University of Mumbai

No. UG/ 87 of 2021

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office pamphlet No. 194 w.e.f. from 2002 to the revised Ordinance, Regulations, Scheme and syllabus for the degree of M.C.A.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in **Master of Computer Application** at its meeting held on 25th June, 2020 and subsequently approved by the Board of Deans at its meeting held on 20th July, 2020 vide item No. 7 have been accepted by the Academic Council at its meeting held on 23rd July, 2020 vide item No. **4.134** and subsequently approved by the Management Council at its online meeting held on 28th August, 2020 vide item No. **2** and that in accordance therewith, in exercise of the powers conferred upon the Management Council under Section 74(4) of the Maharashtra Public Universities Act, 2016 (Mah. Act No. VI of 2017) and the amended Ordinance 2646 relating to the two years program in Master of Computer Application have been brought into force with effect from the academic year **2020-21**. (The said course might be introduced from the academic year 2021-2022 in the wake of prolonged Covid-19 pandemic situation in the country and subsequent delay in the commencement of the new academic year) accordingly. (The same is available on the University's website www.mu.ac.in).

Amended Ordinance 2646 to the duration of the course for the degree of Master of Application (MCA)

Existing Ordinance	Amended Ordinance
The duration of the course for the degree Master of Computer Application (MCA) will of three years i.e six academic terms	The duration of the course for the degree Master of Computer Application (MCA) will of two years i.e. four academic terms

MUMBAI – 400 032
23 January, 2021
To .

(Dr. B.N.Gaikwad)
I/c. REGISTRAR

The Principals of the affiliated Colleges and Directors of the recognized Institutions in Faculty of Humanities. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.134/23/07/2020
M.C/2/28/08/2020

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No. UG/ ꝗ.ꝗ of 2021   MUMBAI-400 032   25ᵗʰ January, 2021

Copy forwarded with Compliments for information to:-

1) The Chairman, Ad-hoc Board of Deans,
2) The Dean Faculty of Science & Technology,
3) The Chairman, Board of Studies in Master of Computer Application,
4) The Director, Board of Examinations and Evaluation,
5) The Director, Board of Students Development,
6) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c. REGISTRAR

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Walfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

UNIVERSITY OF MUMBAI

Master of Computer Applications

MCA

<u>First Year with Effect from AY 2020-21</u>

<u>Second Year with Effect from AY 2021-22</u>

<u>**(New Scheme - 2020)** from Academic Year 2020 – 21</u>

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the
Academic Year 2020–2021)

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Master of Computer Applications (MCA)
2	Eligibility for Admission	After Passing minimum three year duration Bachelor's Degree and Studied Mathematics as one of the subjects at (10+2) level or at Graduate level examination
3	Passing Marks	50% marks in aggregate or equivalent (at least 45% in case of candidates of backward class categories and Persons with Disability belonging to Maharashtra State only).
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	2 years/4 Semesters
6	Level	P.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	With effect from Academic Year: 2020-2021

Date :

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Mazumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in Master Program in Computer Applications (MCA: referred as Master of Computer Applications) education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Science Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs), course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. We are happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of Master of Computer Applications (MCA) education.

Semester based Credit and Grading system enables a much required shift in focus from teacher centric to learner centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE guidelines.

The present curriculum will be implemented for First Year of Master of Computer Applications (MCA) from the academic year 2020-2021. Subsequently this system will be carried forward for Second Year of MCA in the academic year 2021-2022.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Mujumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation of Massive Open Online Courses (MOOC) & Institutional Social Responsibility (ISR) Activities

The new curriculum is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to the learners. In the earlier revision of curriculum, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of the students.

In this new syllabus based on AICTE guidelines overall credits are reduced to provide opportunity of self-learning to the learner. The learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

Massive Open Online Courses (MOOC) are free online courses available for anyone to enroll. MOOC provide an affordable and flexible way to learn new skills and deliver quality educational experiences at scale. The Principals/Directors/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Institutional Social Responsibility (ISR) may be slightly impractical, especially in the modern competitive world, where everyone works for self-interest, but it will succeed if we take decisions based on what will benefit a large number of people and respect everyone's fundamental rights. As individuals we can make our small contributions to society by doing social activities, individual or in association with Institute/Social organizations/NGOs/Clubs etc. To create awareness among students towards institutional & individual social responsibility for societal development ISR activities are incorporated in new MCA syllabus.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Mujumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

As AICTE declared Master of Computer Application a two-year program from academic year 2020-2021, it was a challenge to design the curriculum for two years program keeping the employability intact. It is a privilege to present the new syllabus of Master of Computer Applications (MCA) which will be in effect from academic year 2020-2021.

The basic objective of the syllabus is to equip the students with the strong foundation, necessary skills and latest tools and technology required for making the impression globally. The syllabus is designed keeping in view the requirements of the IT Industry so the inclusion of outcome based approach and project based learning. Since the M.C.A. program is inclined more towards Application Development and thus has more emphasis on latest technology and tools to develop better and faster applications using integrated approach.

The earlier revised curriculum was more focused on providing information and knowledge across various domains, which led to heavily loading of students in terms of direct contact hours. In this regard, MCA Ad-hoc Board of Studies under the faculty of science and technology resolved to minimize the burden of contact hours, resulting total credits of entire program to 88, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning on higher cognitive levels. Therefore in the present curriculum self-learning topics, skill based laboratories and mini projects are incorporated every semester, Semester IV offers MOOC course to enable self-learning. Bridge course is designed additionally as a prerequisite for graduates coming from non IT/CS background. Inclusion of Institute Social Responsibility is another flavor of the curriculum, aimed to inculcate social awareness, values and environmentally responsible behavior among the learners. Curriculum offers the courses from Emerging Areas like Artificial Intelligence, Machine Learning, Data Science, Quantum Computing, IoT, Block chain. Soft skill lab will enable the learners to get proficiency in soft skills, the flexibility in course allows to deliver the content as per the need of each batch of learners. Flexible continuous assessment helps academicians for academic experiments to improve learning experience. These skills further enable the students to take a full, active and responsible role in the IT enabled industries. The course structures are carefully designed so that students get superiority in dealing with diverse situations when they step into the corporate world.

We would like to extend our thanks to Dean Dr. Anuradha Muzumdar, Associate Dean Dr. Suresh Ukarande, Board of Studies members, Directors /Principals, HODs for valuable inputs to strengthen the scope and contents of the syllabus. We would also like to extend our thanks to all M.C.A. Faculty members, Industry experts and alumni for their contribution in designing an outcome based curriculum for 2 years MCA program.

Ad-hoc Board of Studies, MCA, University of Mumbai

Dr. Pooja Raundale : Chairman
Dr. Kavi Arya : Member
Dr. Murlidhar Dhanawade : Member
Dr. Suhasini Vijaykumar : Member
Dr. Jyoti Kharade : Member

Structure for Student Induction Program

New students enter an institution with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

New students be informed that the Induction is mandatory non-credit course for which a certificate will be issued by the institution. At the start of the induction, the incumbents learn about the institutional policies, processes, practices, culture and values, and their mentor groups are formed. The different activities are:

1. **Orientation**: In the first session of Induction program learners and parents to be oriented about institute policies, processes, practices, culture and values. In addition to this, learners will be educated for 1st year academic program information in terms of academic calendar, Assessment plan, grading information, university ordinances, rules and regulations related to academics.

2. **Mentoring**: Mentoring and connecting the students with faculty members is the most important part of student induction. Mentoring process shall be carried out in small groups. For each groups one faculty mentor to be allocated, who will remain the mentor till those students post graduates from the institute. In the second session of Induction program, groups for mentoring to be formed and student mentors and faculty mentors to be introduced to newly inducted students. Introduction of mentoring system to be given to new students. Minimum one meeting to be conducted every month during semesters with students group by faculty mentors. For record keeping appropriate formats to be developed and information to be updated regularly by faculty mentors.

3. **Universal Human Values**: Universal Human Values gets the student to explore oneself and experience the joy of learning, prepares one to stand up to peer pressure and take decisions with courage, be aware of relationships and be sensitive to others, understand the role of money in life and experience the feeling of prosperity. Need for character building has been underlined by many

thinkers, universal human values provide the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but by getting the students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.

4. **Proficiency Modules**: The induction program period can be used to overcome some critical lacunas that students might have, for example, English, Mathematics, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. A diagnostic test should be conducted on Day 2 itself. Before the test, the students should be informed that the test would not affect their grades or any aspect of their admission, placement, study, etc. Purpose of the test is to provide help to those students who need help in English, Mathematics, Computer proficiency etc. Students having more than 80% marks in their qualifying examination in respective subjects need not take the diagnostic test. For those below this cut-off, writing the test is mandatory. Students with weak performance in the test, must attend a non-credit course in Basic English, Basic Mathematics, and Basic Computer Operation etc. Their attending the course is mandatory. There would be no separate fee payable for the course. The classes of Basic courses must start from Day 4 at the latest. Students those who are excluded from basic courses, for them some activity in the domain of creative arts, cultural and literature to be organised.

5. **Physical Activity**: Fitness session, yoga classes, lecture(s) on facing world with sportsman spirit, making young students aware that there is nothing like being failure in the world. The world gives opportunities to all. The incoming students must be divided into batches of 50 students maximum, and a qualified coach in physical education/ faculty member should be attached to each batch. The list of available games, sport, or physical activities should be announced in orientation program on Day 1. They should be asked to fill their choice with three preferences, and the game or sport be allotted to them as per their preference. The physical activity should start from Day 3 onwards, wherein the student learns and plays his assigned game during the induction program. It is also important that along with his assigned game the student also practices yoga.

6. **Creative Arts, Cultural and Literary Activity**: Qualified instructors for arts may be hired on contract basis and be paid honorarium as per norms of the institute. Daily 90 to 120 minute sessions may be arranged. The list of available art forms, such as vocal music, instrumental music, folk music, painting, sketching, dance, group dance, clay modeling, pottery, dramatics, etc. should be announced. They should be asked to fill their choice with three preferences, and the art form be

allotted to them as per their preference. There should be sufficient number of teachers for each art form. The ratio may be kept as 1 teacher for every 25 students. A faculty member interested in literary activity should be assigned for organizing the activity. A list of books which are interesting and educational should be prepared beforehand. Books in Indian languages must be included and even given priority. Students are losing connection with languages in general and their own language, in particular. Students should be assigned a book or other smaller reading material. They should be asked to read and write a critical summary. They should present their summary in front of their group. A literary group may consist of around 30-40 students. Similarly, debating and public speaking activity could also be undertaken. If the college can arrange for a drama workshop where a group of students learn and enact a play it would be very good. Not all the incoming students would do this, but those who wish may be provided the opportunity. Help may be taken from senior students engaged in such extra-curricular activities in the college.

7. **Familiarisation with Institute and Department**: The students admitted visit their department. The Head of the department and other associated faculty should address the new student's right on Day 2 or so. Arrangements should be made about the meeting/gathering. The parents of the students should also be welcomed if they accompany their ward. It would be helpful if an alumnus of the Dept. relates his professional experience related to the field of the study to the incoming students.

8. **Lectures /Workshops by Eminent People**: Eminent people from all walks of life may be invited to deliver lectures, namely, from industry, academia, social science (authors, historians), social work, civil society, alumni etc. be identified and invited to come and address the new students. Motivational lectures about life, meditation, etc. by Ramakrishna Mission, Art of Living, S-VYASA university, Vivekanand Kendras, etc. may be organized. Workshops which rejuvenate or bring relief to students

would also be welcome, such as, Art of Living workshops.

