Scheme & Syllabus for I & II Semesters

2020 SCHEME

MASTER OF COMPUTER APPLICATIONS

2-Year Program

2020-21

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the Global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team work and Innovation

RV College of Engineering[®]

Autonomous Institution affiliated to VTU, Belagavi

Department of Master of Computer Applications

Scheme and Syllabus of I & II Semesters

2020 SCHEME

DEPARTMENT OF
MASTER OF COMPUTER APPLICATIONS

2020-21

DEPARTMENT OF
MASTER OF COMPUTER APPLICATIONS

VISION

Pioneering in ICT Enabled Quality Education and Research with a focus on Sustainable and Inclusive Applications

MISSION

1. To adapt novel methodologies for quality education through experiential learning
2. To empower students with continuous, holistic education, emphasizing on discipline, ethics and social commitment
3. To become a vibrant knowledge center for research and software development.
4. To continuously build capacity steering towards industry- institute collaborative research and entrepreneurial competencies
5. To utilize and develop free and open source software tools for sustainable and inclusive growth

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1   Practice software engineering principles and standards to develop software to meet customer requirements across verticals

PEO2   Contribute to build sustainable and inclusive applications using mathematical, simulation and meta heuristic models

PEO3   Demonstrate entrepreneurial qualities through individual competence and team work

PEO4   Achieve successful professional career with integrity and societal commitments leading to lifelong learning

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1   Solve real world computing system problems of various industries by understanding and applying the principles of mathematics, computing techniques and business concepts

PSO2   Design, test, develop and maintain desktop, web, mobile and cross platform software applications using modern tools and technologies

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	ET	Electronics &Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Processing Signal & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

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RV COLLEGE OF ENGINEERING®
(Autonomous Institution Affiliated to VTU, Belagavi)
MASTER OF COMPUTER APPLICATIONS

Department of Master of Computer Applications

Sl.No	Course Code	Course Title	BoS	Credit Allocation			Total Credits
				Lecture	Tutorial	Practice	
1.	20MAT11	Mathematical Foundation for Computer Applications	MAT	4	1	-	**5**
2.	20MCA12	Linux Shell Scripting	MCA	3	1	-	4
3.	20MCA13	Computer Networks	MCA	4	-	1	**5**
4.	20MCA14	Object Oriented Programming	MCA	4	-	1	**5**
5.	20MCA15	Web Application Programming	MCA	4	-	1	**5**
6.	20HSS16	Professional Practice	HSS	0	-	2	**2**
7.	20MCAB17	Basics of Programming * **(Bridge Course)**		3	**-**	**-**	**0**
	Total number of Credits			**19**	**2**	**5**	**26**
	Total Number of Hours/Week			**19**	**4**	**10**	

*The Basics of Programming (20MCAB17) is a **mandatory audit course** is offered to Non-Computer Science background students only.

SECOND SEMESTER CREDIT SCHEME

Sl.No	Course Code	Course Title	BoS	Credit Allocation			Total Credits
				Lecture	Tutorial	Practice	
1.	20MCA21	Software Engineering	MCA	3	-	-	**3**
2.	20MCA22	Data Structures & Algorithms	MCA	3	1	-	**4**
3.	20MCA23	Database Management System	MCA	3	-	1	**4**
4.	20MCA24X	Elective-I	MCA	3	1	-	**4**
5.	20MCA25X	Elective-II	MCA	3	1	-	**4**
6.	20MCA26X	Elective-III	MCA	4	-	1	**5**
7.	20MCA27	Design-Thinking	MCA	-	-	2	**2**
Total number of Credits				**19**	**3**	**4**	**26**
Total Number of Hours/Week				**19**	**6**	**08**	

ELECTIVE – I			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	20MCA241	Advanced Computer Networks	4
2.	20MCA242	Network Security	4
3.	20MCA243	Internet of Things	4

ELECTIVE – II			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	20MCA251	Machine Learning	4
2.	20MCA252	Big Data Analytics	4
3.	20MCA253	Natural Language Processing	4

ELECTIVE – III			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	20MCA261	PHP based Software Solutions	5
2.	20MCA262	Java based Software Solutions	5
3.	20MCA263	JavaScript based Software Solutions	5

THIRD SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BoS	Credit Allocation			
				L	T	P	Total Credits
1	20MCA31	Project Management	MCA	4	-	-	**4**
2	20MCA32	Modern Application Development	MCA	4	-	1	**5**
3	20MCA33X	Elective-IV	MCA	4	1	-	**5**
4	20MCA34X	Elective-V	MCA	4	1	-	**5**
5	20MCA35X	Elective–VI (with Practice)	MCA	4	-	1	**5**
6	20MCA36	Minor Project	MCA	-	-	2	**2**
Total Number of Credits				**20**	**2**	**4**	**26**
				20	**4**	**8**	

ELECTIVE – IV			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	20MCA331	Cloud Computing	5
2.	20MCA332	Cyber Security	5
3.	20MCA333	Web of Things	5

ELECTIVE – V			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	20MCA341	Artificial Intelligence	5
2.	20MCA342	Augmented & Virtual Reality	5
3.	20MCA343	Deep Learning	5

ELECTIVE – VI			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	20MCA351	PHP Framework based Full Stack Software Solutions	5
2.	20MCA352	Java Framework based Full Stack Software Solutions	5
3.	20MCA353	JavaScript Framework based Full Stack Software Solutions	5

FOURTH SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BoS	Credit Allocation			
				L	T	P	Total Credits
1	20MCA41	Major Project	MCA	-	-	20	20
2	20MCA42	Technical Seminar	MCA	-	-	2	2
Total Number of Credits						22	22

Credits for the TWO Year MCA Program- Scheme 2020					
Total Credits					
Semester	Core	Elective	Project / Industry Internship	Seminar	Total Credits
I	24	00	02	00	26
II	11	13	02	00	26
III	09	15	02	00	26
IV	00	00	20	02	22
Total	44	28	26	02	100

I – SEMESTER						
MATHEMATICAL FOUNDATION FOR COMPUTER APPLICATIONS **(Theory)**						
Course Code	:	**20MAT11**	**CIE**	:	**100 Marks**	
Credits: L:T:P	:	**4:1:0**	**SEE**	:	**100 Marks**	
Total Hours	:	**52L+26T**	**SEE Duration**	:	**03 Hrs**	

UNIT-I	**10 Hrs**

Sets, Relations and Functions

Basics of set theory, Cartesian product of sets. Relations, Properties of relations, Zero-one matrices and directed graphs, Hasse diagram, Equivalence relations and partitions. Functions- types of functions, Special Functions, Function composition and Inverse function.

UNIT – II	**10Hrs**

Logic

Basic connectivity and Truth table, Logical equivalence, logical implications, Quantifiers
– Predicates: Predicative logic, Free and Bound variables, Rules of inference, Consistency. Proofs of theorems-direct, indirect and proof by contradiction, Automatic theorem.

UNIT – III	**11Hrs**

Engineering Optimization

Introduction to Operations Research, Linear Programming Problem- Formation, Classical optimization techniques-Simplex method, Dual Simplex method. Transportation Model-North west corner rule, Vogel's approximation method, Optimum solution using modified distribution method. Assignment Model-Hungarian method.

UNIT – IV	**11 Hrs**

Statistics and Probability

Measures of Central Tendency (Mean, Median, Mode, Other averages), Measures of Dispersion (range, mean deviation, standard deviation), Curve fitting by method of least squares, fitting of curves – polynomial, exponential, power function. Correlation and linear regression analysis.
Basic concepts of probability, conditional probability, Bayes' theorem.

UNIT – V	**10Hrs**

Probability Distributions and Testing of hypothesis

Random variables- discrete and continuous, probability mass function, probability density function, Cumulative density function. Binomial distribution, Poisson distribution, Exponential distribution and Normal distribution.

Testing of hypothesis– Null and alternative hypothesis, Tests - type I and type II error, Test statistic and critical region, Critical value, decision rule, Hypothesis Testing of Mean, proportion, variance.

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand fundamental concepts of sets, relations, functions, logic, statistics and probability theory.
CO2	Apply fundamental concepts of functions, reasoning, statistics and probability theory for different domains in data science and machine learning
CO3	Analyze mathematical concepts like relational algebra, statistics, and probability theory to optimize the solutions of engineering problem.
CO4	Implement overall mathematical knowledge gained to demonstrate and analyze the problems arising in practical situations.

Reference Books:	
1	Discrete and Combinatorial Mathematics, An Applied Introduction, Ralph P Grimaldi, B.V.Ramana, 5th Edition, 2007, Pearson Education, ISBN-10: 8177584243, ISBN-13:9788177584240.
2	Discrete Mathematics & its Applications, Kenneth H Rosen, 7th Edition, 2010, McGraw-Hill, ISBN-10: 0073383090, ISBN-13: 978-0-073383095.
3	Theory and Problems of Probability, Seymour Lipschutz and Marc lars Lipson, 2nd Edition Schaum's Outline Series, ISBN: 0-07-118356-6.
4	Operations Research: Applications and Algorithms, Wayne L Winston, 4th Edition, 2004, Thomson Learning, ISBN 0-534-38058-1.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks are executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

I - SEMESTER					
LINUX SHELL SCRIPTING **(Theory)**					
Course Code	:	**20MCA12**	**CIE**	:	**100 Marks**
Credits: L:T:P	:	**3:1:0**	**SEE**	:	**100 Marks**
Total Hours	:	**39L+26T**	**SEE Duration**	:	**03 Hrs**

UNIT – I	**07Hrs**
The Unix/Unix Like Operating System architecture and commands: Unix Architecture, Features of UNIX, General purpose utility commands, Basic and advanced file attributes, File system, **Introduction to version control system:** git and its usage for managing code repositories. **Introduction to Shell Script:** Shell, Shell Environment	

UNIT – II	**08 Hrs**
Programming through Shell Script: : read, command line arguments, exit, variables, wildcards, escape characters logical operators and conditional operators, if conditional, case conditional, expr computations and string handling, while looping, for looping, set and shift, trap interrupting a program, debugging shell scripts with set command, validation and data entry scripts, function: introduction, scope of variable, return codes, **Scripting Standards** - Scripts and naming convention, Script File Permission, Shell Script Format, Sequence of Script execution	

UNIT – III	**08 Hrs**
Introduction to filters: pr: paginating files**,** head: Displaying the beginning of a file, tail: displaying the end of the file, cut: slitting a file vertically, paste: pasting files, sort: ordering a file, uniq, tr: translating characters. **Filters and regular expression:** grep: Searc hing for a pattern, Basic Regular Expression, Extended Regular Expression and egrep, types of grep. **sed**:stream editor, Line addressing, Context addressing, Text editing, Substitution. **awk**: Simple awk filtering, splitting a line into fields, printf, redirecting and expression, comparison, begin and end, built-in variables and arrays	

UNIT – IV	**08 Hrs**
User Management: Adding a group, adding a user, user profiles, modifying and removing users **Process Management:** Process status, system processes, mechanism of process creation, Internal and External commands, process states and Zombies, killing processes with signals **Job scheduling**: Scheduling jobs with at and crontab. **Log Management**: Running script in background for tracking various log messages, tail with egrep and echo, Central logging (rsyslog)	

UNIT – V	**08 Hrs**
Database Administration and Backup: Backing up each database to a separate file, Backing up a single database, Backup all databases to a single file, schedule a backup to automatically back up a web portal or website data. **Real Time Practice:** Shell scripting to execute different commands on different remote servers, Automatic email alert generation about hardware resources, Automate installation of required git version using shell script, Shell script to backup file system **Introduction to Docker and Curl:** Brief introduction about docker and its usage while automating infrastructure management. **Introduction to Curl**: Automating user communication to and from servers using Curl	

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand how to write shell scripts from basic to advanced level
CO2	Analyze and Identify high-level steps such as verifying user input to automate repetitive tasks
CO3	Apply shell scripting techniques and standards using filters for pattern matching on plain text data and variety of system log files
CO4	Develop effective and interactive scripts using functional blocks, operating system and networking utilities to manage complex and repetitive tasks in real time scenarios

Reference Books	
1	Unix Concepts and Applications, Sumitabha Das, 4th Edition, 2012, McGraw Hill, ISBN:978-0-07-063546-3
2	Learning Linux Shell Scripting, Ganesh Naik, 2nd Edition, May 2018 Packt Pub https://www.packtpub.com/in/networking-and-servers/learning-linux-shell-scripting-second-edition
3	Narendra Kumar Reddy, April 2020 Polu, Packt Publishing https://www.packtpub.com/in/cloud-networking/complete-bash-shell-scripting-video
4	Mastering Linux shell scripting second-edition, Mokhtar Ebrahim, Andrew Mallett, April 18, 2018, Packt Publishing https://www.packtpub.com/in
5	A Complete Course on Linux bash shell scripting with real life examples, Imran Afzal, July 2019, Packt Publishing https://www.packtpub.com/cloud-networking

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours..

