vision in C++ with the OpenCV Library, Adrian Kaehler, O'Reilly Media Inc., 1st Edition, 2016, ISBN: 9781491937990.

Reference Books:
1. Practical OpenCV, Samarth Brahmbhatt, Apress, 1st Edition, 2013, ISBN: 978-1430260790.
2. OpenCV 3: Computer Vision in C++, Adrian Kaehler, O'Reilly, 2017, ISBN: 978-1-491-93799-0.

Assessment Pattern:

CIE-Continuous Internal Evaluation: Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	3	3
Understand	5	2	3
Apply	5	3	2
Analyze	5	2	2
Evaluate	5	3	-
Create	-	2	-

SEE- Semester End Examination: Theory (50 Marks)

Bloom's Category	Tests
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	5
Create	5

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PYTHON PROGRAMMING LAB

Course Code	: 20MCAL36A	**Credits**	:1.5
L:T:P:S	: 0:0:1.5:0	**CIE Marks**	:25
Exam Hours	: 3	**SEE Marks**	:25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Demonstrate python programs using strings and control structures.
CO2	Design python programs using Dictionary, Tuple and List structures.
CO3	Construct python programs for creating functions, classes, pattern matching and handling exceptions.
CO4	Develop machine learning programs for classification algorithms.
CO5	Design machine learning programs for regression analysis methods.
CO6	Develop machine learning programs for clustering algorithms.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	1	-	1	-	1	-	-	1	3	3
CO2	1	2	2	-	1	-	1	-	1	-	-	1	3	3
CO3	1	2	2	2	1	-	1	-	1	-	-	1	3	3
CO4	1	2	2	2	1	-	1	-	1	-	-	1	3	3
CO5	1	2	2	2	1	-	1	-	1	-	-	1	3	3
CO6	1	2	2	2	1	-	1	-	1	-	-	1	3	3

LIST OF PROGRAMS

At the end of the course, the student will be able to write the following programs.

PART-A
1. Basic Programs
2. String Programs
3. Control Structure Programs
4. List Programs
5. Dictionary Programs
6. Tuple Programs
7. Creating Functions
8. Object Oriented Programming
9. Pattern Matching
10. Handling Exceptions

PART-B
1. Implement and demonstrate the FIND-S algorithm.
2. Write a program to demonstrate the working of the decision tree algorithm.
3. Write a program to implement the naïve Bayesian classifier.
4. Write a program for k-means clustering algorithm.
5. Write a program for k-nearest neighbor algorithm.
6. Implement the regression algorithm in order to fit data points.

Assessment Pattern

CIE- Continuous Internal Evaluation: Practical (25 Marks)

Bloom's Taxonomy	Tests
Marks	25
Remember	2
Understand	3
Apply	5
Analyze	5
Evaluate	5
Create	5

SEE-Semester End Examination: Practical (25 Marks)

Bloom's Category	Tests
Marks	25
Remember	2
Understand	3
Apply	5
Analyze	5
Evaluate	5
Create	5

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BIGDATA ANALYTICS LAB

Course Code : 20MCAL37A	**Credits** :1.5
L:T:P:S : 0:0:1.5:0	**CIE Marks** :25
Exam Hours : 3	**SEE Marks** :25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the fundamental concepts of big data analytics.
CO2	Apply various techniques for designing and mining data streams.
CO3	Analyze big data using data sources and its log files.
CO4	Design applications using Map Reduce Concepts.
CO5	Use DML operations to visualize in Hadoop.
CO6	Explore to demonstrate the Hadoop ecosystem as a real-time middleware.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	-	-	1	3	3
CO2	1	-	-	-	-	-	-	-	-	-	-	1	3	3
CO3	1	-	-	-	-	-	-	-	-	-	-	1	3	3
CO4	1	-	2	3	2	-	-	-	-	-	-	1	3	3
CO5	1	2	2	3	2	-	-	1	-	-	-	1	3	3
CO6	1	2	2	3	2	-	-	1	-	-	-	1	3	3