9. **Extra-Curricular Activity**: Every college has extra-curricular activities. Most of them are student

driven. They are organized by student councils and clubs. The extra-curricular activities going on in the college should be presented to the new students under the guidance of faculty advisors for such activity. The new students should be informed about how they can join the activities. Related facilities should be described to them. Presentation on the activities by the student council should be made.

10. **Feedback and Report on the Program**: A formal feedback at the end of the program should be

collected from students by their filling a form in writing or online. Besides the above, each group (of 20 students) should write a report on the Induction Program towards the end of the semester. They would also have to make a presentation of their report. They should be encouraged to use slides while making a presentation. Presentation of the report should be made in the language they are comfortable with, without any insistence that it should be in English. It is more important that they feel comfortable and confident. Each group may make the presentation through 4-5 of its group members or more. In each session, their faculty mentors and student guides, if any, should also be in the audience. These sessions would tell you how well the program ran, and what the students are feeling at the end of the program. This would also serve as a grand closure to the program. A certificate shall be awarded to all the students, upon successful completion of the induction program based on their report and presentation.

Tentative schedule of 1st Week Induction Program:

Day 1
Session 1 Orientation program
Session 2 Mentoring (group formation and introduction)
Day 2
Session 3 Diagnostic test (basic English, Mathematics and Computer Operation)
Session 4 Familiarisation of Department and Institute (Visits to department, Laboratory, Library, Examination cell, Office etc.)
Day 3
Session 5 Physical Activity (Yoga, Sports etc.)
Session 6 Universal human values session
Day 4
Session 7 Proficiency Modules (Short courses on basic Mathematics, English and Computer Operation etc. for identified students)
Session 8 Physical Activity (Yoga, Sports etc)
Day 5
Session 9 Proficiency Modules (Short courses on Basic Mathematics, English and Computer Operation etc. for identified students)
Session 10 Creative Arts, Cultural and Literary Activity

Semester III

Program Structure for
Second Year Master of Computer Applications
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Semester III

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tutorial	Theory	Pract.	Tutorial	Total
MCA31	Big Data Analytics and Visualization	3	--	--	3	--	--	3
MCA32	Distributed System and Cloud Computing	3	--	--	3	--	--	3
MCAE33	Elective - 3	3	--	--	3	--	--	3
MCAE34	Elective - 4	3	--	1	3	--	1	4
MCAL31	Big Data Analytics and Visualization Lab	--	2	--	--	1	--	1
MCAL32	Distributed System and Cloud Computing Lab	--	2	--	--	1	--	1
MCALE33	Elective 3 Lab	--	2	--	--	1	--	1
MCAL34	Skill based Lab Mobile Computing Lab	--	4	--	--	2	--	2
MCAL35	Software Testing Quality Assurance Lab	--	2	--	--	1	--	1
MCAP31	Mini Project: 2 A	--	2	--	--	1	--	1
	Total	**12**	**14**	1	**12**	**07**	**1**	**20**

Program Structure for
Second Year Master of Computer Applications
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Semester III
Examination Scheme

Course Code	Course Name	Examination Scheme					Term Work	Pract & oral	Total
		Theory							
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		CA	Test	Avg					
MCA31	Big Data Analytics and Visualization	20	20	20	80	3	--	--	100
MCA32	Distributed System and Cloud Computing	20	20	20	80	3	--	--	100
MCAE33	Elective - 3	20	20	20	80	3	--	--	100
MCAE34	Elective - 4	20	20	20	80	3	25	--	125
MCAL31	Big Data Analytics and Visualization Lab	--	--	--	--	--	25	50	75
MCAL32	Distributed System and Cloud Computing Lab	--	--	--	--	--	25	50	75
MCALE33	Elective 3 Lab	--	--	--	--	--	25	50	75
MCAL34	Skill based Lab Mobile Computing Lab	--	--	--	--	--	50	50	100
MCAL35	Software Testing Quality Assurance Lab	--	--	--	--	--	25	50	75
MCAP31	Mini Project: 2 A	--	--	--	--	--	50	-	50
Total		--	--	80	320	--	225	250	875

Elective 3

Sr. No.	Course Code	Course Name	Lab Course Code
1	MCAE331	Blockchain	MCALE331
2	MCAE332	Deep Learning	MCALE332
3	MCAE333	Game Development	MCALE333
4	MCAE334	Ethical Hacking	MCALE334
5	MCAE335	Quantum Computing	MCALE335

Elective 4

Sr. No.	Course Code	Course Name
1	MCAE341	Intellectual Property Rights
2	MCAE342	Green Computing
3	MCAE343	Management Information System
4	MCAE344	Cyber Security and Digital Forensics
5	MCAE345	Entrepreneurship Management

Course Code	Course Name	Teaching Scheme		Credits Assigned		
MCA31	Big Data Analytics and Visualization	Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	--	3	--	3
		Examination Scheme				
		Theory			Term Work	End Sem Exam	Total
		CA	Test	AVG			
		20	20	20	--	80	100

Prerequisite: Some prior knowledge about SQL, Data Mining, DBMS would be beneficial.

Course Objectives:

Sr.No.	Course Objective
1	Provide an overview of exciting and growing field of big data analytics
2	Enchase the programming skills using big data technologies such as map reduce, NoSQL, Hive, Pig
3	Use Spark shell and Spark applications to explore, process, and analyze distributed data
4	Teach the component of visualization and understand why visualization is important for data analysis

Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate the key issues in big data management and its associated application for business decision	Understanding
CO2	Develop problem solving and critical thinking skills in fundamental enabling techniques like Map Reduce , NoSQL, Hadoop Ecosystem	Applying
CO3	Use of RDD and Data Frame to create Application in Spark.	Applying
CO4	Implement exploratory data analysis using visualization	Applying

Module	Detailed Contents	Hrs.
1	**Introduction to Big Data and Hadoop:** Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data ,Big Data Applications. Hadoop architecture: HDFS,YARN 2, YARN Daemons. Hadoop Ecosystem. **Self-Learning Topics:** Yet Another Resource Negotiator YARN 1.X	6
2	**HDFS and Map Reduce** **HDFS:** HDFS architecture, Features of HDFS,Rack Awareness,HDFS Federation	6

	Map Reduce:The Map Task, The Reduce Task, Grouping by Key,Partitioner and Combiners, Detail of Map Reduce Execution. **Algorithm Using Map Reduce:** Matrix and Vector Multiplication by Map Reduce Computing Selection and Projection by Map Reduce Computing Grouping and Aggregation by Map Reduce **Self-Learning Topics: Concept of Sorting and Natural Joins**	
3	**NoSQL:** Introduction to NoSQL, No SQL Business drivers NoSQL Data architecture patterns: key value stores, Column family Stores, Graph Stores, Document Stores. NoSQL to manage big data: Analyzing big data with shared nothing architecture, choosing distribution master slave vs. peer to peer. HBASE overview,HBASE data model, Read Write architecture. **Self-Learning Topics: Cassandra Case Study**	5
4	**Hadoop Ecosystem: HIVE and PIG** HIVE: background, architecture, warehouse directory and meta-store, HIVE query language, loading data into table, HIVE built-in functions, joins in HIVE, Partitioning. HiveQL: querying data, sorting and aggregation, PIG : background, architecture, PIG Latin Basics, PIG execution modes, PIG processing – loading and transforming data, PIG built-in functions, filtering, grouping, sorting data Installation of PIG and PIG Latin commands. **Self-Learning Topics:Cloudera IMPALA**	6
5	**Apache Kafka:** Kafka Fundamentals, Kafka architecture, Case Study: Streaming real time data (Read Twitter Feeds and Extract the Hashtags) **Apache Spark:** Spark Basics, Working with RDDs in Spark, Spark Framework, aggregating Data with Pair RDDs, Writing and Deploying Spark Applications, Spark SQL and Data Frames. **Self-Learning Topics: KMeans and Page Rank in Apache Spark**	9
6	**Data Visualization:** Explanation of data visualization, Challenges of big data visualization, Approaches to big data visualization, D3 and big data, Getting started with D3, Another twist on bar chart visualizations, Tableau as a Visualization tool, Dashboards for Big Data - Tableau. **Self-Learning Topics: Splunk via web Interface.**	8

Reference Books:

Reference No	Reference Name
1	Tom White, "HADOOP: The definitive Guide" O Reilly 2012, Third Edition, ISBN: 978-1-449-31152-0
2	Chuck Lam, "Hadoop in Action", Dreamtech Press 2016, First Edition ,ISBN:13

		9788177228137
	3	Shiva Achari," Hadoop Essential " PACKT Publications, ISBN 978-1-78439-668-8
	4	RadhaShankarmani and M. Vijayalakshmi ,"Big Data Analytics "Wiley Textbook Series, Second Edition, ISBN 9788126565757
	5	Jeffrey Aven,"Apache Spark in 24 Hours" Sam's Publication, First Edition, ISBN: **0672338513**
	6	Bill Chambers and MateiZaharia,"Spark: The Definitive Guide: Big Data Processing Made Simple "O'Reilly Media; First edition, ISBN-10: 1491912219;
	7	James D. Miller," Big Data Visualization" PACKT Publications.ISBN-10: 1785281941

Web References:

Reference No	Reference Name
1	https://hadoop.apache.org/docs/stable/
2	https://pig.apache.org/
3	https://hive.apache.org/
4	https://spark.apache.org/documentation.html
5	https://help.tableau.com/current/pro/desktop/en-us/default.htm

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:
1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
MCA32	**Distributed System and Cloud Computing**	**Contact Hours**				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
		3	**--**	**3**	**--**	**3**
		Examination Scheme				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	**Test**	**AVG**		
		20	**20**	**20**	**--**	**80**	**100**

Pre-requisite: Computer Networks, Operating Systems
Course Objectives: The course aim to

Sr.No.	Course Objective
1	Introduce concepts of Distributed Operating System, design issues IPC and RMI.
2	Understand the concepts of clock synchronization and shared memory.
3	Analyze various algorithms in Distributed System Management, File management and process management.
4	Analyze the principles and paradigm of Cloud Computing.
5	Understand the various design issues and challenges in cloud computing

Course Outcomes: On successful completion of course learner/student will be able to

	Outcome	Bloom Level
CO1	Illustrate principles and communication protocols of Distributed systems	Understanding
CO 2	Analyze clock synchronization and various algorithms	Analyzing
CO 3	Analyze Distributed shared memory and management concepts.	Analyzing
CO 4	Analyze Cloud computing and cloud models	Analyzing

Module	Detailed Contents	Hrs
1	**Module: Introduction to Distributed Computing Concepts:** Basic concepts of distributed systems, distributed computing models, issues in designing distributed systems **Inter Process Communication**	**09**