I - SEMESTER					
COMPUTER NETWORKS (Theory & Practice)					
Course Code	:	20MCA13	CIE	:	100 + 50 Marks
Credits: L:T:P	:	4:0:1	SEE	:	100 + 50 Marks
Total Hours	:	52L+26P	SEE Duration	:	03 Hrs

UNIT – I	10Hrs

Introduction- Introduction, Uses of Computer Networks, Network Hardware, Network Software: Protocol Hierarchies, Design Issues for the Layers, Reference Models: The OSI Reference Model, The TCP/IP Reference Model, A Comparison of the OSI and TCP/IP Reference Models, Example Networks: Internet, Architecture of the Internet, Who's Who in the International Standards World Physical Layer-Guided Transmission Media, Digital Modulation and Multiplexing

UNIT – II	10 Hrs

The Data Link Layer - Data link Layer Design issues, Error Detection codes, Sliding Window Protocols (Stop and Wait, Go-Back-N (GBN) and Selective Repeat (SR), Medium Access Control - The Channel Allocation Problem, Multiple Access Protocols, Ethernet

UNIT – III	12 Hrs

The Network Layer- Network Layer Design issues, Routing algorithms- The Optimality Principal, Shortest Path Algorithm, Flooding, Distance Vector Routing, Link State Routing, Hierarchical routing, Congestion Control Algorithms, Quality of Service, Internetworking

UNIT – IV	10 Hrs

The Network Layer in the Internet: The Network Layer in the internet- IP version 4 Protocol, IP version 6 protocol: The Main IPv6 Header, Extension Headers, Internet Control Protocols: ICMP —The Internet Control Message Protocol, ARP—The Address Resolution Protocol, DHCP—The Dynamic Host Configuration Protocol

UNIT – V	10 Hrs

The Transport Layer - Introduction and Transport-Layer Services, Multiplexing and De-multiplexing, Connectionless Transport: UDP, Connection-Oriented Transport: TCP

The Application Layer - Principles of Network Applications, Web and HTTP, Electronic Mail in the Internet, DNS, Socket Programming

LABORATORY / PRACTICE COMPONENT	

1.	Create a LAN with three or more nodes implementing star topology and demonstrate classful addressing
2.	Create a LAN using physical networks/virtual machine and install FTP server to demonstrate file transfer
3.	Demonstrate secured file transfer and computing over wired network and wireless network with SCP and SSH key based computing
4.	Demonstrate to calculate IP addresses using ipcalc
5.	Build DHCP server using dns-masq with and without MAC binding with IPV4 and IPV6
6.	Build DNS server for resolving the names and IP addresses
7.	Build a Firewall to Restrict Network Access using Firewall D or Build a firewall with SNAT or DNAT
8.	Demonstrate basic trouble shooting using ping, traceroute, ifconfig, nslookup, netstat, pathping and route
9.	Demonstrate multiple client server communication on different ports using netcat
10.	Demonstrate Proxy - Server setup for a web server and SSH port forwarding

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand fundamental principles of computer networking and enumerate the layers, protocols and routing algorithms
CO2	Identify the design issues, services, interfaces and protocols for data flow in computer networks
CO3	Implement the protocols and services designed for physical, data link, network, transport and application layers
CO4	Evaluate the principles and protocols in computer networking

Reference Books	
1	Computer Networks, Andrew S. Tanenbaum, David J Wetherall, 5th Edition, 2012, Pearson Education, Pearson Publication, ISBN-1978-81-317-8757-1
2	Computer Networks–A Top Down Approach, James F. Kurose, Keith W. Ross, Pearson Education, 7th Edition, 2017, Pearson Publication, ISBN-13: 978-0-13-359414-0
3	Data Communications and Networking, Forouzan, B. A., 5th Edition, 2013, McGraw-Hill, ISBN: 978-0-07-337622-6
4	Networking Fundamentals, Gordan Davies, 2019, Packt Publishing, ISBN: 978-1-83-864350-8

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory/ Practice - 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.

Total marks for the laboratory is 50.

Master of Computer Applications

I - SEMESTER					
OBJECT ORIENTED PROGRAMMING **(Theory & Practice)**					
Course Code	:	**20MCA14**	**CIE**	:	**100 + 50 Marks**
Credits: L:T:P	:	**4:0:1**	**SEE**	:	**100 + 50 Marks**
Total Hours	:	**52L+26P**	**SEE Duration**	:	**03 Hrs**
UNIT – I					**10 Hrs**
Object oriented programming: Introductions, OOP, classes, class attributes, instances, instance attributes, Encapsulation, Basics of polymorphism: Operator and function overloading, Constructor and Destructor.					
UNIT – II					**12Hrs**
Introduction to Python Programming Language Introduction to python, program output, input, comments, operators, variables and assignment, numbers, if statement, while loop, for loop, and the range() **Data Types, Modules:** Lists and tuples, working with strings, dictionaries, sets **Functions:** built-in Functions: Lambda, MAP, Filters and User defined Functions					
UNIT – III					**11 Hrs**
Modules: What are modules, modules and files, Importing modules, Introduction to Numpy module, Packages **Inheritance:** Introduction, types of inheritance, sub classing and scope, overriding methods **Error and Exceptions**: Introduction to exceptions in python, detecting and handling exceptions, exceptions as strings, raising exceptions, assertions, standard exceptions.					
UNIT – IV					**8 Hrs**
Reading and Writing Files- Introduction to File operation, opening a File, Techniques for Reading Files, Writing Files. **Magic Methods** - Magic method syntax, Available Methods					
UNIT – V					**11 Hrs**
Decorators: Understanding Decorators, Decorator Syntax, Decorators Functions, Decorator classes. **Context Managers:** Context manager syntax, when you should write context managers. **Generators:** Understanding Generators, Generator syntax, Generator Examples **OOP for Database Programming:** Introduction, Architecture, Steps for Connecting Database, Basic Operations with Examples					
LABORATORY/ PRACTICE COMPONENT					
Student should implement using Python Language. Apply Unit testing and integration testing (As per problem definition). Develop various test cases, execute them and analyze the test results					
1. Implement 10 operations on string and Tuple 2. Implement 10 operations on sets and lists 3. Demonstrate dictionary concepts for a given scenario 4. Implement importing of user defined modules using Magic Methods 5. Implement any two types of Inheritance 6. Implement overloading concept 7. Implement overriding concept 8. Demonstrate any five-exception handling mechanism using files 9. Write a python program to Insert, Search, and Retrieve data into Employee DATABASE 10. Write a program to create Fibonacci series using generators and stack the same with a decorator to find the time taken by the generator.					

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the basic concepts of object oriented programming
CO2	Identify and apply relevant object-oriented concepts in any real world scenario.
CO3	Utilize object-oriented concepts to solve any real world problem
CO4	Analyze solutions using OOPs concepts for real world applications

Reference Books	
1	Beginning Python: from novice to Professional, Hetland, Magnus Lie.,3rd Edition, 2017 Apress, ISBN 978-1-4842-0029-2.
2	Professional Python, Sneeringer, Luke, 2016, John Wiley & Sons, ISBN -978-1-119-07085-6.
3	Practical Programming, Paul Gries, Jennifer Campbell, Jason Montojo, 3rd Edition, 2018 An Introduction to Computer Science using Python 3.6, SHROFF Publishers and Distributors Pvt Ltd, ISBN: 13:978935213681-0.
4	Core Python Programming, Wesley J Chun, 3rd Edition, Pearson Education, 2012, ISBN 13: 978-0-13-267820-9.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A min imum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory / Practice- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.

Total marks for the laboratory is 50.

Master of Computer Applications

I - SEMESTER				
WEB APPLICATION PROGRAMMING				
(Theory & Practice)				
Course Code	:	**20MCA15**	**CIE**	:	**100 + 50 Marks**
Credits: L:T:P	:	**4:0:1**	**SEE**	:	**100 + 50 Marks**
Total Hours	:	**52L+26P**	**SEE Duration**	:	**03 Hrs**

UNIT – I	10 Hrs

Introduction to Web Technologies Internet, WWW, Web Browsers, Web Servers, URLs, MIME, HTTP, Security, the Web Programmers Toolbox. WAMP, LAMP, ZAMP, Client-Side Scripting versus Server-Side Scripting.

Mark-up Language: **HTML5 tags**- Formatting, Commenting, Code, Anchors, Backgrounds, Images, Hyper-links, Lists, Tables, Semantic Elements in HTML, Multimedia, Forms

UNIT – II	12Hrs

Front End Design: Cascading Style Sheet (CSS): Introduction to CSS – Basic syntax and structure, In-line Styles, Embedding Style Sheets, Linking External Style Sheets, Backgrounds, manipulating text, Margins and Padding, Positioning using CSS.

Bootstrap:

Getting Started with Bootstrap- Mobile-irst design ,Why Bootstrap, Including Bootstrap in your HTML file, The Bootstrap CDN, Overriding with custom CSS, Using the Bootstrap customizer, Deep customization of Bootstrap, Downloading the Bootstrap source code, Compiling LESS files, using SimpLESS to compile LESS files, using WinLess to compile LESS files, using the command line to compile LESS files, Putting it all together ,using the Bootstrap Grid-using the Bootstrap Grid classes, Customizing the grid for small devices, Adding offsets to columns, Pulling and pushing columns, Nesting columns, Using the Bootstrap variables and mixins, Bootstrap Grid variables, Bootstrap Grid mixins

UNIT – III	8 Hrs

XML: Introduction, syntax, Document structure, Document Type Definitions, Namespaces, XML schema, displaying raw XML documents

JSON

Introduction-JSON: Is a Data Interchange Format, JSON Is Programming Language Independent, JSON Syntax -JSON Is Based on JavaScript Object Literals ,Name-Value Pairs, Proper JSON Syntax ,Syntax Validation, JSON as a Document, The JSON Media Type, JSON Data Types -Quick Look at Data Types, The JSON Data Types ,The JSON Object Data Type, The JSON String Data Type, The JSON Number Data Type ,The JSON Boolean Data Type, The JSON null Data Type ,The JSON Array Data Type, JSON Schema -Contracts with Validation Magic ,Introduction to JSON Schema.

UNIT – IV	11 Hrs

Basics of JavaScript: Overview of JavaScript, Object orientation and JavaScript, Syntactic characteristics, Primitives, operations, and expressions, Screen output and keyboard input, Control statements, Object creation and modification, Arrays, Functions, Constructors, Pattern matching using regular expressions.

UNIT – V	11 Hrs

Document Object Model: The JavaScript Execution Environment, The Document Object Model, Elements Access in Java Script, Events and Event Handling, The DOM 2 Event Model, DOM Tree Traversal and Modification

Data Visualization-Getting Started with D3.js, Using SVG to Create Images Using Code , Base tag , Basic elements , Positioning an element , Styling an element ,Important SVG elements

LABORATORY/ PRACTICE COMPONENT

1. Design a static web portal using HTML5 semantic elements and Bootstrap of online book stores. The website should consist the pages like. Home page, Registration and user Login, User profile page, Books catalogue, Shopping cart, Payment system, order confirmation.
 2. Create an inventory management system portal using HTML5 and apply cascading style sheet for better user interface experience.
 3. Design JSON and XML document to store information about a student in MCA Department, college affiliated to VTU. Make up sample data for 20 students. Access the values through JavaScript and store in the table format.
 4. Design a login page to demonstrate following
     a) Display user name and time on successful login
     b) change the background color of the page
     c) validate the username and password using pattern matching in JavaScript
 5. Design a page to accept student details for selection of electives
     a) Read the values of 20 students
     b) Display various charts using D3 JavaScript.
 	