LIST OF PROGRAMS At the end of the course, the student will be able to write the following programs.	Hours	COs
1. Introduction to SQL and HP Vertica: a) Creation of tables with constrains and insertion of values into tables b) Hands-on DML commands to apply different aggregate function, Group by-Having-Order by clause, Operators. c) Creation of views and working with joins.	2	CO1
2. HP Vertica - Design: a) Creation of schema, tables and execution of SQL statements on Vertica Database. b) Running Database designer. c) Hands-on projections	2	CO2
3. HP Vertica – Data Manipulation: a) Loading data files from different sources to Vertica database. b) Verifying the log files after loading the data into Vertica database. c) Hands-on partitions.	6	CO3
4. Big Data Analytics with Hadoop: a) Verifying Hadoop installation (Pseudo distributed mode), Java path,Hadoop location, Hadoop configuration files, Name Node setup, Job Tracker, Metadata files, Accessing Hadoop on browse. b) Moving data from local file system to Hadoop file system. c) Performing MAP Reduction operation in Hadoop. d) Verification of operation results through terminal and browser.	6	CO4

5. Hadoop Ecosystem: **Sqoop commands :** a) Import of tables from Mysql database to hdfs b) Export files from hdfs to mysql database **II. Pig commands:** a) Loading and storing - from/to local file system, from/to hdfs b) ii) Diagnostic operator – Dump c) iii) Filter operator **III. Hive Commands:** a) Data Definition Language (DDL): CREATE database/ table/ external table , DROP, ALTER, SHOW, DESCRIBE Statements. b) Data Manipulation Language (DML): LOAD, INSERT Statements- INSERT INTO, INSERT OVERWRITE. **IV. HBase shell Command:** Create table with /without version – a) put command b) get command with / without version c) delete column – column family d) drop table	**14**	**CO5, CO6**

Assessment Pattern

CIE- Continuous Internal Evaluation: Practical (25 Marks)

Bloom's Taxonomy	Tests
Marks	**25**
Remember	-
Understand	-
Apply	10
Analyze	-
Evaluate	5
Create	10

SEE-Semester End Examination: Practical (25 Marks)

Bloom's Category	Tests
Marks	25
Remember	-
Understand	-
Apply	10
Analyze	-
Evaluate	5
Create	10

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MINI PROJECT (IOT/CLOUD/PYTHON/ML)

Course Code	: 20MCA38A	**Credits**	:2
L:T:P:S	: 0:0:2:0	**CIE Marks**	:25
Exam Hours	: 3	**SEE Marks**	:25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recall the concepts learnt in IOT/CLOUD/PYTHON/ML courses.
CO2	Illustrate a suitable case study for the domain of applications to be developed.
CO3	Apply the required tools and techniques for software development.
CO4	Examine the requirements and transform them to a software module.
CO5	Assess the valid arguments in case study against the software module developed.
CO6	Formulate the test cases and strategies for the software module developed.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	1	1	3	3
CO2	3	3	3	-	-	-	-	-	-	-	1	1	3	3
CO3	3	3	3	2	1	-	3	1	-	-	1	1	3	3
CO4	3	3	3	2	1	-	3	1	-	-	1	1	3	3
CO5	3	3	3	2	1	-	3	1	-	-	1	1	3	3
CO6	3	3	3	2	1	-	3	1	-	-	1	1	3	3

MINI PROJECT WORK:

This mini project is based on IOT/CLOUD/PYTHON/ML concepts. The sample project titles are shown below:

1. Automated Plant Watering System
2. Raspberry Pi Arduino Intelligent Tea Sensor
3. Lightweight Arduino GSM Mobile Phone
4. Automated Cocktail Drink Machine
5. Campus Automation Using Cloud Computing
6. Detection of Data Leaks Using SQL Injection Prevention
7. Cloud-Based Student Information Chatbot
8. Cloud-Based Bus Ticket System
9. Android Offloading Over Cloud
10. Personal Cloud with Raspberry Pi
11. Remote Monitoring using IoT
12. Text Classification for Business Analytics
13. Encrypted Cloud Storage
14. Sentiment Analysis of Product Reviews
15. Stock Prices Prediction
16. Sales Forecasting
17. Movie Ticket Pricing Prediction
18. Music Recommendation
19. Handwritten Digit Classification
20. Fake News Detection

Project must be done individually.

Final evaluation will be done by: Project Demonstration.

The marks of the mini project would be given on the basis of performance in CIE and SEE.