	Fundamental concepts related to inter process communication including message passing mechanism, Concepts of group communication **Remote Communication** Remote Procedural Call (RPC), Remote Method Invocation (RMI) **Self Learning Topics:** Case study on Java RMI	
2	**Module: Clock synchronization:** Introduction of clock synchronization, Global state, Mutual Exclusion Algorithms, Election algorithms. **Self Learning Topics:** Synchronization in Wireless Networks	04
3	**Module: Distributed Shared Memory:** Fundamental concepts of DSM, types of DSM, various hardware DSM systems, Consistency models, issues in designing and implementing DSM systems. **Self Learning Topics:** MemNet Architecture	05
4	**Module: Distributed System Management:** **Resource Management**Scheduling Algorithms, Task Assignment, Load balancing approach, Load sharing approach **Process Management** Process Migration Mechanism, Thread models **Distributed File System** Concepts of a Distributed File System (DFS), file models **Self Learning Topics:** Case Study of anyone distributed system	06
5	**Module: Introduction to Cloud Computing:** Cloud Computing history and evolution, benefits of cloud computing. **Cloud Computing Architecture** Cloud Architecture model, Types of Clouds: Public Private & Hybrid Clouds, Cloud based services: Platform as a service (PaaS), Software as a service (SaaS), Infrastructure as a service (IaaS) **Self Learning Topics:** Cluster computing, Grid computing, Fog computing	06
6	**Module: Classification of Cloud Implementations:** Amazon Web Services, Microsoft Azure & Google Cloud-- Compute Services, Storage Services, Network Services, Database services, Additional Services. Google AppEngine (GAE), Aneka, Comparativestudy of various Cloud Computing Platforms. **Cloud Issues and Challenges** Cloud computing issues and challenges like Security, Elasticity, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Identity and Access Management **Self Learning Topics:** Widows Azure Platform Appliance	10

Reference Books:

Reference No	Reference Name
1	Pradeep K. Sinha , Distributed Operating System: Concepts and Design, PHI Learning, ISBN No. 978-81-203-1380-4
2	Dr. SunitaMahajan , Seema Shah, Distributed Computing ,Oxford University Press,Second Edition, ISBN No. 978-01-980-9348-0
3	Andrew S. Tanenbaum , Distributed Operating Systems, Pearson Education , ISBN No. 978-81-317-0147-8
4	James Broberg and Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms Wiley, First edition, ISBN No. 978-04-708-8799-8
5	Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Tata McGraw Hill, First Edition, ISBN No. 978-00-706-8351-8
6	RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, Mastering Cloud Computing, Tata Mcgraw Hill, ISBN No. 978-12-590-2995-0

Web References:

Reference No	Reference Name
1	https://nptel.ac.in/courses/106/104/106104182/
2	https://webee.technion.ac.il/~idish/sigactNews/
3	https://curlie.org/Computers/Computer_Science/Distributed_Computing/
4	https://nptel.ac.in/courses/106102114/
5	https://nptel.ac.in/courses/106104024/

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

 The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.

3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
MCAE331	Block Chain	Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	--	3	--	3
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
		CA	Test	AVG		
		20	20	20	--	80	100

Pre-requisite:

Basic knowledge of cryptography, networking, distributed systems and expertise in object oriented programming.

Course Objectives: Course aim to

Sr. No.	Course Objective
1	Provide the overview of the structure and mechanisms of Blockchain
2	Explain permissioned and decentralized Blockchain concepts
3	Understand cryptocurrency transactions and mining Blockchain.
4	Understand and write the smart contracts in Ethereum.
5	Understand the applications of Blockchain technology
6	Understand the hyperledger case studies in Blockchain.

Course Outcomes:

Sr. No.	Outcome	Bloom Level
CO1	Explain Blockchain technologies and their components.	Understanding
CO 2	Interpret the uses of cryptographic techniques in Blockchain	Understanding
CO 3	Demonstrate the use of hyperledger fabric and its components	Understanding
CO 4	Build the smart contracts in Ethereum	Applying
CO 5	Analyze the use of Blockchain technology in various domains	Analyzing

Module	Detailed Contents	Hrs
1	**Module: Introduction:** Basics of blockchain, History, Uses of Blockchain, Structure of a block, Transactions, Public Ledger, Distributed Consensus. Peer to peer systems, centralized and decentralized systems, Types of blockchain **Self-learning Topics:** Basics of cryptography (Symmetric and Asymmetric) RSA algorithm	04
2	**Module: Cryptographic Primitives:** Cryptographic hash functions – collision free, hiding, puzzle friendly (properties), Hash Chain, Hash tree- Merkle Tree, Public Key cryptography, Digital signatures. Use of hash functions and digital signatures in blockchain	06

	Self-learning Topics: Basics of data structure (Linked lists), Hash Functions		
3	**Module: Bitcoin:** Basics (Structure of block, creation of coins), Double Spending, Script (FORTH), Mining Process, Objectives of consensus mechanisms, Consensus in Bitcoin – Proof of Work, Sybil Attack, Proof of Elapsed Time, Proof of Stake, Proof of Burn **Self-learning Topics:** Other Cryptocurrencies.	08	
4	**Module: Permissioned Blockchain:** Smart Contracts, Distributed Consensus, Faults in DC, Algorithms – Paxos, RAFT, Byzantine Fault Tolerance, Practical BFT **Self-learning Topics:** Distributed algorithms, Object oriented Programming Concepts	06	
5	**Module: Ethereum:** History, Architecture, Accout Types , Gas, Transactions, Structure (Blocks, Transactions), Accounts, Ether, Gas, Ethereum Virtual Machine, Ethereum Mining process, Solidity. **Hyperledger Fabric**: Features of hyperledger, Architecture, ordering service, Transaction Flow, Membership and Identity Mangement, Gossip Protocol **Self-learning Topics:** BitcoinVsEthereum, EthereumVsHyperLedger	10	
6	**Module: Case Study**: Blockchain in Government (Digital Identity, Tax Payments, Land Registration, Audit and Compliances), Supply Chain Management, Financial Services	06	

Reference Books:

Reference No	Reference Name
1	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Bitcoin and Cryptocurrency Technologies, Princeton University Press
2	Don Tapscott,AlexTapscott, Blockchain Revolution, ISBN No. 9781101980132
3	Mark Gates, Blockchain ultimate Guide to understanding Blockchain, Bitcoin,Cryptocurrencies, Smart Contracts and Future of money, Wise Fox Publishing
4	VikramDhillon, David Metcalf, Max Hooper, Blockchain Enabled Applications, Apress, ISBN No.13:978-1-4842-3081-7
5	Melanie Swan,Blockchain Blueprint for a new economy, O'Reilly, First Edition, ISBN No.978-1-491-92049-7
6	MayukhMukhopadhyay, Ethereum Smart Contract Development, Packt publishing, First Edition, ISBN No.978-1-78847-304-0
7	Chris Dannen, Introducing Ethereum and Solidity, Apress, ISBN No.978-1-4842-2535-6
8	Martin Quest, Cryptocurrency Master Bundle
9	Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna, Anthony O'Dowd, Salman A. Baset, Hands-On Blockchain with Hyperledger, Packt

Web References:

Reference No	Reference Name

1	https://blockexplorer.com/
2	https://en.wikipedia.org/wiki/Digital_signature
3	https://www.usenix.org/legacy/events/osdi99/full_papers/castro/castro_html/castro.html
4	https://www.hyperledger.org/projects/fabric
5	https://hyperledger-fabric.readthedocs.io/en/release-2.0/
6	https://eprint.iacr.org/2017/375.pdf
7	https://hbr.org/2017/01/the-truth-about-blockchain
8	https://bitcoin.org/bitcoin.pdf
9	https://blockgeeks.com/guides/what-is-blockchain-technology/
10	https://www.cs.hmc.edu/~geoff/classes/hmc.cs070.200101/homework10/hashfuncs.html
11	https://www.globalsign.com/en/ssl-information-center/what-is-public-key-cryptography
12	https://searchsecurity.techtarget.com/definition/asymmetric-cryptography
13	https://www.cryptocompare.com/coins/guides/what-is-a-block-header-in-bitcoin/
14	https://github.com/ethereum/wiki/wiki/White-Paper
15	http://ethdocs.org/en/latest/introduction/index.html
16	https://blockgeeks.com/guides/proof-of-work-vs-proof-of-stake/
17	https://www.coindesk.com/learn/ethereum-101/how-ethereum-works
18	https://www.coindesk.com/short-guide-blockchain-consensus-protocols

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

 The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Contact Hours					
		Theory	Tutorial		Theory	Tutorial	Total
MCAE332	Deep Learning	3	--		3	--	3
		Examination Scheme					
		Theory			Term Work	End Sem Exam	Total
		CA	Test	AVG			
		20	20	20	--	80	100

Prerequisite: Basic knowledge of mathematical and machine learning concepts.

Course Objectives

Sr.No.	Course Objective
1	To explain the concept of neural network and deep learning.
2	To understand appropriate learning rules for each of the architectures and learn several neural network paradigms.
3	To understand major deep learning algorithms and the problem settings for problem solving
4	To learn different regularization techniques used in deep learning.
5	To understand the optimization algorithms used for training of deep learning models.
6	To learn deep learning algorithms -CNN and RNN to solve real world problems.

`**Course Outcomes:**

Sr. No.	Outcome	Bloom Level
CO1	Demonstrate concepts, architectures and algorithms of Neural Networks to solve real world problems.	Understanding
CO 2	Identify deep feed-forward networks and different regularization techniques used in Deep Learning.	Applying
CO 3	Identify challenges in Neural Network optimization and different optimization algorithms used in Deep learning models	Applying
CO 4	Analyze deep learning algorithms which are more appropriate for various types of learning tasks in various domains	Analyzing

Module No.	Detailed Contents	Hrs
01	**ANN Algorithms** : Supervised Learning Network- McCulloch–Pitts Unit and Thresholding logic, Linear Separability, Multi-layer Perceptron Networks, Back-Propagation Network, factors	6

	affecting Backpropagation Training, Unsupervised Learning Networks- MaxNet. **Self learning Topic: -**Mexican Hat Net.	
02	**Deep Feed-forward Networks**: Introduction to Deep Learning, Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Other Architectural Considerations. **Self learning Topic: -** Applications of Deep neural networks.	6
03	**Regularization**: Regularization for Deep Learning - Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout. **Self learning Topic:-**Regularized Linear Regression.	7
04	**Optimization for Training Deep Models:** Need for Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, and Algorithms with Adaptive Learning Rates-AdaGrad, RMSProp, and Approximate Second-Order Methods-Newton's Method. **Self learning Topic:-**Conjugate Gradients Method.	6
05	**Convolutional Networks**: Motivation, Pooling, Convolutional layers, Additional layers, Residual Nets, Applications of deep learning. **Self learning Topic:-**Application of CNN.	7
06	**Recurrent and Recursive Nets:** Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder -Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks. **Self learning Topic:-**Application of RNN.	8

Reference Books:

Reference No	Reference Name
1	Dr. S. N. Sivanandam and Dr. S. N. Deepa, Principles of Soft Computing, John Wiley
2	S. Rajasekaran & G.A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall of India.
3	Goodfellow I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016
4	Christopher M Bishop., Pattern Recognition and Machine Learning, McGraw-Hill, ISBN No0-07-115467-1.