 Note: Each program should be completed and executed within two consecutive lab cycles. However, for CIE test and SEE evaluation the examiner can specify minimum functionalities related to the programs keeping time factor as a constraint.

Course Outcomes: After going through this course, the student will be able to	
CO1	Describe the basic constructs of the web concepts
CO2	Determining and comparing the relevant components that can be applied to a given problem
CO3	Apply the concepts to design and implement the web solutions for the given scenario
CO4	Analyze the web components in building an application

Reference Books	
1	Programming the World Wide Web, Robert W. Sebesta, 10th Edition, 2018, Pearson Education, ISBN: 9780133775983.
2	Web Technology Theory and Practice, M. Srinivasan, 1st Edition, 2019, Pearson Education, ISBN: 9788131774199.
3	Internet and World Wide Web - How to Program, Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, 5th Edition, 2019, Pearson Education, ISBN: 9780132151009
4	Web Programming Building Internet Applications, Chris Bates, Wiley India, 3rd Edition, 2020, ISBN: 9780470017753.
5.	Introduction to JavaScript Object Notation, Lindsay Basset, O'Reilley Media, Inc., August 2015, 9781491929483.
6	Learning Bootstra, Aravind Shenoy, Ulrich Sossou, 2020 O'Reilly Media, ISBN 978-1-78216-184-4.
7	D3.js Quick Start Guide, Matthew Huntington, 2018 Packt Publishing, ISBN-13: 978-1789342383

Continuous Internal Evaluation (CIE): Total marks: 100+50=150
Theory – 100 Marks
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory / Practice- 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.
Total marks for the laboratory is 50.

		I-**SEMESTER**				
		PROFESSIONAL PRACTICE				
Course Code	:	20HSS16		**CIE**	:	**50 Marks**
Credits	:	**L:T:P**	0**:**0:2	**SEE**	:	**50 Marks**
Hours	:	**26** hrs /Semester		**SEE Duration**	:	**02 Hrs**

UNIT 1	**05 Hrs**
Communication Skills: Basics, Method, Means, Process and Purpose, Basics of Business Communication, Written & Oral Communication, Listening. **Communication with Confidence & Clarity**- Interaction with people, the need, the uses and the methods, Getting phonetically correct, using politically correct language, Debate & Extempore. **Assertive Communication**- Concept of Assertive communication, Importance and applicability of Assertive communication, Assertive Words, being assertive.	

UNIT 2	**06 Hrs**
Aptitude Test Preparation- Importance of Aptitude tests, Key Components, Quantitative **Aptitude** – Problem Solving, Data Sufficiency, Data Analysis - Number Systems, Math Vocabulary, fraction decimals, digit places, profit and loss, time and work, time, speed and distance, calendar, clock, permutations and combinations, probability etc. **Mental ability:** coding-decoding, blood relations, puzzle test, logical sequence of words	

UNIT 3	**05 Hrs**
Reasoning and Logical Reasoning: logic, statement- arguments, assumptions, courses of actions, conclusions, deriving conclusions from passages, logical puzzles, Analytical Reasoning, Critical Reasoning **Presentation Skills** - Discussing the basic concepts of presentation skills, Articulation Skills, IQ & GK, How to make effective presentations, body language, Rapport Building	

UNIT 4	**05 Hrs**
Interview Skills: Questions asked and how to handle them, Behavioral, technical and HR Interviews, etiquette **Motivation and Stress Management:** Self-motivation, group motivation, leadership abilities, Stress clauses and stress busters to handle stress and de-stress; Understanding stress - Concept of sound body and mind, Dealing with anxiety, tension, and relaxation techniques. Individual Counselling & Guidance, Career Orientation. Balancing Personal & Professional Life	

UNIT 5	**05 Hrs**
Professional Practice - Professional Dress Code, Time Sense, Respecting People & their Space, Relevant Behavior at different Hierarchical Levels. Positive Attitude, Self-Analysis and Self-Management. **Professional Ethics** - values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects**.** Balancing Personal & Professional Life	

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand and solve problems covering Quantitative, verbal Ability and Logical Reasoning
CO2	Apply and enhance communication, leadership and interpersonal working skills with professional ethics
CO3	Inculcate problem solving, decision making, stress management skills for lifelong learning
CO4	Develop their potential and become confident to acquire a high degree of self

	Reference Books
1	Technical Communication Principles and Practices, Meenakshi Raman and Sangeeta Sharma, Oxford Publishers, 2004
2	Quantitative Aptitude, R S Agarwal, S Chand & Company, 1989
3	A Modern Approach to Verbal Reasoning, R S Agarwal, S Chand & Company,1994
4	Kerry Patterson, Joseph Grenny, Ron McMillan, "Crucial Conversation: Tools for Talking When Stakes are High", McGraw-Hill Publication, 2012 Edition, ISBN: 9780071772204
5	Ethnus, "Aptimithra: Best Aptitude Book", Tata McGraw Hill, 2014 Edition, ISBN: 9781259058738

Continuous Internal Evaluation (CIE); Theory (50 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks and reduced to 10 marks. All quizzes are conducted online. The two tests are conducted for 50 marks each and the sum of the marks scored from two tests is reduced to 30. The marks component for experiential learning is 10.
Total CIE = 30 (T)+10(Q)+10(EL) = 50 Marks

Semester End Evaluation (SEE); Theory (50 Marks) - **SEE** for 50 marks are executed by means of an examination. The duration of the SEE will be for 2 hours.

I-SEMESTER				
BASICS OF PROGRAMMING AND COMPUTER SYSTEM				
(Theory)				
Course Code	:	**20MCAB17**	**CIE** :	**100 Marks**
Credits: L:T:P	:	**3:0:0**	**SEE** :	**100 Marks**
Total Hours	:	**39L**	**SEE Duration** :	**03 Hrs**

UNIT – I	**07Hrs**
C Programming: decision making, control structures and arrays	

C Structure, Data Types, Input-Output Statements, Decision making with if statement, simple if statement, the if..else statement, nesting of if..else statements, the else.if ladder, the switch statement, the ?: operator, the goto statement, the break statement, programming examples.

The while statement, the do...while statement, the for statement, nested loops, jumps in loops, the continue statement, programming examples. One dimensional and two dimensional arrays, declaration and initialization of arrays, reading, writing and manipulation of above types of arrays

UNIT – II	**08 Hrs**

Structures: Defining a structure, declaring structure variables, accessing structure members, structure initialization, copying and comparing structure variables, Operations on individual members, array of structures, structures within structures, structures and functions, Unions, size of structures.

Pointers: Pointers in C, Declaring and accessing pointers in C, Pointer arithmetic, Functions , Call by value, Call by reference, Pointer as function arguments, recursion, Passing arrays to functions, passing strings to functions, Functions returning pointers, Pointers to functions, Programming Examples

UNIT – III	**08 Hrs**

Digital Logic: Binary Systems and Combinational Logic Digital Computers and Digital Systems, Binary Numbers, Number Base Conversion, Octal and Hexadecimal Numbers, subtraction using r's and r-1 complements, Binary Code, Binary Storage and Registers, Binary Logic, Integrated Circuits, Digital Logic Gates

Computer Organization: Computer Types, Functional Units, Basic Operational Concepts, Bus structure, Software, Performance, Multiprocessing and Multi computers, Machine Instruction: Memory Locations and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Interrupts.

UNIT – IV	**08 Hrs**

Operating System: What Operating Systems Do, Computer-System Organization, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments

CPU Scheduling: Basic Concepts of CPU scheduling, Scheduling Algorithms

UNIT – V	**08 Hrs**

Process Synchronization: Background, The Critical-Section Problem, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors , Synchronization Examples, Deadlocks

Memory Management: Background, Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation.

Note: In Unit-IV and Unit- V it is required to teach only the concepts of the topics specified

Course Outcomes: After going through this course, the student will be able to	
CO1	Demonstrate key programing concepts using C
CO2	Understand the basic concepts of Digital Logic
CO3	Understand basic operational concepts of Computer and its working
CO4	Understand and Demonstrate Operating System concepts in general

Reference Books	
1	The Complete Reference, Herbert Schild, 4th Edition, McGraw Hill Education
2	Let us C, Yashwant Kanetkar, BPB Publications
3	Digital Logic and Computer Design", M.Morris Mano, 2012, Pearson.
4	Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 6th Edition, Wiley India Pvt. Limited

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

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Master of Computer Applications

II-SEMESTER					
SOFTWARE ENGINEERING					
(Theory)					
Course Code	:	**20MCA21**	**CIE**	:	**100 Marks**
Credits: L:T:P	:	**3:0:0**	**SEE**	:	**100 Marks**
Total Hours	:	**39L**	**SEE Duration**	:	**03 Hrs**

UNIT – I	08Hrs

Introduction & Software Process Activities

Professional Software Development, IEEE/ ACM code of software engineering ethics, Process activities, Requirements Specification, Characteristics and components of SRS, Structure of SRS (IEEE format), Case study- Develop Software Requirement Specification for any real world application (IEEE format)

UNIT – II	08Hrs

Process Models& Software Development Methods

Software Process models: waterfall, incremental development, Integration and configuration, Plan-driven and Agile Development, Extreme Programming, Scrum; DevOps, DevOps Vs Agile Case study: Identify the suitable development method for any real world problem

UNIT – III	08Hrs

System Design and Modeling

Architectural Design: Architectural design decisions, Architectural patterns;

Interaction Modeling : Use case models , Sequence diagrams; Structural modeling : Class diagrams; Behavioral Modeling : State diagrams; Functional modeling : Data flow diagrams

Case Study-Develop Object oriented models for real world applications

UNIT – IV	08 Hrs

Software Testing, Project Management

Software Testing: Levels of testing, Development testing, Test driven development, Release testing, User testing

Project Management: Project scheduling, Risk management, Plan-driven development, Agile planning, Estimation techniques; Case study- Apply testing and project management concepts using open source tools

UNIT – V	07Hrs

Software Quality Management

Software Quality, Software standards, Software measurement, Quality management and agile development, Configuration management, ISO 9001:2015 standards

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the basic concepts associated with software Engineering
CO2	Describe various system design and models to apply them in real world applications
CO3	Analyze and apply suitable validation and management techniques to provide effective solutions
CO4	Inspect emerging quality standards to build Software products

Reference Books	
1	Software Engineering, Ian Summerville, 10th Edition, 2015, Pearson Education Ltd, ISBN : 9780133943030
2	An Integrated Approach to Software Engineering, Pankaj Jalote, 3rd Edition, 2013, Narosa Publishing House, , ISBN: 81-7319-702-4
3	DevOps for Developers, Michael Huttermann, 2012, Apress, ISBN:978-1-4302-4569-8,
4	Object Oriented Modeling And Design With UML , Michael Blaha and James Rumbaugh, 2nd Edition, Pearson India , ISBN: 9788131711064,

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

II-SEMESTER					
DATA STRUCTURES AND ALGORITHMS					
(Theory)					
Course Code	:	**20MCA22**	**CIE**	:	**100 Marks**
Credits: L:T:P	:	**3:1:0**	**SEE**	:	**100 Marks**
Total Hours	:	**39L+26T**	**SEE Duration**	:	**03 Hrs**
UNIT – I					**07 Hrs**
The Role of Algorithms in Computing: Algorithms, Algorithms as a technology, Analyzing algorithms, Growth of Functions- Asymptotic notations, Recursive algorithms: Factorial, GCD, Fibonacci Sequence, Tower of Hanoi, Mathematical analysis of Recursive and Non-recursive algorithms					
UNIT – II					**08 Hrs**
Elementary Data Structures **Stacks and Queues: stacks, queues, linked list,** Stacks, Stacks Using dynamic arrays, Infix to post fix, Evaluation of expression using stack Queues, Circular Queues Using Dynamic arrays, Linked list: Singly linked list, Doubly Linked List					
UNIT – III					**08 Hrs**
Sorting and Searching Algorithms Heap Sort, Quick Sort, Merge sort, Linear search, binary search algorithm and analysis of all algorithms					
UNIT – IV					**08 Hrs**
Elementary Graph Algorithms Linked list Representation of Graphs, Topological Sort, Minimum Spanning tree, Growing minimum spanning tree, The algorithms of Prim, Dijkstra's algorithm and The Floyd-Warshall algorithm					
UNIT – V					**08 Hrs**
Trees Binary search tree: what is binary search tree, Querying a binary search tree, Insertion and deletion from BST, State space tree: Back tracking, N-queens, Subset Sum problem, Branch Bound: Traveling Salesman problem, Assignment problem					