Assessment Pattern

CIE- Continuous Internal Evaluation: Practical Demonstration (25 Marks)

Bloom's Taxonomy	Tests
Marks	25
Remember	-
Understand	-
Apply	10
Analyze	5
Evaluate	5
Create	5

SEE-Semester End Examination: Practical (25 Marks)

Bloom's Category	Tests
Marks	25
Remember	-
Understand	-
Apply	10
Analyze	5
Evaluate	5
Create	5

Mini Project Work Evaluation: (20MCA38A)

During project work, the evaluation process will be divided into number of phases to assess the continuous progress (Minimum three phases).

❖ The project guides and project coordinator follows rubrics, which is set by the Department for evaluation and then submitted to the head of department.

❖ Each internal guide will verify the statement of project and literature of works and implementation details. The department will encourage students to make publications in standard conferences/journals.

Rubrics for Mini Project Evaluation CIE& SEE:

Review #	Agenda	Assessment	Review Assessment Weightage	Overall Weightage
Review 1	Project Synopsis Evaluation	Rubrics1	25	25 (Avg of R1, R2, R3)
Review 2	Mid-Term Project Evaluation	Rubrics2	25	
Review 3	Final Internal Project Evaluation	Rubrics3	25	
Final Project Viva-Voce	End-Semester Project Evaluation		25	25
Total				50

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FOURTH SEMESTER

MCA SYLLABUS

2-YEAR PROGRAM (2021-22)

INDUSTRY INTERNSHIP / PROJECT WORK

Course Code   : 20MCA41A   **Credits : 21**

L:T:P:S   : 0:0:21:0   **CIE Marks : 150**

Exam Hours   : 3   **SEE Marks : 150**

Course Outcomes: At the end of the Internship/Project, the student will be able to:

CO1	Identify skills to work and gain knowledge in the software industry.
CO2	Map theoretical knowledge with practical knowledge.
CO3	Analyze real-time experience and develop code for projects.
CO4	Demonstrate the strengths in tune with the current industry demands.
CO5	Enhance teamwork skills.
CO6	Demonstrate communication skills required to deliver effective technical presentations.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	1	2	2	1	-	-	1	1	-	3	3
CO2	3	-	3	1	2	2	1	-	-	1	1	-	3	3
CO3	3	3	3	1	2	2	1	2	-	1	1	1	3	3
CO4	3	3	3	1	2	2	1	2	-	1	1	1	3	3
CO5	3	3	3	1	2	2	1	-	-	1	3	-	3	3
CO6	3	3	3	1	2	2	1	-	3	1	1	-	3	3

General Guidelines:

1. The project work must be done individually in a software firm or R & D Institution.
2. Project should be high quality simulated application project work, for a

total duration of 4-6 months.

3. Project work may be application-oriented or research-oriented as per student interest. Therefore, the project reports will vary depending on the type of project undertaken.

4. The student is expected to submit his/her synopsis within a week of time from the commencement of IV semester.

5. An Internal guide will be allocated for each student.

6. The status of project progress must be updated with the internal guide every week.

7. Presentations should be given during subsequent project reviews.

8. Project verification at the place of project work must be mandatory by the external guide, for completion of the work.

9. Project report must be checked for plagiarism, similarity index must be less than or equal to 20%.

10. The CIE of the project work will be evaluated based on the well-defined rubrics during subsequent project reviews.

11. The project report will be evaluated by both internal and external guide assigned by COE.

12. Final presentation of the project report and viva-voce will form the SEE.

13. If project report is not as per the format and not a *high quality simulated application project*, external examiners will have every right to reject the project.

MCA 4th SEMESTER PROJECT REPORT

The format of the report shall include the following:

- A bonafide certificate duly signed by the internal guide, HoD and Principal.
- An undertaking from the student that the work is carried out independently by him/her.
- A Project completion certificate from the organization.
- Acknowledgement.

The sample contents of application project must have the following chapters:

- Abstract
- Introduction
- SRS
- Project Plan
- Analysis and Design
- Implementation (algorithm/coding/screenshots)
- Testing
- Business Model
- Impact on societal/environmental/health/ others
- Conclusion and Future enhancements
- Bibliographic references

Sample contents of research work includes the following chapters:

- Title, Abstract, Keywords
- Introduction
- Literature Survey
- Objectives of Investigation
- Research findings (e.g. proposed methods/system)
- Validation
- Conclusion
- References