5	Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
6	Simon Haykin, Neural Networks and Learning Machines, 3rd Edition Prentice Hall of India, ISBN-10: 0-13-147139-2.
7	Anandita Das., Artificial Intelligence and Soft Computing for Beginners, ShroffPublication.ISBN 9789351106159.
8	Raul Rojas, Neural Networks: A Systematic Introduction, 1996 ISBN 978-3-540-60505
9	Deep Learning Tutorial Release 0.1, LISA lab, University of Montreal

Web References:

Reference No	Reference Name
1	https://olympus.greatlearning.in/courses/10905/pages/courseoutline?module_item_id=445065
2	https://www.youtube.com/watch?v=ve-Tj7kUemg&feature=youtu.be
3	https://www.coursera.org/specializations/deep-learning
4	https://www.tutorialspoint.com/python_deep_learning/index.htm

<u>Assessment:</u>

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator
The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:
1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of   5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
MCAE333	**Game Development**	3	--	3	--	3
		Examination Scheme				
		Theory			**Term Work**	**End Sem Exam**	**Total**
		CA	Test	AVG			
		20	20	20	--	80	100

Pre-requisite:

Basic understanding of any Object Oriented Programming using C#

Course Objectives : Course aim to

Sr.No.	Course Objective
1	Learn basic Principles of Game Development
2	Understand components required to design a Game
3	Learn how to script gaming applications
4	Evaluate and use techniques of game development

Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate Principles of Game Development	Understanding
CO 2	Build applications using various components of Game development	Applying
CO 3	Develop multilayered and interactive games	Analyzing
CO 4	Solve Problems in 2D game development	Creating

Module	Detailed Contents	Hrs
1	**Module: Introduction to Game Development** Game Development, Genres of Game Development,Game development applications, Role of a Game Developer,A Playcentric Design Process,Designing Your Game,Managing game development projects,The Structure of Games,Frameworks and tools for Game Development **Self Learning Topics:**Game Design Strategies	6
2	**Module:Game Development Components** Game Objects,Models,Materials and Textures,Trrain,Environments,Lights and Cameras, Sound Effects	7

	Self Learning Topics: Game Art	
3	**Module:Scripting for Game development** Difference between unity and C# scripting, Scripting basics, Variables, Operators, Conditionals, Iterations, Methods, Input,Classes **Self LearningTopics:**Exception Handling	**7**
4	**Module: Managing State and Transitions** Identifying the Action Objects, Developing a State Machine, Lookup Table, Object Metadata, Processing the Auxiliary Objects, Handling Object Visibility, Handling Special Cases,Collisons **Self LearningTopics:**Gaming Ethics	**7**
5	**Module: Physics and Special Effects** Adding New Assets, Combining Physics and Keyframe Animation, Particle Systems, Other Special Effects,Collisions,Prefabs and animations, Unity Physics Joints,Unity 2D Effectors **Self LearningTopics:**Virtual World	**7**
6	**Module:Inventory Logic** Using Layers,Creating the Inventory Screen,Adding Inventory Icons,Organizing the Inventory Objects, InventoryLayout,Inventory overflow **Self LearningTopics:**Dialog Trees	**6**

Reference Books:

Referen ce No	Reference Name
1	Fullerton, Tracy. Game design workshop: a playcentric approach to creating innovative games. CRC press, 2014.ISBN: 1482217171
2	Schell, Jesse. The Art of Game Design: A book of lenses. CRC press, 2015. ISBN: 1498759564
3	Blackman, Sue. Beginning 3D Game Development with Unity 4: All-in-one, multi-platform game development. Apress, 2013. ISBN: 1430248998
4	Goldstone, Will. Unity game development essentials. Packt Publishing Ltd, 2009. ISBN: 184719818x
5	Murray, Jeff W. C# game programming cookbook for Unity 3D. CRC Press, 2014.
6	Paris Buttfield-addison , Jon Manning , Tim Nugent,Unity Game Development Cookbook: Essentials For Every Game, O'reilly Media, ISBN: 1491999152
7	Geig, Mike. Sams Teach Yourself Unity Game Development in 24 Hours. Pearson Education, 2014. ISBN-13: 978-0-672-33696-6
8	Norton, Terry. Learning C# by developing games with unity 3D. Packt Publishing Ltd, 2013. ISBN: 1849696586
9	Saunders, Kevin, and Jeannie Novak. Game development essentials: Game interface

	design. Cengage Learning, 2012. ISBN-13: 978-1-305-11054-0

Web References:

Referen ce No	Reference Name
1	www.unity.com
2	https://en.wikipedia.org/wiki/Video_game_development
3	https://www.gamedesigning.org/video-game-development/
4	https://github.com/Kavex/GameDev-Resources

<u>**Assessment:**</u>

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks each. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of each test shall be one hour.

Internal Assessment: 20 marks

 The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.

3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of   5 marks each will be asked.

4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

		Teaching Scheme		Credits Assigned		
Course Code	**Course Name**					
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
		3	--	3	--	3
MCAE334	**Ethical Hacking**	**Examination Scheme**				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	**Test**	**AVG**		
		20	20	20	--	80	100

Pre-requisite: Networking concepts, Structured Query Language, encryption algorithms

Course Objectives: course aim to

Sr.No.	Course Objective
1	Teach students to think like an ethical hacker and at the same time follow the code of professional ethics and the prescribed cyber laws.
2	Make oneself aware of the cybercrimes that are taking place in the real world.
3	Learn about the different hacking tools and techniques and practically use these tools to gain better understanding of the ethical hacking concepts.
4	Provide a deep understanding of security issues, threats and concerns in the cyber world and provide countermeasures to curb hacking.

Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Recall the networking, sql, and encryption algorithm concepts to further study ethical hacking techniques, threats, tools and prevention against attacks.	Remembering
CO 2	Understand ethical hacking concepts, cases, ethics and cyberlaws.	Understanding
CO 3	Apply available hacking tools to find a solution to a given hacking issue.	Applying
CO 4	Analyze and classify the real-world hacking cases and situations.	Analyzing

Module	Detailed Contents	Hrs
1	**Module: Introduction to ethical Hacking:** What is ethical hacking? Types of hacking, advantages, disadvantages and purpose of hacking, Types of hackers, Code of ethics, Types of attacks and attack vector types, Prevention from hackers, The Indian IT Act 2000 and	04

	Amendments to the Indian IT Act(2008) ,Phases of hacking. **Self-Learning Topics:** ethical hacking tools	
2	**Module:Footprinting and Reconnaissance.** What is footprinting? Active and passive footprinting, purpose of footprinting , objectives of footprinting, footprinting threats, Types of footprinting, footprinting countermeasures. **Self-Learning Topics:** footprintingtools	**05**
3	**Module: Scanning networks, Enumeration and sniffing:** **Scanning networks:** Network scanning and its types, objectives of network scanning, scanning live systems, scanning techniques-TCP Connect / Full Open Scan, Types of Stealth scans, port scanning countermeasures, IDS evasion techniques, Banner grabbing and its tools, vulnerability scanning, proxy servers, anonymizers, IP spoofing and its countermeasures. **Enumeration and Sniffing:** What is Enumeration? Enumeration techniques, Enumeration types, Enumeration countermeasures, what is sniffing? Wiretrapping and its types, packet sniffing, sniffing threats, how sniffers work?, sniffing methods-ARP spoofing and MAC flooding, active and passive sniffing, types of sniffing attacks, sniffing countermeasures, sniffing detection techniques. **Self-Learning Topics:** Scanning, enumeration and sniffing tools.	**08**
4	**Module: Trojans and other Attacks:** Worms, viruses, Trojans, Types of worms, viruses and worms, Preventing malware attacks, types of attacks**:** (DoS /DDoS), Waterhole attack, brute force, phishing and fake WAP, Eavesdropping, Man-in-the-middle, buffer overflow, DNS poisoning, ARP poisoning, Identity Theft, IoT Attacks, BOTs and BOTNETs, Steganography - text, image and audio and video, types of Social Engineering: Physical social engineering**,** Remote social engineering and hybrid social engineering. **Self-Learning Topics: case studies, malware tools and steganographic tools.**	**08**
5	**Module: Hacking web servers, web applications and sql injection:** **Session hijacking:** What is session hijacking? , why session hijacking is successful? session hijacking techniques, session hijacking process, Types of session hijacking,	**08**

| | session hijacking countermeasures: protecting and preventing,

Hacking web servers and web applications:

Causes of webservers being compromised, web server attacks, stages of web server attacks, defending against web server attacks, web application components, its working, architecture, web server attack vectors, web application threats and counter measures.

SQL Injection:

What is SQL injection, SQL injection threats, SQL injection attacks, SQL injection detection, Types of SQL injection, SQL injection methodology, SQL injection prevention and countermeasures.

Self-Learning Topics: tools of session hijacking, web servers and applications and

 SQL injection. | |
|---|---|---|
| **6** | **Module: Wireless network hacking, cloud computing security, cryptography, Pen testing:**
Types of wireless Architecture, wireless encryption techniques-WEP and WPA, breaking WEP/WPA and defending WPA encryption, wireless Sniffing, Characteristics, types of cloud computing services, models and benefits, threats and attacks, cryptography and its objectives, cryptography types, cryptography attacks, what is Pen Testing, need for pen testing, types and techniques of pen testing, phases of pen testing.
Self-Learning Topics: Tools of WEP/WPA, cloud computing, cryptography, Pen testing. | **07** |

Reference Books:

Reference No	Reference Name
1	Matt Walker, All-In-One-CEH-Certified-Ethical-Hacker-Exam-Guide.
2	Manthan Desai Basics of ethical hacking for beginners.
3	SunitBelapure and Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives.
4	Srinivasan, J. Suresh, Cloud Computing: A practical approach for learning and implementation, Pearson.
5	Sean-Philip Oriyano, Sybex, Certified Ethical Hacker Study Guide v9, Study Guide Edition,2016.
6	Emmett Duley and Chuck Easttom ,Comptia Security+ Study Guide.
7	Alana Maurushat, Ethical Hacking.
8	TutorialsPoint Professionals, Ethical Hacking by TutorialsPoint.

Web References:

Reference No	Reference Name
1	Code of ethics link https://cert.eccouncil.org/code-of-ethics.html
2	https://arc.bukancoder.co/Certified-Ethical-Hacker-Module-V8/

| 3 | https://www.edureka.co/blog/steganography-tutorial |
| 4 | https://www.guru99.com/how-to-hack-using-social-enginering.html |

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.