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand data abstraction, data structures, order notation, various complexity measures
CO2	Identify relevant data structures to develop solutions for a problem
CO3	Apply relevant data structures and programming techniques to design efficient algorithms for different applications
CO4	Analyze and evaluate the algorithms based on the data structures used, order of notation and performance metrics

Reference Books	
1	Introduction to Algorithms, Thomas H Corman, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd edition, 2009, The MIT press, Cambridge, Massachusetts, London, England, ISBN: 978-0-262-53305-8
2	Fundamentals of Data Structures in C, Horowitz, Sahni, Anderson-Freed, 2nd Edition, 2012, University Press, ISBN: 978-81-7371-605-8
3	Introduction to Analysis and Design of Algorithms, Anany Levitin,3rd Edition, 2016, ISBN-13: 978-03-2135-828-8
4	Computing Without Computers: A Gentle Introduction to Computer Programming, Data Structures and Algorithms, Paul Curzon, Version 0.15

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

II-SEMESTER					
DATABASE MANAGEMENT SYSTEMS **(Theory & Practice)**					
Course Code	:	**20MCA23**	**CIE**	:	**100+50 Marks**
Credits: L:T:P	:	**3:0:1**	**SEE**	:	**100+50 Marks**
Total Hours	:	**39L+ 26P**	**SEE Duration**	:	**03 Hrs**

UNIT – I	07 Hrs

Introduction to Databases, Database Languages and Architecture

Introduction to data, information, databases, database management system; Characteristics of database approach, Data models, Schema and instances, Three schema architecture and Data Independence, Database Languages and Interfaces, Database System Environment, Centralized and Client/ Server Architectures of DBMSs

UNIT – II	08 Hrs

Conceptual Data Modeling and Relational Model

A Sample Database Application, Entity Types, Entity Sets, Attributes, Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, Refining the ER Design for the Company Database, ER Diagrams, Naming Conventions, and Design Issues

Relational Model Concepts, Relational Model Constraints and Relational Database Schemas and Keys, Update Operations, Transactions, and Dealing with Constraint Violations, Relational Database Design Using ER-to-Relational Mapping

UNIT – III	08 Hrs

Structured Query Language

Data Definition and Data Types, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, INSERT, DELETE, and UPDATE Statements in SQL, More Complex SQL Retrieval Queries, Views (Virtual Tables) in SQL, Schema Change Statements in SQL ,Discretionary Access Control Based on Granting and Revoking Privileges, Transaction Support in SQL (Commit, Rollback, Save point)

UNIT – IV	08 Hrs

Normalization and Transaction Concepts

Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Cod Normal Form

Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Two-Phase Locking Techniques for Concurrency Control

UNIT – V	08 Hrs

Introduction to NoSQL

NoSQL, SQL versus NoSQL, Types of NoSQL Databases, CAP theorem

Getting Started with MongoDB – Documents, Collections, Databases, Getting and Starting MongoDB, MongoDB Shell, Data Types, Inserting and Saving Documents, Removing Documents, Updating Documents, Introduction to find, Query Criteria, Type Specific Queries and $where Queries. Example Application: Real-Time Analytics using Python

LABORATORY / PRACTICE COMPONENT

1. Explore all SQL Language commands related to DDL, DML, DCL, TCL
2. Design, Create and Implement the databases for the Domains like
- Health Care
- Energy
- Agriculture
- Telecom
- Tourism
- Others

3. Create and implement CRUD operations using non-relational databases for the above mentioned domains.

__Note__

During regular practice sessions, students will be executing any 6 defined queries for any above four domains.

During Examination (CIE and SEE) Students are required to execute minimum 6 Queries asked by the examiners.

Exercise 1 is for practice session only. Exercise 2 and Exercise 3 will be considered for CIE and SEE.

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the basic concepts of structured and unstructured data models
CO2	Apply the structured and non-structured data model concepts to design and solve the given problem
CO3	Analyze relational and non-relational data model to check the performance of the data models with respect to design and manipulations
CO4	Implement a relational and non-relational data model for any given problem

Reference Books	
1	Fundamentals of Database Systems, RamezElmasri, Shamkant B. Navathe, 6th Edition, 2011, Pearson Addison Wesley, ISBN 13: 978-0-136-08620-8
2	Database Management System, Raghu Ramakrishnan, Johannes Gehrke, 3rd Edition, 2003, Mc Graw-Hill, ISBN-10: 0072465638
3	Professional NOSQL, Shashank Tiwari, 2011, Inc.WROXPress, John Wiley & Sons, ISBN: 978-0-470-94224-6,
4	MongoDB: The Definitive, Guide Kristina Chodorow and Michael Dirolf, 1st Edition, 2010 O'Reilly Media, ISBN: 978-1-449-38156-1.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150
Theory – 100 Marks
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory / Practice - 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.
Total marks for the laboratory is 50.

II-SEMESTER					
ADVANCED COMPUTER NETWORKS					
(Theory)					
Course Code	:	**20MCA241**	**CIE**	:	**100 Marks**
Credits: L:T:P	:	**3:1:0**	**SEE**	:	**100 Marks**
Total Hours	:	**39L+26T**	**SEE Duration**	:	**03 Hrs**

UNIT – I	**07Hrs**
Internet Protocol- Introduction, Error and Control Messages (ICMP): The Internet Control Message Protocol, Error Reporting vs Error Correction, Testing Destination Reachability and status, Echo Request and Reply Message Format. Classless and Subnet Address Extension (CIDR) : Review of Relevant Facts, Proxy ARP, Subnet Addressing, Subnet Mask Representation, Broadcasting the Subnets, A Classless Addressing example	

UNIT – II	**08 Hrs**
Wireless LANS and PANS – Fundamentals of WLAN's, 802.11 Standards, HIPERLAN Standard, Blue tooth specifications, Transport Protocol group, ZigBee Specification Wireless WANS and MANS – The Cellular Concept and Cellular Architecture- Capacity enhancement .Channel Allocation Algorithms	

UNIT – III	**08 Hrs**
Mobile IP - Introduction, Mobility, Routing and Addressing, Mobile IP Characteristics, Overview of Mobile IP Operations, Mobile Addressing Details, Foreign Agent Discovery, Agent Registration, registration message format, communication with a foreign agent, datagram transmission and reception, two- crossing problem, communication with computers on the home network Private	

UNIT – IV	**07 Hrs**
Advanced Internetwork Router Implementation: The Global Internet-Routing Areas, Inter domain Routing(BGP), IP Version 6(IPv6), Multiprotocol Label Switching(MPLS)-Destination Based forwarding, Explicit Routing, Network Interconnection- NAT, VPN- Introduction,	

UNIT – V	**09 Hrs**
SDN - Introduction, Centralized and Distributed Control and Data Planes- Introduction, Control plane, Data plane, Moving Information Between Planes, Distributed Control Planes, IP and MPLS, Convergence Time, Load Balancing, High Availability.	

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the advanced networking concepts
CO2	Apply various networking classifications in day to day computing
CO3	Analyze the importance of routing and congestion control principles
CO4	Access the different routing protocol methods in the networking support layers

Reference Books	
1	Ad Hoc Wireless Networks Architecture and Protocols, C. Siva Ram Murthy, B. S. Manoj, 2011, Pearson Publication, ISBN 978–81-317-5905-9
2	Internet working with TCP/IP, Principles, Protocols, and Architectures, Douglas E Comer, Volume 1, 4th Edition, , 2001, Pearson Education, ISBN 81-7808-444-9
3	SDN: Software Defined Networks, Thomas D. Nadeau & Ken Gray, 2013, O'reilly, ISBN978-1-449-34230-2
4	Software Defined Networks A Comprehensive Approach, Paul Göransson, Chuck Black, 2014, Elsevier, ISBN: 978-0-12-416675-2

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours..

II-SEMESTER				
NETWORK SECURITY **(Theory)**				
Course Code	:	**20MCA242**	**CIE**	:	**100 Marks**
Credits: L:T:P	:	**3:1:0**	**SEE**	:	**100 Marks**
Total Hours	:	**39L+26T**	**SEE Duration**	:	**03 Hrs**

UNIT – I	09 Hrs

Introduction- Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. Standards

Number Theory, Divisibility, The Greatest Common Divisor- Euclid Algorithm, Modular Arithmetic, Remainder Arithmetic- General Principles, Euler's Theorem – Definition-theorem

Cryptography

Symmetric Encryption and message confidentiality-Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Random and Pseudo random Numbers, Stream Ciphers and RC4.

UNIT – II	08 Hrs

Cryptography Contd..

Public-Key Cryptography and Message Authentication- Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public Key Cryptography Principles, Public Key Cryptography Algorithms, Digital Signatures.

UNIT – III	08 Hrs

Network Security Applications- Key Distribution and User Authentication-

Symmetric Key Distribution using Symmetric Encryption Kerberos (Version 4 & 5), X.509 Certificates, Public Key Infrastructure.

Transport-Level Security- Web Security Considerations; Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS Secure Shell (SSH)

UNIT – IV	07 Hrs

Network Security Applications -Electronic Mail Security-Pretty Good Privacy (PGP), S/MIME, Domain Keys Identified Mail (DKIM**).**

IP Security- IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites

UNIT– V	07 Hrs

System Security

Intruders -Intruders, Intrusion Detection, Password Management.

Malicious Software-Types of Malicious Software, Propagation – Infected Content – Viruses, Virus counter measures, Propagation – Vulnerability Exploit – Worms, Propagation – Social Engineering – SPAM, Trojans, Payload – System Corruption, Payload – Attack Agent – Zombie, Bots, Payload – Information Theft – Key loggers, Phishing, Spyware, Payload – Stealthing – Backdoors, Root kits, Countermeasures, Distributed Denial of Service Attacks and counter measures.

Firewalls-The Need for Firewalls, Firewall characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configurations.

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the basic Network security concepts
CO2	Analyze the network security threats
CO3	Apply appropriate techniques to address security threats
CO4	Evaluate network security mechanisms

Reference Books	
1	Network Security Essentials Applications and Standards, William Stallings , 5th Edition, 2014, Pearson, ISBN-13 9780133370522.
2	Cryptography and Network Security: Principles and Practice, William Stallings, 6th Edition, 2014, Pearson, ISBN-13 9780133354690.
3	Security in computing, Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, 5th Edition, 2015, Prentice Hall, ISBN-13 9780134085043.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

II-SEMESTER				
INTERNET OF THINGS				
(Theory)				
Course Code	:	20MCA243	CIE	:	100 Marks
Credits: L:T:P	:	3:1:0	SEE	:	100 Marks
Total Hours	:	39L+26T	SEE Duration	:	03 Hrs

UNIT – I	07 Hrs

Introduction to Internet of Things:
Fundamentals of Electronics and devices for Internet of Things. Physical and Logical design of IoT Technologies that enable Internet of Things Applications and Use cases, IoT Deployment Levels. Network and Communication, Standards related to Internet of Things, Protocols in Internet of things

UNIT – II	08 Hrs

Programming with Arduino : Understanding the eco system of Arduino, Pinout configuration, Digital input and output, Analog input and output, working with sensors and actuators. Arduino serial communication. Communication interfaces (SPI and I2C) wired and wireless communication with Arduino and logging sensor data from arduino to a file.