RESEARCH / TECHNICAL SEMINAR

Course Code   : 20MCA42A   Credits :02

L:T:P:S   : 0:0:0:2   CIE Marks :25

Exam Hours   : 3   SEE Marks :25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the recent trends in computing technology to address research challenges.
CO2	Analyze and interpret the data related to a domain technology.
CO3	Develop required skills to proficient with the technologies.
CO4	Conceptualize the solution for the identified problem statement.
CO5	Formulate the methodology for the chosen problem statement.
CO6	Exemplify the communication skills for effective presentation.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	1	-	-	3	3
CO2	1	-	-	2	-	-	-	-	-	1	-	-	3	3
CO3	1	-	-	-	2	-	-	-	-	1	-	-	3	3
CO4	1	2	3	2	-	-	-	-	-	1	-	-	3	3
CO5	1	2	1	-	-	-	-	-	-	1	-	-	3	3
CO6	1	2	1	-	-	-	-	-	3	1	-	-	3	3

RESEARCH / TECHNICAL SEMINAR:

This **RESEARCH / TECHNICAL SEMINAR** is based on current technological research trends.

Research / Technical Seminar Guidelines:

1. Select broad area of your interest (E.g. Computer Networks, Machine Learning/Data mining, Databases, etc…)
2. Select a specific research area. (E.g. In Data mining, one can choose cluster analysis or Classification or Association rule mining, subsequently you can choose a more narrowed topic like Density based clustering or Grid based clustering etc…)
3. Further search at least 15 recent research papers (e.g. last 2-5 years) related to your specific topic in IEEE explore or Science Direct or ACM digital library, etc… From these papers, select best 5 papers, preferably Journal papers or reputed conferences. (E.g. Machine Learning Journals: IEEE PAMI, Knowledge and Data engg. Elsevier – Pattern recognition, PRL, Data and Knowledge engineering, Springer- PAA, Data mining and Knowledge discovery, Reputed conferences- ICPR, CVPR, KDD, ICAPR, etc…)
4. Read these 5 papers thoroughly. Write down a summary of each paper based on their contributions (ideas), Improvements claimed, Parameters used for comparison, Experiments carried out, Tools used.
5. Write a report based on summary highlighting contributions, differences, your ideas to improve those methods, your analysis and interpretation.

Seminar Work Evaluation: (20MCA42A)
- Seminar coordinators follow rubrics, which is set by the Department for evaluation of seminar work and report prepared by the students.
- Seminar reviews will be evaluated by the respective internal guides.

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ELECTIVE - 6

DESIGN THINKING

Course Code	: 20MCA431A	**Credits**	:02
L:T:P:S	: 2:0:0:0	**CIE Marks**	:25
Exam Hours	: 2	**SEE Marks**	:25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the fundamentals of design thinking.
CO2	Distinguish various tools and strategies for design thinking.
CO3	Implement a strategic business plan.
CO4	Derive a business model with its essential elements.
CO5	Evaluate the designs with required Law.
CO6	Develop the prototype using the design thinking methods.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-		-	-	-	-	-	-	-	-	3	3
CO2	2	2	-	-	3	-	-	-	-	-	-	-	3	3
CO3	-	2	-	-	-	-	-	-	-	-	-	1	3	3
CO4	-	-	-	-	-	-	-	3	-	-	-	-	3	3
CO5	-	2	-	-	-	-	-	-	-	-	-	-	3	3
CO6	2	-	-	-	-	-	-	-	-	-	-	1	3	3

	SYLLABUS		
Module	**Contents of the Module**	**Hours**	**COs**
1	**Design thinking overview:** Definition, Introduction, Customizing the process. **Building blocks of Design Thinking**: Information gathering, Problem Analysis and Definition, Idea Generation, Synthesis through modelling, Critical Evaluation.	5	**CO1**
2	**Tools and Strategies:** Diagramming, Reflecting, Presenting. **Politics and Society:** Expanding the politics of Civic engagement, Managing gridlocked debates.	5	**CO2**
3	**Business:** Implementing a strategic technology Plan, Creativity in the culinary arts, Empathy as a means to Innovate in Pharmaceutical company.	5	**CO3**
4	**Business:** Visioning, Listening and Diagramming at a University, Fast-Fail and Iterative, Dinner conversation as a model for effective interviews. **Health and Science:** Health Care Delivery, A Design approach to treating Cancer.	5	**CO4**
5	**Law:** Problem Definition, Alternatives and the Big Idea. **Writing:** Draft as prototype, Writing Prose for writing Pros.	5	**CO5, CO6**

Text Books:
1. Design thinking: A guide to creative problem solving for everyone, Andrew Pressman, Taylor & Francis publishers, 2019, ISBN: 9781138673472.
2. Basics of Design Thinking, Gavin Ambrose, Paul Harris, AVA Publishers, 2010, ISBN: 9782940411177.