3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
		3	--	3	--	3
MCAE335	**Quantum Computing**	**Examination Scheme**				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	Test	AVG		
		20	20	20	--	80	100

Pre-requisite: Basic understanding of Physics and Mathematics

Course Objectives: Course aim to

Sr.No.	Course Objective
1	Impart the basic concepts of the emerging field of Quantum Computing
2	Learn and use various Quantum Computing algorithms
3	Demonstrate the working of basic quantum computing operations
4	Identify the basic requirements for implementing Quantum Computers

Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO 1	Understand basic principles and components of Quantum Computing	Understanding
CO 2	Analyze Quantum Computing algorithms	Analyzing
CO 3	Design programs to perform basic Quantum Computing operations	Creating
CO 4	Identify classes of problems that can be solved using Quantum Computing	Applying

Module	Detailed Contents	Hrs
1	**Module: Overview of Traditional Computing** Computers and the Strong Church-Turing thesis, Circuit Model of Computation, Linear Algebra Formulation of the Circuit Model, Reversible Computation, Dirac Notation, Operators, Functions of Operators **Self-Learning Topics:** Basic Linear Algebra	6

2	**Module: Qubits and General Quantum Operations**	8
	State of a Quantum System, Composite Systems, Measurement, Mixed States and General Quantum Operations: Mixed States, Partial Trace, General Quantum Operations	
	Self-Learning Topics: Binary Operations	
3	**Module: Quantum Model of Computation**	8
	The Quantum Circuit Model, Quantum Gates: 1 Qubit Gates, Universal Sets of Quantum Gates, Discrete Set of Universal Operations.	
	Self-Learning Topics: Basic Gates	
4	**Module: Programming for a QPU**	8
	One Qubit: Physical Qubit, Introducing the Circle Notation, QPU Instructions; Multiple Qubits: Circle Notation for Multi-Qubit Registers, Single Qubit Operations in Multi-Qubit Registers, QPU Instructions; Quantum Teleportation	
	Self-Learning Topics: Additional QPU Instructions for Multiple Qubits	
5	**Module: Quantum Arithmetic & Logic**	6
	Arithmetic on a QPU, Building Increment and Decrement Operators, Adding Two Quantum Integers, Negative Integers, Quantum Conditional Execution, Mapping Boolean Logic to QPU Operations, Basic Quantum Logic.	
	Self-Learning Topics: Overview of Quantum Phase Estimation	
6	**Module: QPU Applications**	4
	Real Data: Non-integer Data, QRAM, Matrix Encodings: How can a QPU Operations represent a Matrix; Quantum Supersampling (QSS): What can a QPU do for Computer Graphics, Conventional Supersampling, Computing Phase-Encoded Images.	
	Self-Learning Topics: Shor's Factoring Algorithm	

Reference Books:

Reference No	Reference Name
1	Kaye P, Laflamme R, Mosca M. An introduction to quantum computing. Oxford university press; 2007. ISBN No. 0198570007
2	Johnson, Eric R., NicHarrigan, and Mercedes Gimeno-Segovia. Programming Quantum Computers: Essential Algorithms and Code Samples. O'Reilly; 2019.

	ISBN No. 1492039683
3	Nielsen MA, Chuang I. Quantum computation and quantum information. Cambridge University Press; 2012. ISBN No. 9780511976667
4	Silva V. Practical Quantum Computing for Developers. Apress; 2018. ISBN No. 9781484242179
5	Rieffel EG, Polak WH. Quantum computing: A gentle introduction. MIT Press; 2011. ISBN No. 9780262526678
6	Aaronson S. Quantum computing since Democritus. Cambridge University Press; 2013. ISBN No. 9780521199568

Web References:

Reference No	Reference Name
1	https://cra.org/ccc/wp-content/uploads/sites/2/2018/11/Next-Steps-in-Quantum-Computing.pdf
2	https://www.ibm.com/quantum-computing/
3	https://eandt.theiet.org/content/articles/2019/04/quantum-for-dummies-the-basics-explained/
4	https://www.cl.cam.ac.uk/teaching/1718/QuantComp/
5	https://nptel.ac.in/courses/104104082/

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.

3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
MCAE341	**Intellectual Property Rights**	3	1	3	1	4
		Examination Scheme				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	**Test**	**AVG**		
		20	20	20	25	80	125

Pre-requisite: Nil

Course Objectives: The course aim to

Sr. No.	Course Objective
01	Describe the concept of intellectual property, explain the classification of intellectual property rights, and elaborate on the justification and scope of IPRs.
02	Create awareness of the rights and infringements of rights and related protections of inventions, creations, and ideas using various IPRs under IP Laws of India as well as International Treaty procedures.
03	Describe registration process of various intellectual property in India as well as abroad.
04	Understand the circumstances under which a granted patent/copyright/design etc., could be revoked, opposed, taken away, or licensed.
05	Familiarize with the databases and tools for searching and filing of patents and other IPRs.
06	Discuss the National IPR Policy of India.

Course Outcomes: On successful completion of the course learner/student should be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Define the key concepts of Intellectual Property and IP Infringements.	Remembering
CO2	Understand and acquire knowledge of IPR policy followed in India.	Understanding
CO3	Demonstrate the know-how required to identify, assess, and apply for IP rights protection under various applicable laws and treaties in force.	Applying
CO4	Analyze the development, registration procedure, protection, compliance, and enforcement of various intellectual property rights.	Analyzing

Module	Detailed Contents	Hrs.
1	**Module: Introduction and Historical Background** **Introduction:** The Concept of Property: Its Definition, Its Features, and Classification – Intellectual Property as Creations of the Human Mind – Justifying Intellectual Property : Arguments for and Against It – Types of IPRs: Patent, Copyright, Trademark, Trade Secret, Industrial Design, Geographical Indication, Semiconductor Integrated Circuit Layout Design, Plant Variety & Farmer's Rights; Genetic Resources and Traditional Knowledge **Historical Background:** Evolution of IPRs through Various International Agreements, Treaties, & Conventions: From Paris Convention (1883) To WTO-TRIPS Agreement (1995) – Global IPR Organizations: WIPO (1967) and WTO (1995) **Self-Learning Topics:** Relevance of Intellectual Property in Today's Knowledge Economy	05
2	**Module: Patents** **Introduction to Patent:** What is a Patent? – Conditions for Grant of Patent – Patentable Inventions and Inventions Not Patentable – Process and Product Patents – Patent Specifications – The Process for Obtaining a Patent in India and Abroad – PCT Patent – Post-Grant Opposition, Revocation and Compulsory Licensing – Rights Granted to a Patentee – Patent Infringement & Its Remedies – Patent Search and Databases – e-filing of Patent Application **Emergence of Technology Patents:** Patenting the Inventions of Information Technology: Patenting Computer Programs and Software – Software Patents vs Software Copyrights: Lessons for India – Patenting of Biotechnology Inventions (or Patenting Life) **Self-Learning Topics:** Biotech Patents in India	09
3	**Module: Copyrights** **Introduction to Copyright:** Nature of Copyright – Copyright as a Property, Statutory Right, Idea versus Expression – Requirements for Copyrights – Idea-Expression Dichotomy: Merging of the Idea with Expression, Originality & Fixation – Various Works Protectable Under Copyrights – Authorship and Ownership – Registration of Copyrights – Term of the Copyright – Copyright Infringement, Its Remedies & Penalties. **Copyrights in the Digital Age** – Internet and Copyright – Copyrights in Computer Software – Copyrights for Electronic Database – Digital Copyright Protection in India **Self-Learning Topics:** Fair Use – Instances of Fair Use: Using Copyrighted Works in Education and Library	09
4	**Module: Trademarks and Trade Secrets** **Trademarks:** Introduction – The Rationale and Functions of a Trademark – Different Types of Trademarks – Categories of Trademark Distinctiveness – Recognizing a Good Trademark – What Cannot be Registered as a Trademark? – Registration & Renewal of a Trademark – Rights Granted by Trademark	08

		Registration – Different Classes of Trademark Infringement – Acts of Trademark Infringement & Remedies **Trade Secrets:** Trade Secret and its Characteristics - Kinds and Examples of Trade Secrets - Protection of Trade Secrets - Patents and Trade Secrets **Self-Learning Topics:** Origin of Trademarks System in India – Misappropriation of Trade Secrets	
5	**Module: Designs and Geographical Indications** **Design:** Defining a Design – Essentials of a Design – Registration & Term of Designs – Copyright in Registered Designs – Conditions for Registration of Industrial Designs – Procedure for Registration of Industrial Designs – Infringement of Industrial Designs and Remedies Against Infringement – The Hague Agreement **Geographical Indications:** Introduction - Concept of Geographical Indications - Kinds of Geographical Indications – Registration of GIs – Benefits of Registering GIs – Infringement of a Registered GI and Remedies Thereof **Self-Learning Topics:** IPRs forSemiconductor Integrated Circuit Layout Design		07
6	**Module: Harnessing Intellectual Property for National Development** India's New National IPR Policy, 2016: Vision Statement, Mission Statement and Objectives – IPR Administration System in India – Govt of India Initiatives & Schemes towards Promoting IPR **Self-Learning Topics:** Managing of Intellectual Property in Organizations		02

Reference Books:

Ref No	Reference Name
1	Nithyananda, K. V., Intellectual Property Rights: Protection and Management, Cengage Learning (2017), First Edition, ISBN: 9789386668578
2	NeerajPandey&KhusdeepDharni, Intellectual Property Rights, PHI Learning (2014), First Edition, ISBN: 812034989X, 9788120349896
3	Sreenivasulu N.S, Law Relating to Intellectual Property, Partridge Publishing (2013), First Edition, ISBN: 1482813939, 9781482813937
4	Ramakrishna B & Anil Kumar H.S, Fundamentals of Intellectual Property Rights – For Students, Industrialists, and Patent Lawyers, Notion Press (2017), First Edition, ISBN:1946556327, 9781946556325
5	Siva Vaidhyanathan, Intellectual Property: A Very Short Introduction, Oxford University Press (2017), Second Edition, ISBN: 9780195372779
6	Ahuja V. K., Law Relating to Intellectual Property Rights, Lexis Nexis (2017), Third Edition, ISBN: 9788131251652

Web References:

Reference No	Reference Name
1	National IPR Policy 2016 - http://cipam.gov.in/wp-content/uploads/2017/10/National-IPR-Policy-English-.pdf
2	**Intellectual Property – The Future, CIPAM, 2017** - http://cipam.gov.in/wp-

	content/uploads/2017/09/bookletIPR.pdf
3	WIPO Intellectual Property Handbook – (https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)
5	https://www.startupindia.gov.in/
6	https://dipp.gov.in/
7	http://ipindia.nic.in/

Intellectual Property Rights: Tutorials

Sr. No	Detailed Contents	Hrs.
01	Study of a real-world case on Patents	02
02	Study of a real-world case on Copyrights	02
03	Study of a real-world case on Trademarks	02
04	Study of a real-world case on Trade Secrets	02
05	Study of a real-world case on Industrial Design	02
06	Study of a real-world case on Geographical Indication	02

<u>**Assessment:**</u>

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

Term Work : 25 marks

The term work will be based on the tutorial performance of the student**.**

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	1	3	1	4
MCAE342	**Green Computing**	**Examination Scheme**				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	Test	AVG		
		20	20	20	25	80	125

Pre-requisite:

- ☐ Knowledge of computer peripherals
- ☐ Knowledge of data storage devices
- ☐ Some awareness towards Environment as a whole

Course Objectives: The course aim to

Sr. No.	Course Objective
01	Explain why Green IT is important to the enterprise over all
02	Create awareness among stakeholders and promote green initiatives in their environments leading to a green movement.
03	Adopt special skills such as knowledge about energy efficiency, ethical IT assets disposal, carbon footprint estimation.
04	Create eco-friendly environment.
05	Conduct basic equipment usage audits
06	Improve energy efficiency of their personal computing environment as well as the enterprise-wide computing environment

Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Acquire expertise for improving the energy efficiency for laptops and personal computers by reducing the power consumption requirements	Remembering
CO2	Assess enterprise-wide and personal computing and computing energy consumption	Understanding
CO3	Recognize the necessity for long-term sustainability in IT	Understanding
CO4	Formulate plans for reducing IT heating and cooling requirements	Creating
CO5	Evaluate the regulatory and governance issues surrounding IT	Evaluating
CO6	Choose the best sustainable hardware for their applications	Analyzing