UNIT – III	08 Hrs

Programming with Raspberry Pi : Understanding the eco system of Raspberry Pi3, Pinout configuration, Digital input and output, working with sensors and actuators. Raspberry Pi serial communication. Communication interfaces (SPI and I2C) wired and wireless communication with raspberry Pi.   Serial communication from raspberry Pi3 to Arduino

UNIT – IV	08 Hrs

Programming with esp8266 (nodemcu)and esp32: Understanding the eco system of esp8266and esp 32, pinout configuration, Digital, Analog input and output, working with sensors and actuators. communication from raspberry Pi to nodeMCU/esp32, Network configuration with esp8266 and esp32 , wireless communication using nodeMCU and esp32

UNIT – V	08 Hrs

IoT Application Development: Integrating sensors with IoT Dashboards and notification services
NodeJS based web application development to monitor and control IoT devices. Integration of Adafruit / ThingsBoard and similar tools with sensors and actuators. Integrating Applications with notification services like email, twitter or sms
Introduction to Flow based IoT Dashboard : NodeRED, Creating simple dashboards
Introduction to MQTT based Dashboard implementation: Configure and setup Open HAB
Introduction to IoT data visualization tools and technologies: visualization libraries (p5 javaascript) and dashboard

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the fundamentals of electronics and hardware devices needed for IoT including deployment levels, Network protocols and standards
CO2	Differentiate between various development boards, sensors, actuators, architecture of Arduino, Raspberry Pi, nodemcu and esp32 with Arduino IDE and other frameworks
CO3	Interact with Arduino, RaspberryPi, nodemcu and esp32 using python, JavaScript and c/c++ to program the devices (sensors and actuators)
CO4	Develop minimal IoT Applications (Dashboards) and integrate several essential alerting services like tweet / email including visualization of IoT Data

Reference Books	
1.	Exploring Arduino: Tools and Techniques for Engineering, Wizardry 1st Edition WILEY, ISBN-10: 1118549368, ISBN-13: 978-1118549360.
2.	Internet of Things with Raspberry Pi 3 Maneesh Rao, Pack Publihing
3.	Internet of Things with ESP8266 , Marco Schwartz , 29 Jul 2016, PACKT
4	Internet of Things: A Hands-on Approach by ArshdeepBahga, Vijay Madisetti, July 1st 2015 by Orient Blackswan Private Ltd ISBN : 8173719543
5	Building the Web of Things , Dominique D. Guinard and Vlad M. Trifa, Manning Publication, ISBN 9781617292682
6	The Official ESP32 Book , ISBN : 978-1-907920-63-9, Elector

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

II-SEMESTER					
MACHINE LEARNING					
(Theory)					
Course Code	:	20MCA251	**CIE**	:	100 Marks
Credits: L:T:P	:	3:1:0	**SEE**	:	100 Marks
Total Hours	:	39L+26T	**SEE Duration**	:	03 Hrs

UNIT – I	07Hrs
Introduction to Machine Learning, Preparing to Model: Introduction to Machine learning - Human learning, machine learning, types, problems not to be solved using machine learning, Application, Issues Machine learning activities, Basic type of data in Machine learning, Exploring structure of data, Data quality and Remediation, Data Pre-processing	

UNIT – II	08 Hrs
Modeling and Evaluation / Feature Engineering–. Selecting the Model, Training the Model, Model Representation and Interpretability, Evaluating performance of a model, Introduction to Feature Engineering, Feature Transformation, Feature Subset Selection	

UNIT – III	08 Hrs
Supervised learning **Bayesian Concept –** Bayes theorem and concept learning - Brute force Bayesian algorithm, Naïve Base Classifier **Classification**: Classification Model, Classification learning steps, Classification Algorithms-k-nearest Neighbor (KNN), Decision Tree, Random Forest Model, Support Vector Machines	

UNIT – IV	08 Hrs
Regression: Introduction, Examples of Regression, Regression Algorithms- Simple Linear Algorithms, Multiple Linear Regression, Assumption in Regression Analysis, Main Problems in Regression Analysis, Logistic Regression **Other types of learning Overview** –Representation Learning, Active Learning, Ensemble Learning Algorithm , Regularization Learning algorithm	

UNIT – V	08Hrs
Unsupervised learning : Introduction, Unsupervised/s supervised learning, applications of Unsupervised Learning, Clustering- Clustering as a machine learning task, different types of clustering techniques, Partitioning methods, K-medoids, Hierarchical clustering, Density based Methods – DBSCAN. Finding Pattering using Association Rule	

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the need of data and pre-processing, machine learning techniques for various application
CO2	Identify and apply the appropriate techniques to process the data and solve the applications using machine learning techniques
CO3	Implement machine learning techniques for various problems
CO4	Appraise the different data processing and machine learning techniques for various application

Reference Books	
1.	Machine Learning, SaikatDutt, Subramanian Chandramouli, Amit Kumar Das, Pearson, 4th impression, 2019, Pearson Publications, ISBN 978-93-530-6669-7
2.	Machine Learning, Tom M Mitchel, McGraw Hill publications, ISBN-0070428077
3.	Introduction to Machine Learning with Python: A Guide for Data Scientists. Andreas C. Müller, Sarah Guido, 1st Edition, O'Reilly, ISBN-13: 978-1449369415
4.	Introduction to Machine Learning, Ethem Alpaydın, Second Edition, The MIT Press

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

II - SEMESTER					
BIG DATA ANALYTICS **(Theory)**					
Course Code	:	**20MCA252**	**CIE**	:	**100 Marks**
Credits: L:T:P	:	**3:1:0**	**SEE**	:	**100 Marks**
Total Hours	:	**39T+26T**	**SEE Duration**	:	**03 Hrs**

UNIT – I	07 Hrs

Introduction to Data Analytics & Hadoop Eco System
Hadoop Fundamentals
Data, Data Analysis and storage, Comparison with other systems – Relational Database Management Systems
The Hadoop Distributed File system
The Design of HDFS, HDFS Concepts – Blocks, Name nodes and Data nodes, Block Caching, HDFS Federation, HDFS High Availability, The Command-Line Interface, Hadoop File system – Interfaces
Data Flow – Anatomy of a File Read, Anatomy of a File Write

UNIT – II	08 Hrs

Map Reduce – Distributed Processing Framework- A Weather Dataset – Data format, Analyzing the data with Unix Tools, Analyzing the Data with Hadoop – Java MapReduce, Scaling Out
Working of Map Reduce - Anatomy of a Map Reduce Job Run, Failures, Shuffle and Sort, Task Execution
Map Reduce Formats - Input Formats, Output Formats

UNIT – III	08 Hrs

Pig Introduction – **Scripting** - Execution types, Running Pig programs, Grunt, Pig Latin Editors, Comparison with databases
Pig Latin – Structure, Statements, Expressions, Types, Schemas, Functions, Macros
Data Processing Operators – Parameter Substitution - Preprocessing, Loading and storing of data, Filtering Data, Grouping and Joining Data, Sorting Data, Combining and splitting Data
Pig in Practice– Parallelism, Anonymous Relations

UNIT – IV	07 Hrs

Hive Introduction – The Hive shell, Hive services, the Meta store
Comparison with Traditional Databases – Schema on Read Versus Schema on Write, Updates, Transactions and Indexes
Hive QL – Data Types, operators and functions
Tables – Managed Tables and External Tables, Partitions and Buckets, Storage Formats, Importing Data, Altering Tables, Dropping Tables
Querying Data – Sorting and Aggregating, Joins, Sub queries, Views

UNIT – V	09 Hrs

Spark: Analyzing the data on Cluster using MLib
Installing Spark, An Example, Spark Applications, Jobs, Stages, and Tasks, A Scala Standalone Application, A Java Example, A Python Example, Resilient Distributed Datasets, Creation, Transformations and Actions, Persistence, Serialization, Shared Variables, Broadcast Variables, Accumulators, Anatomy of a Spark Job Run, Job Submission, DAG Construction, Task Scheduling, Task Execution, Executors and Cluster Managers, Spark on YARN
Data Visualization with Tableau – Introduction to Tableau software, Tableau Desktop Workspace, Data Analytics in Tableau Public, Using visual controls in Tableau Public

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the fundamentals of big data analytics frameworks
CO2	Apply big data analytics frameworks and visualization techniques to solve problems
CO3	Analyze the use of big data analytics and visualization for various problems
CO4	Assess the solutions of big data analytics ecosystems

Reference Books:	
1	Hadoop – The Definitive Guide; Storage and Analysis at Internet scale, Tom White, 4th Edition, 2015, O'Reilly, Shroff Publishers & Distributers Pvt. Ltd., ISBN – 978-93-5213-067-2
2	Big Data – Black Book, DT Editorial Services, Edition – 2015, Dreamtech Press, ISBN - 978-93-511-9-757-7
3	Hadoop for Dummies, Dirk deRoos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss, 2014, John Wiley & Sons, Inc., ISBN: 978-1-118-60755-8 (pbk); ISBN 978-1-118-65220-6 (ebk); ISBN 978-1-118-70503-2 (ebk)
4	Big Data Principles and best practices of scalable real-time data systems", Nathan Marz and James Warren, April 2015, ISBN 9781617290343

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

Master of Computer Applications

II - SEMESTER					
NATURAL LANGUAGE PROCESSING					
(Theory)					
Course Code	:	20MCA253	**CIE**	:	100 Marks
Credits: L:T:P	:	3:1:0	**SEE Marks**	:	100 Marks
Total Hours	:	39L+26T	**SEE Duration**	:	03 Hrs

UNIT – I	08 Hrs
Overview and Language Modeling: Overview: Origins and challenges of NLP-Language, Knowledge and Grammar-Processing Indian Languages- NLP Applications -Information Retrieval. **Language Modeling**: Various Grammar- based Language Models - Statistical Language Model	

UNIT – II	08 Hrs
Word Level and Syntactic Analysis: Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency- Parsing-Probabilistic Parsing	

UNIT – III	08 Hrs
Semantic Analysis and Natural Language Generation: Introduction, Meaning Representation, Lexical Semantics, Ambiguity, Word Sense Generation **Natural Language Generation**: Introduction, Architecture of NLG Systems, Generation Tasks and Representations, Application of NLG.	

UNIT – IV	08 Hrs
Lexical Resources: Introduction, WordNet, FrameNet, Stemmer, POS Tagger **Machine Translation and Lexical Resources:** Introduction, Problems in machine translation, Characteristics of Indian languages, machine Translation approaches, Direct machine translation, Rule based machine translation, corpus based machine translation, semantics or knowledge based MT Systems	

UNIT – V	07 Hrs
Taggers and NLP Application : Using Tagger, Tagged Corpora, Automatic Tagging, N-gram Tagging, Transformation based Tagging **NLP Applications:** Information extraction, Machine Translation, Natural Language Generation, Discourse processing	

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the concept of Natural Language Processing and its applications
CO2	Identify and Recognize the various techniques to analyze the documents based on the words, syntax, semantics and other resources for various NLP Applications
CO3	Apply different methods and models to build an NLP application
CO4	Analyze and Evaluate the different methods to build models

Reference Books:	
1	Natural Language Processing and Information Retrieval, Tanveer Siddiqui, U.S. Tiwary, 2008, OUP India, ISBN : 9780195692327
2	Natural Language Processing with Python, Steven Bird, Ewan Klein, Edward Loper, June 2009, O'Reilly Media, ISBN : 9780596516499
3	Speech and Language Processing, Daniel Jurafsky and James H Martin, 2nd edition, 2009 Pearson Education,
4	"The Handbook of computational linguistics and Natural Language processing", Alexander Clark, Chris Fox, Shalom Lappin, 2010, Wiley Blackwell

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The question paper will be set for maximum of 100 marks and shall consist of TEN questions from FIVE units with 20 marks each. Out of the ten questions, students must answer FIVE questions; one from each unit. The questions will have Internal Choice with maximum 3 sub divisions. The duration of the SEE will be for 3 hours.

Master of Computer Applications

II-SEMESTER **PHP BASED SOFTWARE SOLUTIONS** **(Theory & Practice)**
Course Code	:	20MCA261		**CIE**	:	100+50 Marks
Credits: L:T:P	:	4:0:1		**SEE**	:	100+50 Marks
Total Hours	:	52L+26P		**SEE Duration**	:	03 Hrs

UNIT – I	10 Hrs

Introduction to PHP: What Does PHP Do? A brief history of PHP- The Evolution of PHP, The widespread use of PHP. Installing PHP, A walk through PHP- configuration page, Forms, Databases, Graphics.