Reference Books:
1. Complete Design Thinking Guide for successful professionals, Daniel Ling, Kindle edition, ISBN: 9789810955649.
2. Design thinking methodology Book, Emrah Yayici, Kindle Edition, 2016, ISBN: 9786058603752.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (25 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	-	-
Remember	5	-	-
Understand	5	-	-
Apply	5	-	-
Analyze	5	-	-
Evaluate	2	-	-
Create	3	-	-

SEE- Semester End Examination: Theory (25 Marks)

Bloom's Category	Tests
Marks	**25**
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	2
Create	3

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RESEARCH METHODOLOGY AND IPR

Course Code	: 20MCA432A	**Credits**	:02
L:T:P:S	: 2:0:0:0	**CIE Marks**	:25
Exam Hours	: 2	**SEE Marks**	:25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the Research Methodology (RM) types and their significances.
CO2	Define a research problem and its design.
CO3	Illustrate the criteria of sampling with relevant characteristics.
CO4	Investigate IPR with its infringement & remedies.
CO5	Evaluate and protect author's work from theft or piracy.
CO6	Design a product or process to meet the products specification according to its originality.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	1	1	-	-	-	-	-	3	3
CO2	-	3	-	-	-	1	1	-	2	-	-	-	3	3
CO3	-	3	-	-	-	1	1	-	1	-	-	-	3	3
CO4	-	3	-	-	-	1	1	-	-	-	-	-	3	3
CO5	-	3	-	-	-	1	1	-	-	-	-	-	3	3
CO6	-	3	3	-	-	1	1	-	-	-	-	-	3	3

SYLLABUS			
Module	**Contents of the Module**	**Hours**	**COs**
1	**Research Methodology:** An Introduction – Meaning, Objectives, Motivation, Types, Approaches, Significance, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing how research is done, Research process, Criteria of good research, Problems encountered by researchers.	5	CO1
2	**Defining the research problem:** Definition, Problem selection, Necessity of defining the problem, Techniques involved in defining a problem and illustration. **Research Design:** Meaning, Need, Features of a good design, Important concepts relating to research design, Different research designs.	5	CO2
3	**Sampling design:** Census and Sample survey, Implications of a sample design, Steps in sampling design, Criteria of sampling procedure, characteristics, types of sample designs, Select a random sample.	5	CO3
4	**IPR:** Introduction, copyright and related rights – background and basic principles, Subsistence of copyright, Authorship and Ownership of copyright, Author's rights, Infringement and remedies.	5	CO4
5	**Copyright, Designs and Patents Act:** Defences to copyright infringement and the permitted acts, Copyright and the permitted acts, Copyright and computer software, Rights in performances.	5	CO5, CO6

Text Books:

1. Research Methodology Methods and techniques, C.R Kothari, Gaurav Garg, New Age, 2020,4th Edition, ISBN:978938669225.
2. Intellectual Property, David I Bainbridge, Pearson, 2010, 8th Edition, ISBN: 978-1-4082-2928-6.

Reference Books:

1. Research Methodology – a step-by-step guide for beginners, Ranjit Kumar, SAGE, 2011, ISBN: 978-1-84920-300-5.
2. Essentials of Research Design and Methodology, Geoffrey Marczyk, David DeMatteo, David Festinger, John Wiley & Sons Inc., 2005.

Assessment Pattern

CIE-Continuous Internal Evaluation: Theory (25 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	-	-
Remember	5	-	-
Understand	5	-	-
Apply	5	-	-
Analyze	5	-	-
Evaluate	3	-	-
Create	2	-	-

SEE- Semester End Examination: Theory (25 Marks)

Bloom's Category	Tests
Marks	**25**
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	3
Create	2