Module	Detailed Contents	Hrs.
1	**Trends and Reasons to Go Green:** ☐ Overview andIssues ☐ ConsumptionIssues o Minimizing PowerUsage o Cooling **Self-Learning Topics:**Current Initiatives andStandards	**05**
2	**Introduction to Green IT:** ☐ GreenIT ☐ Holistic Approach to GreeningIT ☐ Greening byIT **(can be used for case study also)** o Using RFID for EnvironmentalSustainability o SmartGrids o Smart Buildings and Homes o Green Supply Chain andLogistics o Enterprise-Wide EnvironmentalSustainability **Self-Learning Topics:**Awareness toImplementation	**06**
3	**Green Hardware** ☐ Introduction, ☐ Life Cycle of a Device or Hardware, ☐ Reuse, Recycle and Dispose **Green Software** ☐ Introduction ☐ Energy-Saving SoftwareTechniques **Sustainable Software Development** **Self-Learning Topics:**Changing the way we work	**07**
4	**Green Data Centers** ☐ Data Centre ITInfrastructure ☐ Data Centre Facility Infrastructure: Implications for Energy Efficiency ☐ IT InfrastructureManagement ☐ Green Data Centre Metrics **Green Data Storage** ☐ Introduction ☐ Storage Media PowerCharacteristics ☐ Energy Management Techniques for HardDisks ☐ System-Level EnergyManagement **Green Networks and Communications** ☐ Introduction ☐ Objectives of Green NetworkProtocols ☐ Green Network Protocols andStandards **Self-Learning Topics:**Refer some latest IEEE papers on the relevant topics	**08**
5	**Enterprise GreenIT Strategy:** ☐ Introduction ☐ Approaching Green IT Strategies ☐ Business Drivers of Green IT Strategy ☐ Organizational Considerations in a Green ITStrategy ☐ Steps in Developing a Green ITStrategy ☐ Metrics and Measurements in GreenStrategies	**06**

	Enterprise Green IT Readiness ☐ Background: Readiness and Capability ☐ Development of the G-Readiness Framework ☐ Measuring an Organization's G-Readiness **Self-Learning Topics:** Sustainable IT Roadmap	
6	**Managing Green IT** ☐ Introduction ☐ Strategizing GreenInitiatives ☐ Implementation of GreenIT ☐ InformationAssurance ☐ Communication and SocialMedia **Green Cloud Computing and Environmental Sustainability** ☐ Cloud Computing and Energy Usage Model: ☐ Features of Clouds Enabling Green Computing ☐ Towards Energy Efficiency of Cloud Computing ☐ Green Cloud Architecture **The Future of Green IT** ☐ Green Computing and theFuture ☐ Megatrends for GreenComputing ☐ Tele-presence Instead ofTravel ☐ Tele-commuting Instead ofCommuting ☐ Deep GreenApproach **Self-Learning Topics:** Green IT Regulations and Standards	**08**

Reference Books:

Reference No.	Reference Name
1	Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line,Toby Velte, Anthony Velte, Robert Elsenpeter, 2008, McGraw Hill.
2	Harnessing Green IT,San Murugesan, G. R. Gangadharan, 2013, WILEY.
3	Green Computing-Tools and Techniques for saving energy, money and resources, Bud E. Smith, 2014, CRCPress.
4	GREEN IT FOR SUSTAINABLE BUSINESS PRACTICE, Mark G. O'Neill, An ISEB FoundationGuide.
5	Green Computing and Green IT BestPractices, Jason Harris
6	The Green of IT – How Companies Can Make a Difference for the Environment, John Lamb, IBM Press (2009).
7	Green Project Management, Richard Maltzman and David Shirley, CRC Press a Taylor and Francis Company (2010)
8	Foundations of Green IT, Marty Poniatowski, Prentice Hall, 2009

Web References: http://www.carbonfootprint.com

https://www.energystar.gov/

Tutorials

Sr. No.	Detailed Contents	Hrs.
1	Calculating the Energy Consumption or Carbon Footprint for a given location (eg: your College, Residence, or a specific building) and suggesting means of reducing Energy consumption or Carbon Footprint respectively	02
2	Use of Greening by IT Tools in a live location and submitting a report which indicates Before and After effects	02
3	Calculating the amount of E-waste generated from a given location (eg: your College, Residence, or a specific building) and monitoring the process of proper handling of E-waste.	02
4	Preparing a report on how Green Data Center can be feasibly applied to your Institute. Verifying the report from Industry Expert. Calculating the cost of implementing Green Data Center	02
5	Developing an Green IT Strategy for a given location (eg: your College, Residence, or a specific building) and submitting a report for the same	02
6	Studying which of the latest Green IT techniques (eg:- Remote Maintenance using Tools, E-Learning & E-Training, Web Conferencing & E-Webinar Meetings, E-Signatures, Virtual Filing & Cloud Computing) can be applied to your Institute and submitting report for the same.	02

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

Term Work : 25 marks

The term work will be based on the tutorial performance of the student.

End Semester Theory Examination:

1.   Question paper will comprise of total 06 questions, each carrying 20marks.
2.   Total 04 questions need to be solved.
3.   Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4.   Remaining questions will be randomly selected from all the modules.
5.   Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	1	3	1	4
MCAE343	**Management Information System**	**Examination Scheme**				
		Theory		Term Work	End Sem Exam	Total
		CA	Test	AVG		
		20	20	20	25	80	125

Pre-requisite: knowledge of computer peripheral, knowledge of information and security

Course Objectives: The course aim to

Sr.No.	Course Objective
1	Understand the nature of management information systems and their applications in business.
2	Identify the major management challenges in building and using information systems.
3	Learn and explore IT security and Infrastructure. of management information systems.
4	Understand the ERP and its component.

Course Outcomes: On successful completion of course learner/ student will be able to

Sr.No.	Outcome	Bloom Level
CO 1	Understand theoretical aspects of Management Information Systems.	Understanding
CO 2	Know the procedures and practices for handling information system effectively.	Understanding
CO 3	Acquire knowledge in various Decision Support Systems.	Remembering
CO 4	Recognize the necessity of IT security and Infrastructure in Management Information Systems.	Applying

Module	Detailed Contents	Hrs
1	**Management Information Systems (MIS):** Perspectives on Information Systems, Nature and scope of MIS, Characteristics of MIS, Need and Role of MIS, Impact of MIS, functions and future of MIS, MIS: A support to the management, MIS: organization effectiveness, MIS for a digital firm **Self Learning Topics:** Case Study on digital firm	6

2	**Information System and MIS:** **Organisations and Information Systems:** Modern Organisation, Information Systems in Organisations, Managing Information Systems in Organisations **Concepts of Management Information Systems:** Data and Information, Information as a Resource, Information in Organisational Functions, Types of Information Technology, Types of Information Systems, Decision Making with MIS, Communication in Organizations. **Self Learning Topics:** Case Study: Management Issues- Challenges for Managers	7	
3	**Decision Support System, Knowledge Management and Management of Global Enterprise:** Decision Support System(DSS), DSS Models, Group Decision Support System(GDSS), Knowledge based Expert System(KBES), Enterprise Resource Planning(ERP) System, ERP Model and Modules, Benefits of ERP, Supply Chain Management(SCM), Information Management in SCM, Customer Relationship Management(CRM) **Self Learning Topics:** Study of EMS and MIS	8	
4	**Business Intelligence for MIS:** Business Intelligence and MIS, what is Business Intelligence (BI), Tools and Techniques of BI, why is BI Developed? How is BI used? Process of generation of BI, MIS and BI. **Self Learning Topics:** Case illustration of BI	6	
5	**Managing Information Systems and Information Technology Infrastructure:** **Managing Information System:** Challenges of Managing the IT Function, Vendor Management, IT Governance, **Information Technology Infrastructure and Choices:** What is the IT Infrastructure?, IT Infrastructure Decisions, Infrastructure Components, Networks **Self Learning Topics:** Case Study of Managing Information System	6	
6	**Information Security:** Introduction, Threats and Vulnerability, Controlling Security Threat and Vulnerability, Managing Security Threat in E-Business, Measures of Information Security, Information Security Management. **Self Learning Topics:** Network Security, and Cyber Security for Information	7	

Reference Books:

Reference No	Reference Name
1	Management Information Systems- A global digital Enterprise perspective, 5th edition - By W.S.Jawdekar, TMG Publications
2	MIS: Managing Information Systems in Business, Government and Society, 2ed by Rahul De, Wiley
3	Management Information System, James O'Brien, 7th edition, TMH
4	Management Information Systems, Loudon and Loudon, 11th edition, Pearson.

Web References:

Reference No	Reference Name
1	https://en.wikipedia.org/wiki/Management_information_system

MIS: Tutorial

Sr. No.	Detailed Contents	Hrs
1	Subject Instructor/Mentor can form the groups of the students and they can discuss the case studies with the guidance of Instructor/Mentor to understand and explore the applications of MIS in various Industries.	
2	Case studies can be chosen in the area like application of MIS in functional area and service sectors i.e. Banking, Insurance, Health Care, Aviation, Food Industry and Education etc.	12
3	Case studies based on various opensource technologies can also be included in discussion to understand the software supports in decision making of MIS.	

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of the test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

Term Work : 25 marks

The term work will be based on the tutorial performance of the student.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.

3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
MCAE344	Cyber Security and Digital Forensics	Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	1	3	1	4
		Examination Scheme				
		Theory			Term Work	End Sem Exam	Total
		CA	Test	AVG			
		20	20	20	25	80	125

Pre-requisite: NIL

Course Objectives: Course aim to

Sr.No.	Course Objective
1	Understand basics of cyber security
2	Acquire the knowledge of various tools and methods used in cyber crime
3	Learn the fundamentals of digital forensic
4	Apply appropriate skills and knowledge for solving digital forensic problems

Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate understanding of basic concepts in cyber security	Understanding
CO 2	Make use of various tools and methods used in cybercrime	Applying
CO 3	Adapt fundamental knowledge of digital forensics	Creating
CO 4	Determine skills and knowledge for solving digital forensics Problems	Evaluating

Module	Detailed Contents	Hrs
1	**Module: Introduction to Cyber Security** Cybercrime and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA- 2000, A global Perspective on cybercrimes. **Self learningTopic:**Amendments to the Indian IT Act(2008).	4
2	**Module: Cyber offenses & Cybercrimes** How criminal plan the attacks, Industrial Spying/Industrial Espionage, Hacking, Online Frauds, Pornographic Offenses, E-Mail Spoofing, Spamming,data diddling , salami attack, Cyber defamation, Internet Time Theft,SocialEngg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era. **Self learning Topic:** Security Challenges Posed by Mobile Devices.	7
3	**Module:Tools and Methods Used in Cybercrime** Phishing, Password Cracking, Keyloggers and Spywares, Virus ,worms and trojans, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer	6

		OverFlow, Attacks on Wireless Networks,Identity Theft (ID Theft)	
		Self learning Topic: Various types of viruses,Worms and Trojans	
4		**Module: Introduction to Digital Forensics**	5
		Introduction to Digital Forensics and its uses. Need of digital Forensics, Digital forensic life cycle, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing and Antiforensics. **Self learning Topic:** Various digital forensic models/ framework	
5		**Module: Data Recovery and Evidence Collection**	8
		Data Recovery: Defined, data backup and recovery, role of backup in data recovery, Data recovery solutions, Hiding and recovering Hidden data Evidence Collection and Data Seizure: What is digital evidence, rules of evidence, Characteristics of evidence, Types of evidence, Volatile evidence, General procedure for collecting evidence, Methods of collection and collection steps, Collecting and archiving, Evidence handling procedures, Challenges in evidence handling Duplication and Preservation of Digital Evidence **Self learningTopic:**Symmetric and Asymmetric Encryption	
6		**Module: Network Forensic and Steganography**	10
		Network Forensics : Network Fundamentals, Network Types, Network security tools and attacks, Intrusion Detection Systems (types and advantages and disadvantages) Email Investigations – E-Mail protocol, E-Mail as Evidence, Working of E-Mail, Steps in the E- Mail communication, IP Tracking, E-Mail Recovery, Android Forensic-Android forensic- The evolution of Android, The Android model, Android security, The Android file hierarchy, The Android file system, Android Data Extraction Techniques: Manual data extraction,Logical data extraction, Physical data extraction Cyber Forensics Tools: Tool Selection, hardware, Software, Tools (FKT, PKT) Steganography – categories of steganography in Forensics (Text, Image, Audio) **Self learning Topic:** Various forms of Internet Frauds	