Language Basics: Lexical Structure- Case Sensitivity, Statements and Semicolons, White Space and Line Breaks, Comments, Literals, Identifiers, Key Words. Data Types-Integers, floating-Point Numbers, Strings, Booleans, Arrays, Objects, Resources, Callbacks, NULL. Variables- Variable Variables, Variable References, Variable Scope, Garbage Collection. Expressions and operators- Number of operands, Operator precedence, operator Associativity, Implicit Casting, Arithmetic operators, String Concatenation operator, Auto-Increment and Auto-Decrement operators, Comparison operators, Bitwise operators, logical operators, Casting operatrs, Assignment Operators, Miscellaneous Operators. Flow-Control Statements- if, switch, while, for, foreach, try...catch, declare, exit and return, goto. Including Code, Embedding PHP in Wen pages.

UNIT – II	11 Hrs

PHP Functions: Calling a Function, Defining a Function, Variable Scope-Global Variables, Static Variables. Function Parameters- passing Parameters by Value, Passing Parameters by Reference, Default Parameters, Variable Parameters, Missing Parameters, Type Hinting. Return Values, Variable Functions, Anonymous Functions

Strings: Qouting String Constants- Variable Interpolation, Single-Quoted Strings, Double Quoted Strings, Here Documents. Printing Strings- echo, print(), printf(), print_r() and var_dump(). Accessing Individual Characters, Cleaning Strings-Removing Whitespace, Changing case. Encoding and Escaping-HTML, URLs, SQL, C-String Encoding. Comparing Strings- Exact Comparisons, Approximate Equality. Manipulating and Searching Strings- Substrings, Miscellaneous String Functions, Decomposing a String, String-Searching Functions. Regular Expressions- The Basics, Character Classes, Alternatives, Repeating Sequences, Sub patterns, Delimiters, Match Behavior, character Classes, Anchors, Quantifiers and Greed, Non capturing Groups, Back references, Trailing options, Inline options, Look ahead and Look behind, Cut, Conditional Expressions, Functions

UNIT – III	11 Hrs

Arrays: Indexed Versus Associative Arrays, Identifying Elements of an Array, Storing Data in Arrays-Appending Values to an Array, Assigning a Range of values, Getting the Size of an Array, Padding an Array. Multidimensional Arrays, Extracting Multiple Values, Slicing an Array, Splitting an Array into Chunks, Ket and Values, Checking Whether an Element Exists, Removing and Inserting Elements in an Array. Converting between Arrays and variables- creating Variables from an Array, Creating an Array from variables. Traversing Arrays- The foreach Construct, the Iterator Functions, Using a for Loop, Calling a Function for Each Array Element, Reducing an Array, Searching for Values. Sorting- Sorting One Array at a Time, Natural-order Sorting, Sorting Multiple Arrays at once, Reversing Arrays, Randomizing Order. Acting on Entire Array- Calculating the Sum of an Array, Merging Two Arrays, Calculating the Difference between Two Arrays, Filtering Elements from an Array. Using Arrays to Implement Data Types- Sets, Stacks.
Implementing the Iterator Interface Date and Times

UNIT – IV	10 Hrs
Web Techniques: HTTP Basics, Variables, Server Information, processing Forms- Methods, Parameters, Self-processing pages, Sticky Forms, Multivalued Parameters, Sticky Multivalued Parameters, File Uploads, Form Validation. Stting Response headers- Different Content Types, Redirections, Expiration, Authentication. Maintaining State- Cookies, Sessions, Combining Cookies and Sessions. SSL	

UNIT – V	10 Hrs
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. **Databases:** Using PHP to Access a Database, Relational Databases and SQL- PHP Data Objects	

LABORATORY / PRACTICE COMPONENT
1. Write a PHP program to implement the basic constructs of the language like, Arrays, regular expression, iterations, etc 2. Demonstrate OOP concepts using PHP such as inheritance, polymorphism, encapsulation, etc 3. Demonstrate function types supported by PHP. Eg- Parameterized function, function with return type, etc 4. Design and implement forms with relevant database operations considering applications like exam registration from, event registration from, passport application form etc. 5. Demonstrate use of Session and Cookies for application login, number of times web is been visited, validating login, etc **Note:** Each program should be completed and executed within two consecutive lab cycles. However, for CIE test and SEE evaluation the examiner can specify minimum functionalities related to the programs keeping time factor as a constraint.

Course Outcomes: After going through this course, the student will be able to	
CO1	Compare and Contrast between various elements of web page design
CO2	Enabling and configuring interactive capabilities
CO3	Demonstrate critical thinking skills to design and create customized web page
CO4	Design and create personal and /or commercial websites

Reference Books	
1.	Learning PHP, MySQL & JavaScript With jQuery, CSS & HTML, Robin Nixon, O'Reilly Media, Inc., 4th Edition, 2015, ISBN 13: 978-93-5213-015-3
2.	Web Content Management: Systems, Features, and Best Practices, Deane Barker, 1st Edition, 2016, O'Reilly Media, Inc., ISBN 978-1-4919-0812-9
3.	Beginning Drupal 8, Todd Tomlinson, 1st Edition, 2015, Apress Publishing Company, ISBN-13 (pbk): 978-1-4302-6580-1

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.

Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory / Practice - 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.

Total marks for the laboratory is 50.

II –SEMESTER				
JAVA BASED SOFTWARE SOLUTIONS **(Theory and Practice)**				
Course Code	: 20MCA262	**CIE**	:	100+50 Marks
Credits: L:T:P	: 4:0:1	**SEE**	:	100+50 Marks
Total Hours	: 52L+26P	**SEE Duration**	:	03 Hrs
UNIT – I				**12 Hrs**
Java Programming Fundamentals: Introduction to Java Programming, Applications of Java Programming, The Java Development Kit, The Java Keywords, Identifiers in Java, User input using Scanners, The Scope and Lifetime of Variables, operators, Type Casting, Operator Precedence, Expressions, Conditional and Control Statements, Arrays, String Handling, **Classes, Objects and Methods:** Class Fundamentals, How Objects are Created, Reference Variables and Assignment, Methods, Returning from a Method, Returning Value, Using Parameters, Constructors, The new operator Revisited, Garbage Collection and Finalizers, this Keyword, Understanding Static.				
UNIT – II				**10 Hrs**
Inheritance, Interface, Packages: Inheritance: Fundamentals, Overloading, Overriding, super keyword, Using final. **Interface**: Fundamentals, Creating an Interface, Implementing an Interface, Using Interface References, Implementing Multiple Interfaces. **Package** : Fundamentals, Importing Packages, Creating user defined packages **Exception Handling:** Exception Handling: Fundamentals, Hierarchy, Catching subclass Exceptions, try blocks can be nested, Throwing an Exception, Throwable, using finally, and using throws, Java's Built-in Exceptions.				
UNIT – III				**08 Hrs**
JDBC: Talking to Database, Immediate Solutions, Essential JDBC program, using prepared Statement Object, Interactive SQL tool. JDBC in Action Result sets, Batch updates, Mapping, Basic JDBC data types, Advanced JDBC data types, immediate solutions.				
UNIT – IV				**11 Hrs**
Servlets- Servlet Structure, Servlet packaging, HTML building utilities, Lifecycle, Single Thread model interface, **Handling Client Request**: Form Data, Handling Client Request: HTTP Request Headers. **Generating server Response**: HTTP Status codes, HTTP Response Headers, Handling Cookies, Session Tracking				
UNIT – V				**11 Hrs**
JSP: Overview of JSP Technology, Need of JSP, Benefits of JSP, Advantages of JSP, Basic syntax, Invoking java code with JSP scripting elements, creating Template Text, Invoking java code from JSP, Limiting java code in JSP, using JSP expressions, comparing servlets and JSP, writing scriptlets. For example Using Scriptlets to make parts of JSP conditional, using declarations, declaration example, Including Files, JSP Directives - page.				

LABORATORY / PRACTICE COMPONENT

1. Write a Java application for Education Domain which demonstrates the following scenario
   a. scope of variable
   b. this keyword
   c. constructor overloading and method overloading
   d. static keyword
2. Write a Java application to demonstrate the following concepts
   a. Inheritance and interface
   b. packages
3. Write a Java application to insert data into any DATABASE and retrieve info based on particular queries (For example update, delete, search etc...) with proper usage of user defined Exception Handling (also make use of throw, throws.) (Ex: if input exceeds the greater than the text field then user defined exception can be given)

4. Write a Java Servlet Program to implement a dynamic HTML for the following scenario
   a. Display the auto web page refresh using HTTPRequest and HTTPResponse
   b. Verify the user authentication using ServletConfig

5. Write a JSP program to demonstrate for a given scenario
   a. Session API and cookies
   b. Conditional and exceptional handling techniques

Note: Each program should be completed and executed within two consecutive lab cycles. However, for CIE test and SEE evaluation the examiner can specify minimum functionalities related to the programs keeping time factor as a constraint.

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the basic concepts of Java Application Programming
CO2	Identify and Apply various technologies for Java application programming
CO3	Demonstrate various problem solving methods for developing application
CO4	Analyze solutions using Java API concepts for real world applications

Reference Books	
1	"Java Fundamentals, A Comprehensive Introduction ", Herbert Schildt, Dale Skrien, Tata McGraw Hill Edition, 2013, McGraw Hill Publication, ISBN-13:9781249006593
2	"Core Servlets and JavaServer Pages. Volume 1: Core Technologies.", Marty Hall, Larry Brown, 2nd Edition" Pearson Hall, ISBN-13: 97886278043.
3	"Advanced Java", Prof. M. T. Savaliya, Dreamtech Press, Wiley India, ISBN-13: 9789351199342.
4	"Advanced Java Programming", Prasanalakshmi B, 1st edition, 2015 CBS Publishing, ISBN:9788123923833

Continuous Internal Evaluation (CIE): Total marks: 100+50=150
Theory – 100 Marks
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory / Practice - 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.
Total marks for the laboratory is 50.

II-SEMESTER					
JAVASCRIPT BASED SOFTWARE SOLUTIONS **(Theory and Practice)**					
Course Code	:	20MCA263	**CIE**	:	100+50 Marks
Credits: L:T:P	:	4:0:1	**SEE**	:	100+50 Marks
Total Hours	:	52L+26P	**SEE Duration**	:	03 Hrs

UNIT – I	10 Hrs

Introduction:
Foundations of Web Apps ,The World Wide Web HTML and XML ,XML documents Unicode and UTF-8 ,XML namespaces, Correct XML documents, The evolution of HTML,HTML forms, JavaScript Types and data literals in JavaScript, Variable scope, Strict Mode, Different kinds of objects, Array lists, Maps, JavaScript supports four types of basic data structures ,Defining and using classes, JavaScript as an object-oriented language , Further reading about JavaScript

UNIT – II	12 Hrs

Building a Minimal JavaScript Front-End App:
Folder Structure, Write the Model Code, Representing the collection of all Book instances, Loading all Book instances, Saving all Book instances, Creating a new Book instance, Updating an existing Book instance, Deleting an existing Book instance, Creating test data, Clearing all data, Initialize the Application, Implement the List Objects Use Case , Implement the Create Object Use Case , Implement the Update Object Use Case , Implement the Delete Object Use Case, Run the App and Get the Code, Possible Variations and Extensions , Using Indexed DB as an Alternative to Local Storage.

UNIT – III	10 Hrs

Integrity Constraints and Data Validation
String Length Constraints, Mandatory Value Constraints, Range Constraints, Interval Constraints ,Pattern Constraints ,Cardinality Constraints , Uniqueness Constraints, Standard Identifiers (Primary Keys) , Referential Integrity Constraints, Frozen Value Constraints, Constraint Validation in MVC Applications

UNIT – IV	10Hrs

Constraint Validation in a JavaScript Front-End Web App
Using the HTML5 Form Validation API , New Issues Make a JavaScript Data Model ,Set up the folder structure and create four initial files , Style the user interface with CSS, Provide general utility functions and JavaScript fixes in library files , Create a start page, Write the Model Code, Encode the model class as a constructor function, Encode the property checks, Encode the property setters, Add a serialization function, Data management operations, The View and Controller Layers, The data management UI pages, Initialize the app , Initialize the data management use cases

UNIT – V	10 Hrs

Implementing Unidirectional Functional Associations with Plain JavaScript
Implementing Single-Valued Reference Properties in JavaScript, Make a JavaScript Data Model New issues, Write the Model Code, Encode each class of the JavaScript data model as a constructor function, Encode the property setters, Encode the add and remove operations ,Implement a deletion policy, Serialization and De-Serialization, The View and Controller Layers, Initialize the app, Show information about associated objects in the List Objects use case, Allow selecting associated objects in the create and update use cases.