****

ENTREPRENEURSHIP AND INNOVATION MANAGEMENT

Course Code	: 20MCA433A	**Credits**	:02
L:T:P:S	: 2:0:0:0	**CIE Marks**	:25
Exam Hours	: 2	**SEE Marks**	:25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss the fundamentals of innovation portfolio.
CO2	Distinguish Innovation voices through its various levels.
CO3	Illustrate the business model using the tools for profit and growth.
CO4	Examine the characteristics of opportunity costs and hidden benefits.
CO5	Evaluate the procedure for optimizing and eliminating the trade-offs.
CO6	Compose the real time case studies for Innovation and Entrepreneurship.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	1	-	-	-	-	3	3	3
CO2	-	-	-	-	-	-	1	-	-	-	-	3	3	3
CO3	-	2	-	-	-	-	1	-	-	-	-	3	3	3
CO4	-	-	-	-	-	-	1	3	-	-	-	3	3	3
CO5	-	-	-	-	-	1	1	-	-	-	1	3	3	3
CO6	-	-	-	-	-	1	1	-	3	-	1	3	3	3

SYLLABUS			
Module	Contents of the Module	Hours	Cos
1	**Innovation Imperative:** Introduction to Innovation, A key fallacy, Innovation to energize, Innovate for growth and profit, Innovate for survival. **The Innovation Portfolio:** Vision, Portfolios and Feelings, Strategy and Innovation, Identifying feelings and needs, Innovating experiences, Battling commoditization, Technology and psychology, Searching for innovation opportunities, Process Innovation, Innovation portfolios for established organizations, Pioneers, Migrators, Settlers. **Case study** – *Ingersoll-Rand (India) Ltd.*	5	CO1, CO6
2	**The innovation voices**: Thinking 'Inside the Box', The four voices, Voice of the Product, Profile your product for profit and growth, Voice of the customer, Voice of the organization, Inspiration, Perspiration, Foster creativity in organizations. **The innovative mind:** Introduction, Three levels of Innovation, Individual Innovator, Creativity muscles, Innovative teams, Build a global team, Innovative Organization. **Case study -** *Reinventing project management at Tata Steel, Indicorps*.	5	CO2, CO6
3	**Tools for profit and growth**: Price-Cost-Value – Introduction, Business model, Definitions, Business Design as Ecosystem, Systems Thinking, Feedback effects, Technology, Meet Psychology. **Creating value, cutting costs:** Friends or Foes, The power of vision, Best market research. **Case study -***Viewmax, Air Deccan*.	5	CO3, CO6

4	**Hidden costs, Hidden benefits**: Measure and manage costs, Accounting vs. Economic costs, Definitions, Reading the numbers, Risk-adjusted opportunity cost of shareholders' equity, Search of the bottom-bottom line, Collect the rent, Other hidden costs. **Depreciation**: Hidden benefits, Reconciling growth and cost cutting, Measurement and Change management, Sunk costs. **Case study -** *Passenger power seat adjuster, Comprehensive Trauma consortium*.	5	CO4, CO6
5	**Trade-offs - Optimizing and elimination**: Introduction, Efficiency and Effectiveness, Value Innovation, Defying Trade-offs, Even swaps, Comparative advantage. **Case study**–*Kodak's trade-off dilemma, Tata Consultancy Services-trade-offs*.	5	CO5, CO6

Text Books:

1. Entrepreneurship: A Tools – Oriented Approach, George Abe, Vandeplas Publishing, 2020, ISBN: 9781600425127.
2. Innovation Management, Shlomo Maital, D.V.R.Seshadri, SAGE publications, 2nd Edition, 2012, ISBN: 978-81-321-0722-4.
3. Innovation and Entrepreneurship, Drucker, Routledge, Harper Business Publishers, 2015, ISBN: 978-1-138-01919-5.

Reference Books:

1. Social Entrepreneurship and Innovation: International Case Studies and Practices, Peter Gabriel, Ken Banke, Kogar Page publishers, 2021, ISBN: 9781398695573.
2. Managing Technology Entrepreneurship and Innovation, Paul Trott, Dap Hartmann, Patrick Van der Duin, Victor, J. Roland, Taylor & Francis, 2015, ISBN: 9781317498209.
3. Digital Entrepreneurship and Global Innovation, Loana Lancu, IGI Global, 2016, ISBN: 9781522509547.