Reference Books:

Reference No	Reference Name
1	Nina Godbole, SunitBelapurCyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives –, Wiley India Publications Released: April 2011
2	John Sammons, "The Basics of Digital Forensics", Elsevier 2012
3	Computer Forensics, Computer Crime Scene Investigation. By John R. Vacca, Charles River Media, INC. 2nd Edition

4	Jain, Dr. dhananjay R. Kalbande,Digital Forensic The Fascinating world of Digital forensic
5	Anthony Reyes,The Best Damn Cybercrime and Digital Forensic Book Period,, Jack Wiles
6	Practical Mobile Forensics: SatishBommisetty,RohitTamma and Heather Mahalik, Pack Publishing LTD 2014, ISBN-978-1-78328-831-1
7	Investigating Network Intrusions and Cybercrime EC-Council	Press
8	Computer Forensic investing Network Intrusions and cyber crime by Course Technology
9	Michael Gregg & David Kim,Inside Network Security Assessment: Guarding Your IT Infrastructure, Pearson Publication
10	Suresh T. Vishwanathan-The Indian Cyber Law ; Bharat Law House New Delhi

Web References:

Referen ce No	Reference Name
1	Computer Forensic Training Center Online http://www.cftco.com/ Computer Forensics World
2	http://www.computerforensicsworld.com/ Computer Forensic Services
3	http://www.computer-forensic.com/
4	Digital Forensic Magazine http://www.digitalforensicsmagazine.com/
5	The Journal of Digital Forensics, Security and Law http://www.jdfsl.org/
6	Journal of Digital Forensic Practice http://www.tandf.co.uk/15567281
7	https://www.researchgate.net/publication/220846511
8	https://www.researchgate.net/publication/306301164
9	https://www.researchgate.net/publication/308646775_An_introduction_to_steganography_methods

TUTORIAL :

Sr.No	Detailed content	Hrs .
1	Given a list of cases, identify whether the it falls under the category of virus, worms or trojans.	1
2	Two real life case study related to data diddling, salami attack and social engineering. Also , explaining what precautions needs to be taken from these attacks.	1

3	Any real life cases that were booked under the following sections: 1.Section 65 2. Sections 66A,66B,66C,66D,66E,66F	1
4	Various types of viruses, worms and trojans and explain how they work.	1
5	SQL injection technique. Make a presentation slide and demonstrate.	1
6	Take any 2 cyber crimes, explain in detail as a presentation. Also download its related video to demonstrate it in the class.	1
7	Understanding relevance of the OSI 7 Layer Model to Computer Forensics	1
8	Screen lock bypassing techniques and different of password cracking methods	1
9	Cyber Forensics Tools: Tool Selection, hardware, Software, Tools (FKT, PKT)	1
10	Investigate and browse recovered e-mails in 'R-Mail' tool.	1
11	Investigation of information of captured packets by using 'Wireshark' tool.	1
12	Recovering deleted data from an Android device by using the 'FKT' tool.	1

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks each. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of each test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

Term Work : 25 marks

The term work will be based on the tutorial performance of the student.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.

3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
MCAE345	**Entrepreneurship Management**	3	1	3	1	4
		Examination Scheme				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	**Test**	**AVG**		
		20	20	20	25	80	125

Pre-requisite: Nil

Course Objectives: The course aim to

Sr. No.	Course Objective
1	Instill a spirit of entrepreneurship among the student participants.
2	Provide an overview of the competences needed to become an entrepreneur.
3	Understand growth and managing strategies of venture and Social Responsibilities
4	Understand how to design effective and efficient Business Plan for intended users.
5	Understand role of Small-Scale Industries (SSI) & Institutions Supporting Small Scale Enterprise
6	Recognize the importance of entrepreneurship and identify the profile of entrepreneurs and their role in economic growth.

Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO1	Understand the concepts and fundamentals of Entrepreneurship.	Understanding
CO 2	Understand the growth and development strategies for venture and Social Responsibilities	Understanding
CO 3	Identify the Role of Small-Scale Industries (SSI) & Institutions Supporting Small Scale Enterprise.	Applying
CO 4	Analyse the process of Business Idea generation and converting the idea into a Business Model.	Analyzing
CO 5	Evaluate the effectiveness of different entrepreneurial strategies, policies and measures for promoting small industries.	Evaluating
CO 6	Create presentations and marketing strategies that articulate financial, operational, organizational, market, and sales knowledge for value creation.	Creating

Module No.	Detailed Contents	Hours
1	**Module: Overview of Entrepreneurship: The Entrepreneurial Perspective** Concept and Definitions: Manager, Entrepreneur, Entrepreneurship and Intrapreneurship, Importance and Significance of Growth of Entrepreneurial Activity, Traits, Characteristics, Skills and Qualities of Entrepreneurs, Classification and Types of Entrepreneurs, Emerging trends and issues in Entrepreneurship. **Self-learning topics:** Differences Between Entrepreneurs, Intrapreneurs&Ultrapreneurs	5
2	**Module: Creativity and New Venture Management** **Creative Business Ideas:** Identify and Recognizing Opportunities: Observing Trends and solving problems, Creativity: Concept, Components and types, Sources of New Venture Ideas: Concept, Pre-selection Process, Sources of Business Idea, Preliminary Research, Business Idea Evaluation, Other Analysis. **Writing a Business Plan:** Introduction of Business Plan, Guidelines for writing A Business Plan, Layout of Business Plan (Executive summary, Business Description, Industry Analysis, Market Analysis, Management Team and Company Structure, Operations Plan, Product Design and Development Plan, Financial Projections and Critical Risk Assessment, Harvest Strategy, Milestone Scheduling), Presenting the Business Plan to Investors. Why some Business Plans Fail. **Self-learning topics:** Writing business plan for benefiting to an entrepreneur	8
3	**Module: Small Scale Industries Management** Introduction to Small Industry: Introduction, Concept of small industry, Position in India, Role of small industries in economic development. Definition of Small-scale Industries, Undertakings, SSI Policy Statement, Procedure for SSI Registration, The Strengths and Weakness of Small Business. Reasons for the significance of small sector, various forms of small-scale enterprises, Small Industries during various five-year Plans, Policies and measures for promoting small industries. **Self-learning topics:** Growth and Performance of Small-Scale Industries (SSI) in India, Problems for SSI.	7
4	**Module: Entrepreneurship Development and Government** **Role of Central Government and State Government in promoting Entrepreneurship** - Introduction to various incentives, subsidies and grants - Export Oriented Units - Fiscal and Tax concessions available **Role of following agencies in the Entrepreneurship Development -** District Industries Centers (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB) **Self-learning topics:** List out all the Central & State Government policies implemented for Entrepreneurship Development.	7

5	**Module: Marketing the Product or Service**	6
	Small Business Marketing: Strategy and Research: Concept, Marketing Strategies, Market Research. Product: Heart of Marketing Mix, Purchasing, Selecting Suppliers, Managing and controlling Inventor. Place: Location Types, Layout & Design. Price and Promotion: Economics of Pricing, Breakeven Analysis, Pricing-Setting Techniques, Credit Policies, Promotions.	
	Self-learning topics: Role of Digital Marketing for an entrepreneur as promoting their product	
6	**Module: Growth and Development of the Venture & Social Responsibility**	7
	Small Business Growth: Growing Firm, Transition to Professional Management, The Next Step: An Exit Strategy, Leadership in Action: Leadership Attributes, Negotiations, Delegation, Motivation Employees, HRM: Job Analysis, Recruitments, Selections, Trainings, Compensations, Introduction of Social Responsibility, Corporate Social Responsibility (CSR), Dimensions of CSR.	
	Self-learning topics: Operation management responsibilities in managing Small Business.	

Reference Books:

Reference No	Reference Name
1	Barringer, Ireland, "Entrepreneurship: Successfully Learning New Ventures", Pearson, Latest Edition
2	Robert D Hisrich, Michael P Peters, Dean A Shepherd, Entrepreneurship, Sixth Edition, The McGraw Hill Company.
3	Pocket Mentor "Creating A Business Plan", Harvard Business School Press, Boston, Massachusetts
4	David Butler "Enterprise Planning Development- Small Business Start-up Survival and Growth", Butterworth-Heinemann
5	Entrepreneurship and Small Business Management by Dr. C L Bansal, HarAnand Publications Pvt. Ltd. New Delhi, 2012
6	Entrepreneurship by Lall, Madhurima. Sahai, Shikha. Excel Books, New Delhi, 2008, 2nd Edition
7	Strategic Entrepreneurship "A Decision-making approach to new venture creation and management" Philip A. Wickham, Pearson Education Society
8	"Small Business Management" Entrepreneurship and Beyond, 5th Edition, Timoth S. Hatten
9	Vasant Desai, The Dynamics of Entrepreneurial Development and Management, 2015, Himalaya Publishing House.
10	PoornimaCharantimath, Entrepreneurship Development- Small Business Enterprise, Pearson.
11	Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
12	Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi

Web References:

Reference No	Reference Name
1	http://niesbud.nic.in/
2	http://msme.gov.in/
3	http://ssi.nic.in/
4	www.womenentrepreneursindia.com
5	www.msmetraining.gov.in
6	https://www.startupindia.gov.in
7	https://www.makeinindia.com
8	https://mygov.in
9	www.dcmesme.gov.in
10	www.nsic.co.in

EM: Tutorials

Sr. No.	Detailed Contents	Hrs.
1	Entrepreneurial Tasks.	01
2	Entrepreneurship Development in rural areas (Agriculture/Allied Business)	01
3	Women Entrepreneurship Development. (Case Study)	01
4	Team Building Activities (Board of Members/ Employees)	01
5	Entrepreneurship in Service Sector.	01
6	Preparing Business Plan	01
7	Scenarios for fundraising in Entrepreneurship	01
8	E-Business Brainstorming Activities	01
9	Impact of Globalization and Liberalization on SSI.	01
10	Risk Management in Entrepreneurship.	01
11	Social Development through Entrepreneurship.	01
12	CSR Case Study.	01

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

Assignments /Quiz /Case studies /Projects / Any other measure with the permission of the Director/Principal/HOD/Coordinator

The continuous evaluation has to be done throughout the Semester. The faculty can use the flexibility of the mode as per the requirement of the subject.

Test: 20 marks

Assessment consists of one class tests of 20 marks each. The Class Test is to be conducted when approx. 50 -60% of the syllabus is completed. Duration of each test shall be one hour.

Internal Assessment: 20 marks

The Internal Assessment marks (out of 20) will be the average of the Class test and the Continuous Assessment.