LABORATORY / PRACTICE COMPONENT
1. Create an application for inventory management system using class methods in JavaScript.
2. Design and demonstrate an application for online booking cart for CRUD data management operations for the necessary products using Model View Controller layers.
3. Develop an application for vehicle Insurance using appropriate integrity constraints and validations.
4. Develop an application to register for a Music academy using different types of validation API.
5. Develop an application for Employees attendance system for various departments by using view and controller layers and implement Single-Valued Reference Properties in JavaScript.
Note: Each program should be completed and executed within two consecutive lab cycles. However, for CIE test and SEE evaluation the examiner can specify minimum functionalities related to the programs keeping time factor as a constraint.

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the motivation, significance for using design patterns to create web applications
CO2	Identify and apply the appropriate model for developing applications
CO3	Implement JavaScript methods for building web page contents
CO4	Demonstrate MVC Model for enterprise application development

Reference Books	
1	Engineering Front-End Web Apps with Plain JavaScript, Gerd Wagner, 2020 web-engineering.info
2	Eloquent JavaScript". Marijn Haverbeke, 3rd Edition, 2020, A Modern Introduction to Programming Paperback ISBN:978-1593275846

Continuous Internal Evaluation (CIE): Total marks: 100+50=150
Theory – 100 Marks
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 30.
Total CIE = 50 (T)+20(Q)+30(EL) = 100 Marks

Laboratory / Practice - 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks.
Total marks for the laboratory is 50.

II-SEMESTER					
DESIGN-THINKING **(Practice)**					
Course Code	:	**20MCA27**	**CIE**	:	**50 Marks**
Credits: L:T:P	:	**0:0:2**	**SEE**	:	**50 Marks**
Total Hours	:	**52P(26 contact hrs+ 26 Non-contact hrs)**	**SEE Duration**	:	**03 Hrs**

STAGE – I
Empathy: The Empathy phases of the process are focused on understanding the experiences, emotions and motivations of others. Designers use specific empathy methods to learn more about the needs of the users for whom they are designing. **Methods:** Interviewing Probes and Observations
STAGE – II
Define: The Define phase of the process is focused on developing a point of view about the need of your user. During this stage of process, designers narrow from lots of information to a statement that is inspiring and specific **Methods:** Empathy Mapping, Point of View.
STAGE-III
Ideate: The Ideate phase of the process is focused on generating as many solutions to a problem as possible. Once many solutions have been generated, students will select one to move forward to prototyping **Methods :** Brainstorming and Selection
STAGE-IV
Prototype: The Prototype phase is where designers construct representation of their solutions. These representations are intended to elicit feedback and answer specific questions about a concept. **Methods :** Improve, Rapid and Experiential Prototyping
STAGE-V
Test: The Test phase of the process is focused on getting specific feedback about how ideas can improve. It is important to remember during this phase that prototypes are imperfect but feedback is gift. **Methods:** Testing

Course Outcomes: After completing the course, the students will be able to	
CO1	Learn to use different modes of thinking to understand the problem instead of finding answers/solutions for questions/problems
CO2	Acquire abductive reasoning to find new problems
CO3	Sow the seed of creativity to look for innovative solutions for a problem
CO4	Adopt human centric approaches while developing new solutions, products or services.

Guidelines for Design Thinking Lab:	
1.	The Design Thinking Lab (DTL) is to be carried out by a team of two-three students.
2.	Each student in a team must contribute equally in the tasks mentioned below
3.	Each group has to select a theme that will provide solutions to the challenges of societal concern. Normally three to four themes would be identified by the by the department
4.	The above five stages specified will be evaluated in three phases
5.	For every Phase of evaluation, the committee constituted by the department along with the coordinators would evaluate for CIE. The committee shall consist of respective coordinator & two senior faculty members as examiners. The evaluation will be done for each student separately.
6.	The team should prepare a Digital Poster and a report should be submitted after incorporation of any modifications suggested by the evaluation committee.

Scheme of Continuous Internal Examination (CIE)

Evaluation of the work will be done by the committee appointed by the director, Dept of MCA. The student should submit report on the Case Study.

Evaluation will be carried out in THREE Phases.

Phase	Activity	Marks
I	Phase I	10
II	Phase II	15
III	Phase III	25

Scheme for Semester End Examination (SEE)

The evaluation will be done by Internal and External examiners. The following weightage would be given for the examination.