Assessment Pattern

CIE- Continuous Internal Evaluation: Theory (25 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	-	-
Remember	5	-	-
Understand	5	-	-
Apply	5	-	-
Analyze	5	-	-
Evaluate	5	-	-
Create	-	-	-

SEE- Semester End Examination: Theory (25 Marks)

Bloom's Category	Tests
Marks	**25**
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	-

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PROFESSIONAL ETHICS

Course Code	: 20MCA434A	**Credits**	:02
L:T:P:S	: 2:0:0:0	**CIE Marks**	:25
Exam Hours	: 2	**SEE Marks**	:25

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Discuss the intricacies of ethical issues.
CO2	Summarize the aspects of computer crime and IPR.
CO3	Examine the policies for regulating Internet content and technology safety.
CO4	Investigate on the computer technologies for accessibility issues.
CO5	Evaluate the software development strategies with engineering standards.
CO6	Develop the social networking ethical issues.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	1	-	-	-	3	1	-	-	1	-	-	3	3
CO2	-	1	-	-	-	3	1	-	-	1	-	-	3	3
CO3	-	1	-	-	-	3	1	-	-	1	-	-	3	3
CO4	-	1	-	-	-	3	1	-	-	1	-	-	3	3
CO5	2	1	-	-	-	3	1	-	-	1	-	-	3	3
CO6	-	1	2	-	-	3	1	-	-	1	-	-	3	3

	SYLLABUS		
Module	**Contents of the Module**	**Hours**	**COs**
1	**COMPUTER ETHICS INTRODUCTION AND COMPUTER HACKING:** Introduction to Computer ethics, An overview, Identifying an ethical issue, Ethics and law, Ethical theories, Professional Code of conduct, An ethical dilemma, A framework for ethical decision making, Computer hacking, Introduction, definition of hacking, Destructive programs, hacker ethics, Professional constraints, BCS code of conduct, To hack or not to hack, Ethical positions on hacking.	**5**	**CO1**
2	**ASPECTS OF COMPUTER CRIME AND INTELLECTUAL PROPERTY RIGHTS:** Aspects of computer crime, Introduction to computer crime, computer security measures, Professional duties and obligations, Intellectual Property Rights, The nature of Intellectual property, Intellectual Property, Patents, Trademarks, Trade Secrets, Software Issues, Copyright, The extent and nature of software piracy, Ethical and professional issues, free software and open source code.	**5**	**CO2**
3	**REGULATING INTERNET CONTENT, TECHNOLOGY AND SAFETY:** Introduction, In defence of freedom expression, censorship, laws upholding free speech, Free speech and the Internet, Ethical and professional issues, Internet technologies and privacy, Safety and risk, assessment of safety and risk, Risk benefit analysis, reducing risk.	**5**	**CO3**

4	**COMPUTER TECHNOLOGIES ACCESSIBILITY ISSUES:** Introduction, Principle of equal access, Obstacles to access for individuals, professional responsibility, Empowering computers in the workplace, Introduction – computers and employment, computers and the quality of work, computerized monitoring in the work place, telecommuting, social, legal and professional issues, Use of Software, Computers and Internet-based Tools, Liability for Software errors, Documentation Authentication and Control, Software engineering code of ethics and practices, IEEE-CS – ACM Joint task force.	5	CO4
5	**SOFTWARE DEVELOPMENT AND SOCIAL NETWORKING:** Software Development, strategies for engineering quality standards, Quality management standards, Social Networking, Company owned social network web site, the use of social networks in the hiring process, Social Networking ethical issues, Cyber bullying, stalking, Online virtual world, Crime in virtual world, digital rights management, Online defamation, Piracy and Fraud.	5	CO5, CO6

Text Books:
1. Ethics in Computing, Science and Engineering, Barry G. Bludell, Springer International publishing, 2020, ISBN: 9783030271268.
2. Ethics in Information Technology, George Reynolds, CengageLearning,2011.
3. Ethical, legal and professional issues in computing, Penny Duquenoy, Simon Jones and Barry G Blundell, Middlesex University Press, 2008.

Reference Books:

1. Ethics in Engineering Practice and Research, Cambridge University Press, 2011.
2. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet, Sara Baase, 3rd Edition, Prentice Hall, 2008.

Assessment Pattern:

CIE – Continuous Internal Evaluation: Theory (25 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	25	-	-
Remember	10	-	-
Understand	10	-	-
Apply	3	-	-
Analyze	2	-	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination: Theory (25Marks)

Bloom's Category	Tests
Marks	25
Remember	10
Understand	10
Apply	3
Analyze	2
Evaluate	-
Create	-

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ECONOMICS FOR SOFTWARE ENGINEERS

Course Code	: 20MCA435A	**Credits**	:02
L:T:P:S	: 2:0:0:0	**CIE Marks**	:25
Exam Hours	: 2	**SEE Marks**	:25

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss overview of software systems life cycle costing and engineering economy.
CO2	Categorize economic analysis alternatives for life cycle framework techniques.
CO3	Characterize Simulation based costing and costing complex systems.
CO4	Identify parametric cost estimation methods for software-intensive systems.
CO5	Evaluate costing and managing Off-the Shelf Systems.
CO6	Formulate Project Management's Role in life cycle costing.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	1	-	-	1	3	-	-	1	-	3	3
CO2	-	1	-	1	-	-	1	3	-	-	1	-	3	3
CO3	-	1	-	1	3	-	1	3	-	-	1	-	3	3
CO4	-	1	-	1	-	-	1	3	-	-	1	-	3	3
CO5	-	1	-	1	-	-	1	3	-	-	1	-	3	3
CO6	-	1	-	1	-	-	1	3	-	-	1	-	3	3

SYLLABUS			
Module	Contents of the Module	Hours	COs
1	**Overview of Systems Life Cycle Costing:** Introduction to Systems Life Cycle Costing, Economic Analysis, Cost Estimation – Parametric, Analogy, Engineering Build-up, Cost Management. **Introduction to Engineering Economy:** Introduction, Capital Budgeting Decision, Time Value of Money, Amortization, Investment/Deflation.	5	CO1
2	**Advanced Economic Analysis of Alternatives**: Introduction to Advanced Cash Flow analysis – Depreciation, Corporate Income Taxes, Income and Cash Flow Statements, Expected Value, Sensitivity Analysis, Break-Even Analysis. **Life Cycle Framework and Techniques**: Introduction to Developing Life Cycle Models, Developing LCC Models, Categories, Estimating LCC throughout the Product.	5	CO2
3	**Simulation-Based Costing:** Introduction, Review of Probability and Statistics, Discrete Process Generators, Continuous Process Generators, Probability and Statistics, Simulation in Practice, Using Readiness Level for Model Input, Simulation using Spreadsheets. **Costing of Complex Systems**: Introduction, Issues surrounding complex systems, Systems Engineering and Management Costs – Hardware Costs, Software Costs, Interfaces and Integration at the System Level, System Engineering/Project Management Costs and Requirements to Architectures.	5	CO3

4	**Software-Intensive Systems:** Introduction, Software Estimating Techniques, Algorithmic, Mathematical and Statistical. **Parametric Cost Estimation:** Introduction, Role of statistics, Some CERs Interest – Learning Curves, Wright's method. **Cost as an Independent Variable:** Introduction, CAIV Evolution through the Life Cycle, CAIV Metrics, Design to Cost versus CAIV.	5	CO4
5	**Costing and Managing Off-the Shelf Systems:** Introduction, COTS – Hardware-centric, Software-centric, Integration Costs, GOTS, Software Reuse, Open Source. **Cost of Quality:** Introduction, Six Sigma, CMMI, Generic Cost of Quality Models. **Project Management's Role in Life Cycle Costing:** Introduction, Basics of Networks, Work Breakdown Structure, Progress Measurement, Simulation of Networks.	5	CO5, CO6

Text Books:

1. Systems Life Cycle Costing – Economic Analysis, Estimation and Management, John Vail Farr, CRC Press, 2011, ISBN: 978-1-4398-2892-2.
2. Life Cycle Sustainability Assessment for Decision Making – Methodologies and Case Studies, Jingzheng Ren, Sara Toniolo, Elsevier, 2020, ISBN: 978-0-12-818355-7.

Reference Books:

1. Life-Cycle Cost Models for Green Buildings with Optimal green star credits, I.M.Chethana S. Illankoon, Vivian W.Y. Tam and Khoa N.LE, Elsevier, 2021, ISBN: 978-0-12-820062-9.

Assessment Pattern

CIE - Continuous Internal Evaluation: Theory (25 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	25	-	-
Remember	5	-	-
Understand	5	-	-
Apply	5	-	-
Analyze	5	-	-
Evaluate	3	-	-
Create	2	-	-

SEE- Semester End Examination: Theory (25 Marks)

Bloom's Category	Tests
Marks	**25**
Remember	-
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	5

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