1. Written presentation of synopsis: Write up   05 Marks
2. Presentation / Demonstration of the project Idea / Solution   15 Marks
3. Demonstration of the Prototype   20 Marks
4. Viva- Voce   05 Marks
5. Report   05 Marks
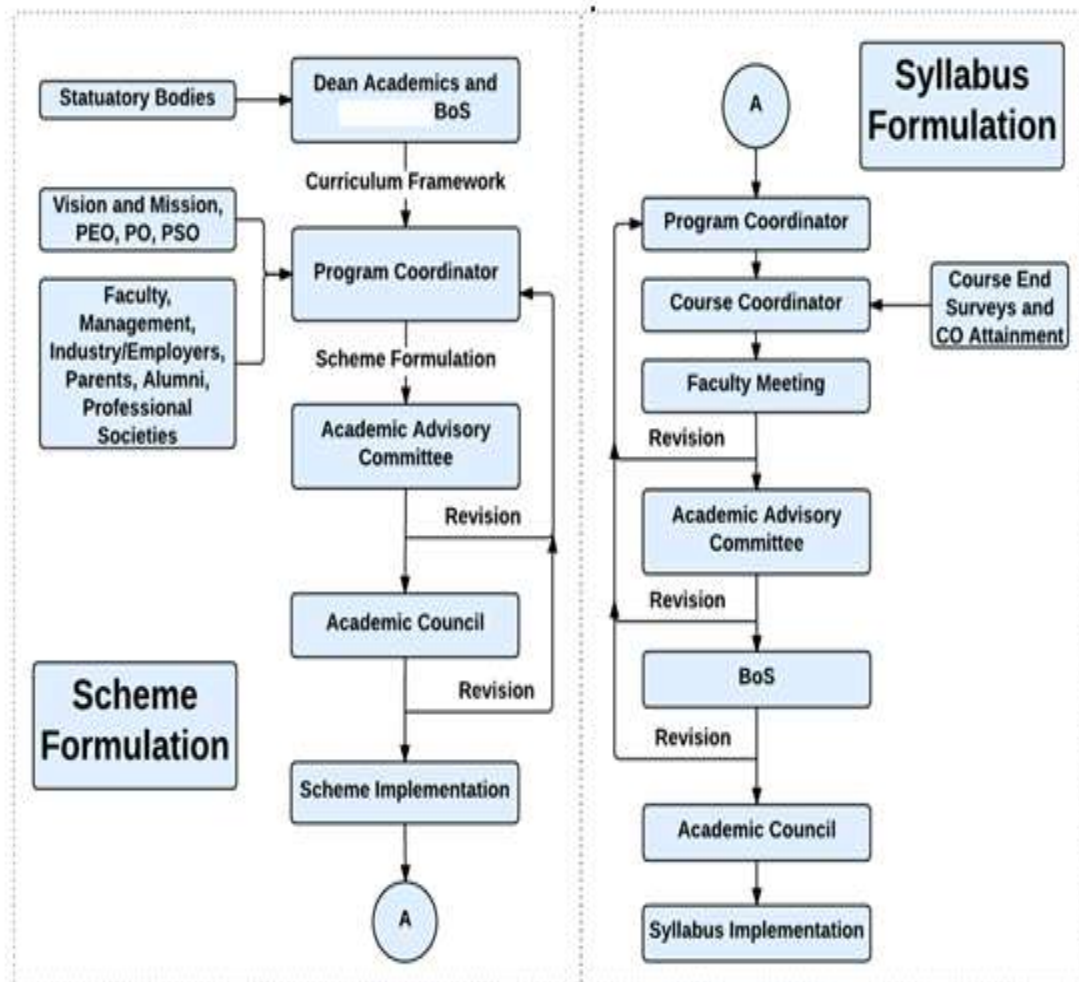
Curriculum Design Process
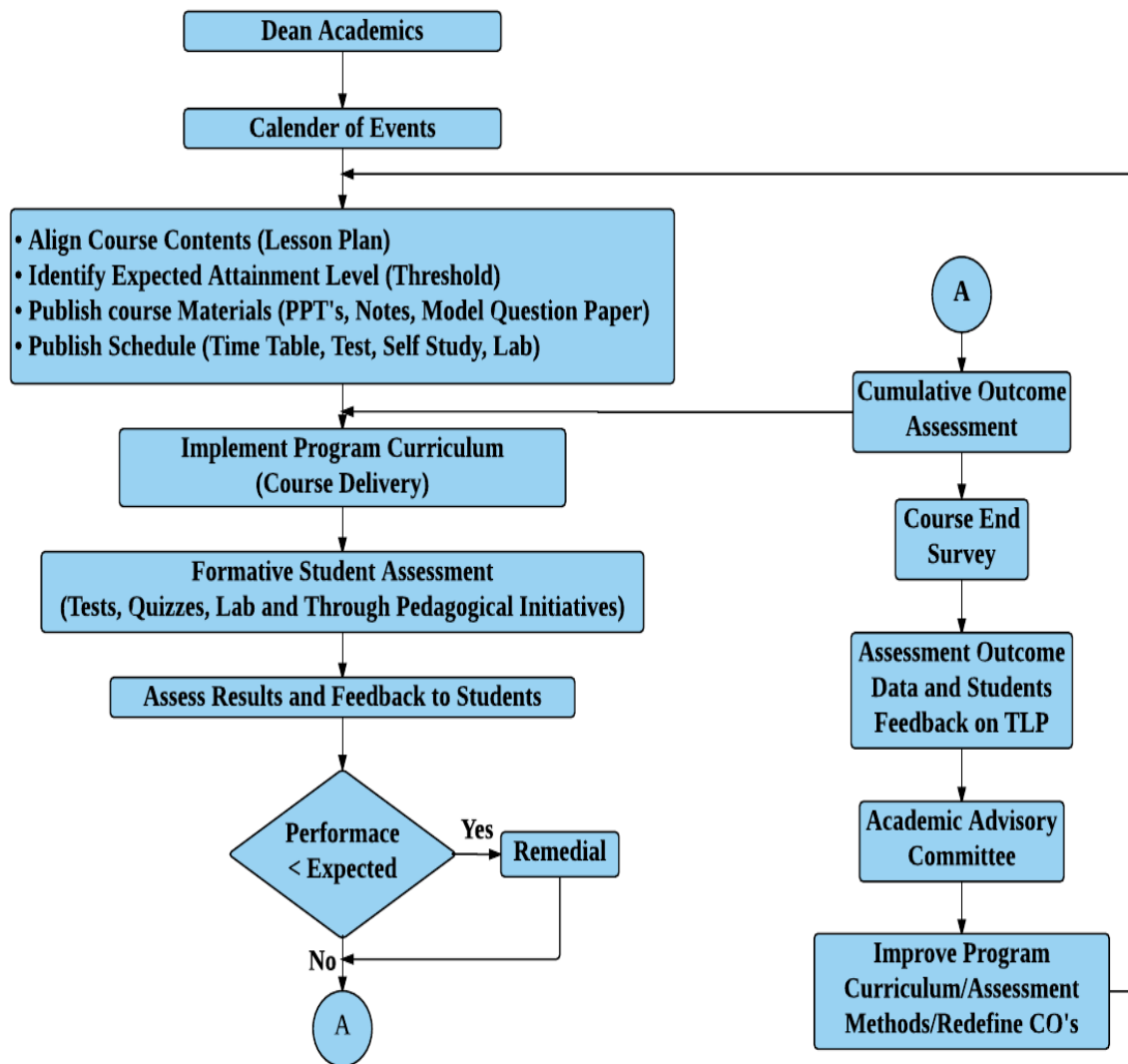
Figure 1: Curriculum Design Process
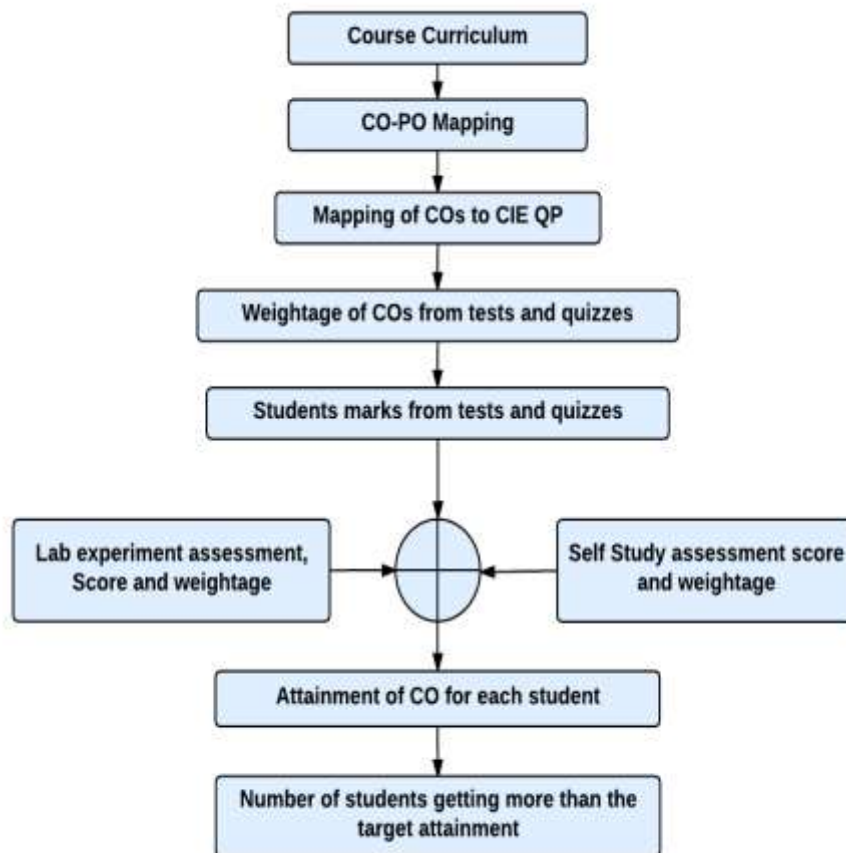
Figure 2:Academic Planning and Implementation
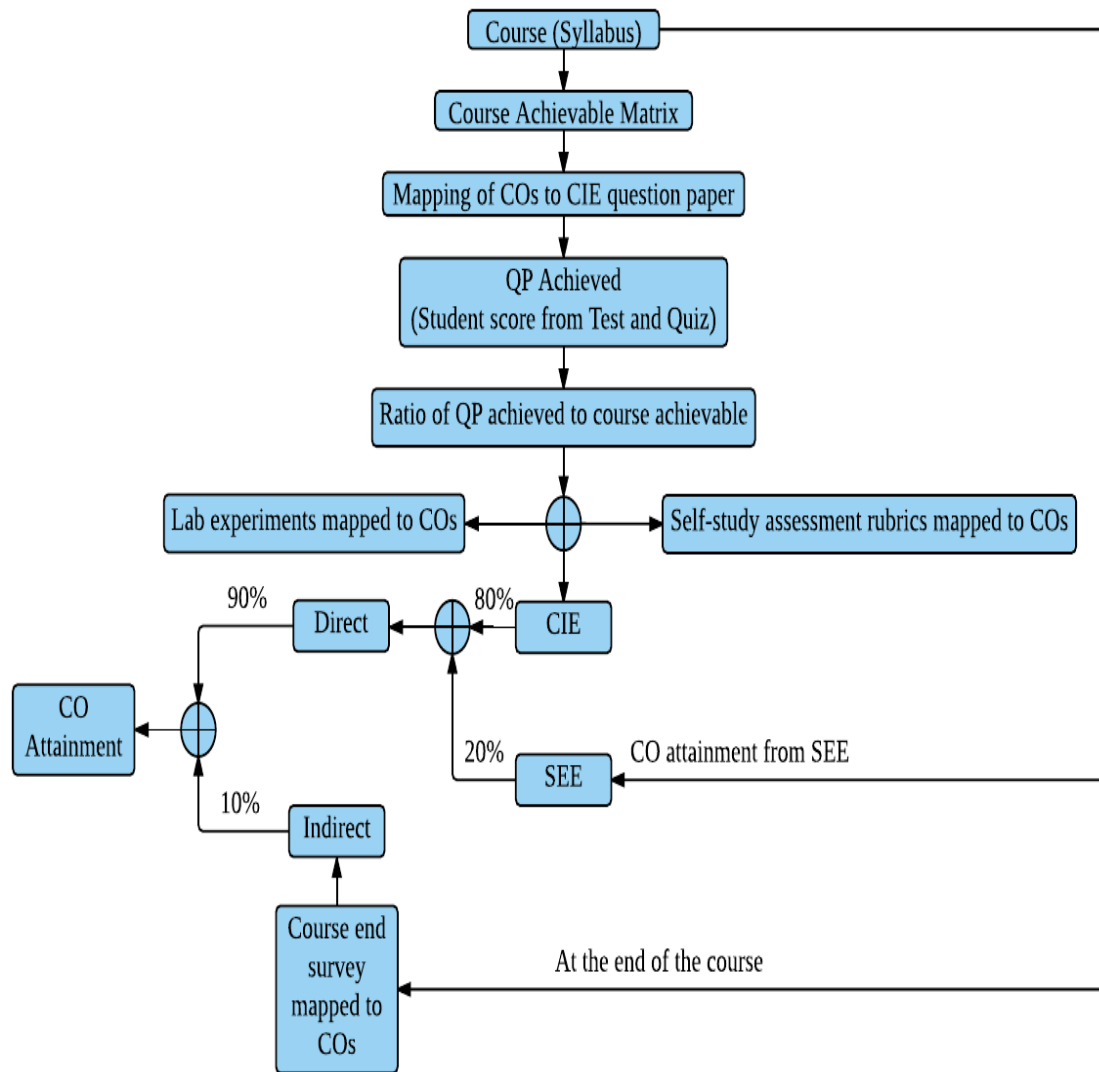
Figure 3: Process for Course Outcome Attainment
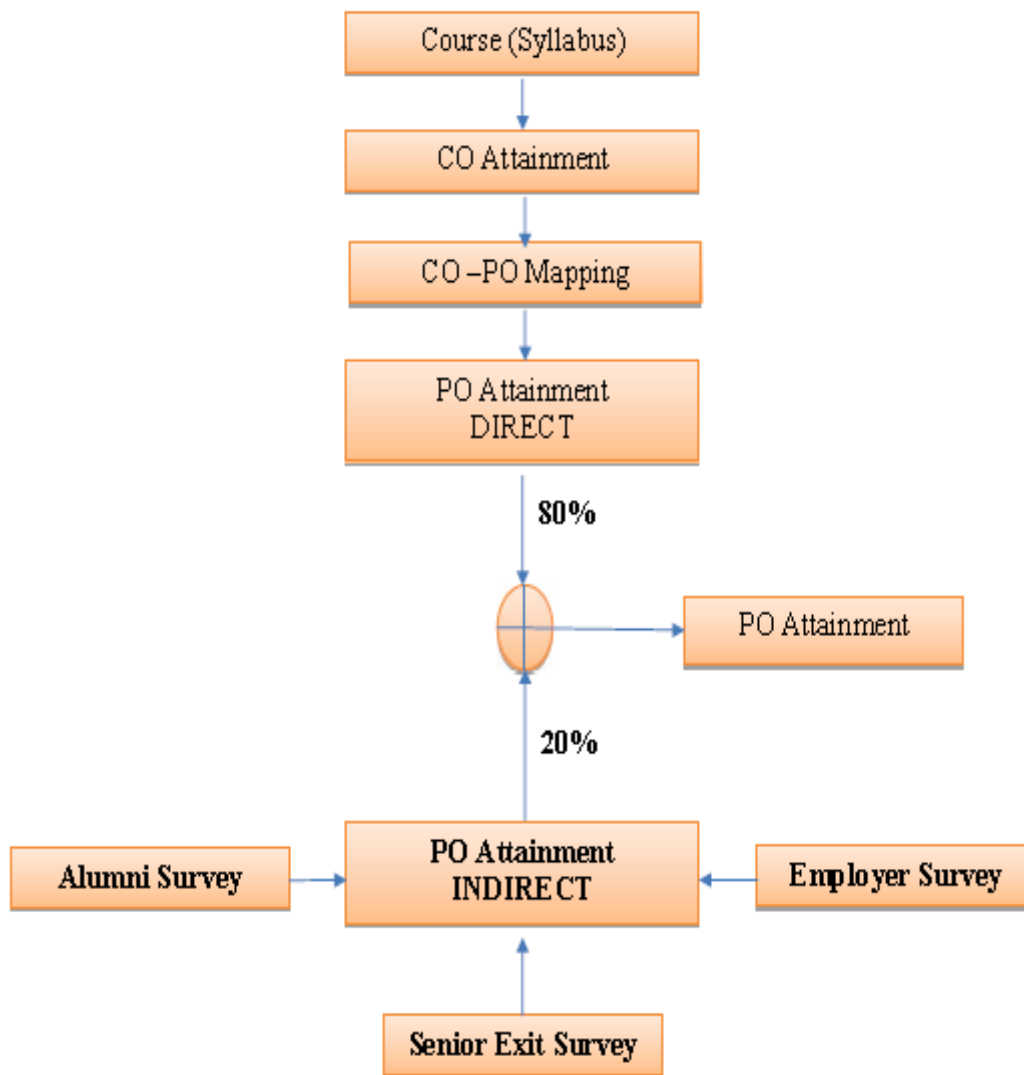
Figure 4: Final CO Attainment Process

Figure 5: Program Outcome Attainment Process

PROGRAMME OUTCOMES (PO)

MCA Graduates will be able to:

PO1   **Computational Knowledge:** Acquire in-depth computational knowledge and mathematics with an ability to abstract and conceptualize models from defined problems and requirements

PO2   **Problem Analysis:** Identify, formulate, conduct literature survey and solve complex computing problems through analysis as well as provide optimal solutions

PO3   **Design / Development of Solutions:** Design and evaluate solutions for complex problems, components or processes that meet specified needs after considering public health and safety, cultural, societal, and environmental factors

PO4   **Conduct investigations of complex Computing problems:** Conduct literature survey to analyze and extract information relevant to unfamiliar problems and synthesize information to provide valid conclusions and interpret data by applying appropriate research methods, tools and design experiments

PO5   **Use of Modern Tool**: Create, select, adapt and apply appropriate techniques, resources, and modern IT tools to complex computing system activities, with an understanding of the limitations

PO6   **Professional Ethics:** Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practices

PO7   **Life-long Learning:** Engage in lifelong learning independently for continual development to improve knowledge and competence as a computing professional

PO8   **Project management and finance:** Demonstrate knowledge and understanding of management principles and apply these to multidisciplinary software development as a team member and manage projects efficiently as a leader considering economical and financial factors

PO9   **Communication Efficacy:** Understand and communicate effectively with the computing community and with society at large, regarding complex computing systems activities confidently and effectively by writing effective reports and design documentations by adhering to appropriate standards, make effective presentations and give / receive clear instructions

PO10   **Societal and Environmental Concern:** Understand responsibilities and consequences based on societal, environmental, health, safety, legal and cultural issues within local and global contexts relevant to professional computing practices

PO11   **Individual and Team Work:** Function effectively as an individual, as a member or leader in diverse teams in multidisciplinary environments

PO12   **Innovation and Entrepreneurship:** Identify a timely opportunity for entrepreneurship and use innovation to pursue and create value addition for the betterment of the individual and society at large