Term Work : 25 marks

The term work will be based on the tutorial performance of the student**.**

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL31	Big Data Analytics and Visualization	02	01	25	30	20	75

Prerequisite: Basic Understanding of SQL, Java Programming and Python

Lab Course Objectives

Sr.No.	Course Objective
1	Understand Various Components of Hadoop for instance Hadoop2.x, HDFS, Map Reduce
2	Understand and gain knowledge of NoSQL DB and Data Modelling Concept
3	Teach Hadoop Ecosystem Projects Hive and Pig and its Programming Modules.
4	Learn Functional programming in spark and execute and create spark applications.
5	Teach Data Visualization and its importance using Tableau

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate HDFS Commands in Hadoop	Understanding
CO 2	Apply Map Reduce Programming Paradigm to solve the algorithmic problems	Applying
CO 3	Build No SQL Database and Query it Using Mongo DB	Applying
CO 4	Analyze the Data Using Hadoop Ecosystem Projects: Hive and Pig	Analyze
CO 5	Explain RDD and Data Frame Creation in Apache Spark	Evaluate
CO 6	Create various Visualizations using Tableau.	Creating

Description:

Module No	Detailed Contents	Hrs.
1	Set up and Configuration Hadoop Using Cloudera Creating a HDFS System with minimum 1 Name Node and 1 Data Nodes HDFS Commands **Self-Learning Topics**: Set up Hadoop in Linux Environment	2
2	Map Reduce Programming Examples Word Count. Union, Intersection and Difference. Matrix Multiplication. **Self-Learning Topics**: Natural Join Programming Example	4

3	Mongo DB: Installation and Creation of database and Collection	4
	CRUD Document: Insert, Query, Update and Delete Document.	
	Self-Learning Topics: HBASE Commands	
4	Hive: Introduction Creation of Database and Table, Hive Partition, Hive Built in Function and Operators, Hive View and Index.	4
	Self-Learning Topics: Configure Hive Metastore to MySQL	
5	Pig: Pig Latin Basic	4
	Pig Shell, Pig Data Types, Creating a Pig Data Model, Reading and Storing Data, Pig Operations	
	Self-Learning Topics:	
6	Spark: RDD, Actions and Transformation on RDD ,	2
	Ways to Create -file, data in memory, other RDD.	
	Lazy Execution, Persisting RDD	
	Self-Learning Topics: Machine Learning Algorithms like K-Means using Spark.	
7	Visualization: Connect to data, Build Charts and Analyze Data, Create Dashboard, Create Stories using Tableau	6
	Self-Learning Topics: Tableau using web.	

Reference Books:

Reference No	Reference Name
1	Tom White, "HADOOP: The definitive Guide" O Reilly 2012, Third Edition, ISBN: 978-1-449-31152-0
2	Chuck Lam, "Hadoop in Action", Dreamtech Press 2016, First Edition ,ISBN:13 9788177228137
3	Shiva Achari," Hadoop Essential " PACKT Publications, ISBN 978-1-78439-668-8
4	RadhaShankarmani and M. Vijayalakshmi ,"Big Data Analytics "Wiley Textbook Series, Second Edition, ISBN 9788126565757
5	Jeffrey Aven,"Apache Spark in 24 Hours" Sam's Publication, First Edition, ISBN: **0672338513**
6	Bill Chambers and MateiZaharia,"Spark: The Definitive Guide: Big Data Processing Made Simple "O'Reilly Media; First edition, ISBN-10: 1491912219;
7	James D. Miller," Big Data Visualization" PACKT Publications. ISBN-10: 1785281941

Web References:

Reference No	Reference Name
1	https://hadoop.apache.org/docs/stable/
2	https://hive.apache.org/
3	https://pig.apache.org/
4	https://spark.apache.org/documentation.html
5	https://help.tableau.com/current/pro/desktop/en-us/default.htm

Suggested list of experiments

Practical No	Problem Statement
1	**HDFS:** List of Commands (mkdir, touchz, copy from local/put, copy to local/get, move from local, cp, rmr, du, dus, stat)
2	**Map Reduce:** 　**1.** Write a program in Map Reduce for WordCount operation. 　**2.** Write a program in Map Reduce for Union operation. 　**3.** Write a program in Map Reduce for Intersection operation. 　**4.** Write a program in Map Reduce for Grouping and Aggregation. 　**5.** Write a program in Map Reduce for Matrix Multiplication
3	**MongoDB :** 　1. Installation 　2. Sample Database Creation 　3. Query the Sample Database using MongoDB querying commands 　　a. Create Collection 　　b. Insert Document 　　c. Query Document 　　d. Delete Document 　　e. Indexing
4	**Hive:** 　1. Hive Data Types 　2. Create Database & Table in Hive 　3. Hive Partitioning 　4. Hive Built-In Operators 　5. Hive Built-In Functions 　6. Hive Views and Indexes 　**7.** HiveQL : Select Where, Select OrderBy, Select GroupBy, Select Joins
5	**Pig:** 　1. Pig Latin Basic 　2. Pig Data Types, 　3. Download the data 　4. Create your Script 　5. Save and Execute the Script 　6. Pig Operations : Diagnostic Operators, Grouping and Joining, Combining & Splitting, Filtering, Sorting
6	**Spark**: 　1. Downloading Data Set and Processing it Spark 　2. Word Count in Apache Spark.
7	**Visualization using Tableau:** Tableau: Tool Overview, Importing Data, Analyzing with Charts, Creating Dashboards, Working with maps, Telling Stories with tableau.

Assessment:

Term Work: Will be based on <u>Continuous Assessment</u>

　　1. Laboratory work will be based on the syllabus with minimum 10 experiments.

　　　　　　　　　　Experiments 20 marks

　　　　　　　　　　Attendance   5 marks

　　2. Practical will be evaluated by the subject teacher and documented according to a rubrics.

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL34	**Distributed System and Cloud Computing Lab**	**02**	**01**	25	30	20	75

Pre-requisite: Basic overview of Distributed systems and Cloud Computing.

Lab Course Objectives:

Sr.No.	Course Objective
1	Understand the concepts of Remote Process Communication, Remote Procedure Call and Remote Method Invocation.
2	Understand the concepts of Remote Object Communication.
3	Understand the mutual exculsion concept.
4	Understand the implementation of Cloud Computing Services.
5	Learn implementation of Identity Management using Cloud Computing concept.
6	Learn use of various tools and techniques to develop efficient, dynamic applications.

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Develop Remote Process Communication, Remote Procedure Call and Remote Method Invocation concepts.	Applying
CO 2	Develop Remote Object Communication programs.	Creating
CO 3	Develop mutual exclusion concept using Token ring algorithm.	Creating
CO 4	Implementation of Cloud Computing Services.	Applying
CO 5	Implementation of Identity Management using Cloud Computingconcept.	Applying
CO 6	Design Apps using Cloud Computing for windows Azure / Amazon AWS using Windows Azure Platform Training Kit and Visual Studio and Google App Engine by using Eclipse IDE.	Creating

Description:

Module	Detailed Contents	Hrs.

1	**Module: Remote Process Communication:** Develop a multi-client chat server application where multiple clients chat with each other concurrently. The messages sent by different clients are first communicated to the server and then the server, on behalf of the source client, communicates the messages to the appropriate destination client. **Self Learning Topics:** Other applications based on Remote process communication	**02**
2	**Module: Remote Procedure Call:** A remote procedure call is an inter process communication technique that is used for client-server-based applications. A client has a request message that the RPC translates and sends to the server. This request may be a procedure or a function call to a remote server. When the server receives the request, it sends the required response back to the client. The client is blocked while the server is processing the call and only resumed execution after the server is finished. **Self Learning Topics:** Other types of call semantics	**04**
3	**Module: Remote Method Invocation:** The Remote Method Invocation is an API that provides a mechanism to create distributed application in java. The client invokes methods via an interface. These methods are implemented on the server side. **Self Learning Topics:** Concept of client and server applications, remote interface, RMI registry tools	**04**
4	**Module: Remote Object Communication:** Pass remote objects from the server to the client. The client will receive the stub object (through remote interfaces) and saves it in an object variable with the same type as the remote interface. Then the client can access the actual object on the server through the variable. **Self Learning Topics:** Concept of JDBC	**04**
5	**Module: Mutual Exclusion:** Token ring algorithm solves the mutual exclusion existing in the process communication. **Self Learning Topics:** Other algorithms of Mutual Exclusion	**02**
6	**Module: Implementation of Cloud Computing Services:** Cloud Computing provides different services such as SaaS, PaaS, IaaS, Storage as service and many more. Storage as a Service is a business model in which a large company rents space in their storage infrastructure to a smaller company or individual. **Self Learning Topics:** Other types of Cloud Services	**02**
7	**Module: Implementation of Identity Management using Cloud Computing concept:** The main goal of identity management is to ensure that only authenticated users are granted access to the specific applications, systems or IT environments for which they are authorized. **Self Learning Topics:** Other tools to implement the technique	**02**

	Module: App Development using Cloud Computing: Make use of various tools and techniques to develop efficient, dynamic applications. Self Learning Topics: Other Technique of application Development and its Complexity	
8		06

Reference Books:

Reference No	Reference Name
1	Pradeep K. Sinha, Distributed Operating Systems concepts and design, PHI, ISBN No. 978-81-203-1380-4
2	Herbert Schildt, The Complete Reference JAVA, Tata McGraw-Hill,7th Edition, ISBN No. 978-0-07-163177-8
3	Horstmann, Cornell, Core Java 2 Volume I Fundamentals, Sun Micro System, 7th Edition, ISBN No-13:978-0131482029
4	Horstmann, Cornell, Core Java 2 Volume II Advanced Features, Sun Micro System, 7th Edition, ISBN No-13:978-0131118263
5	Dr. Kumar Saurabh, Cloud Computing insights into new-era infrastructure, Willey ISBN No.10:8126528834
6	RajkumarBuyya, James Broberg, AndrzejGoscinski, Cloud Computing Principles and Paradigms, Willey Publication, ISBN No. 9780470887998
7	GautamShroff, Enterprise Cloud Computing Technology, Architecture, Applications, Cambridge University Press, ISBN No. 978-0-521-13735-5

Web References:

Reference No	Reference Name
1	https://onlinelibrary.wiley.com/
2	https://nptel.ac.in/courses/106106168/
3	https://nptel.ac.in/courses/106/105/106105167/
4	http://www.tutorialspoint.com
5	http://www.javapoint.com
6	https://aws.amazon.com/

Suggested list of experiments

Practical No	Problem Statement
1	To develop a program for multi-client chat server using Socket
2	To implement a Server calculator using RPC concept. (Make use of datagram)
3	To implement a Date Time Server using RPC concept. (Make use of datagram)
4	To retrieve day, time and date function from server to client. This program should display server day, time and date. (Use Concept of JDBC and RMI for accessing multiple data access objects)
5	The client should provide an equation to the server through an interface. The server will solve the expression given by the client.
6	Using MySQL create Library database. Create table Book (Book_id, Book_name, Book_author) and retrieve the Book information from Library database using Remote Object Communication concept.
7	Using MySQL create Elecrtic_Bill database. Create table Bill

	(consumer_name, bill_due_date, bill_amount) and retrieve the Bill information from the Elecrtic_Bill database using Remote Object Communication concept.
8	Implementation of mutual exclusion using Token ring algorithm.
9	Implementation of Storage as a Service using Google Docs
10	Implementation of Identity Management.
11	To develop Application for windows Azure / Amazon AWS using Windows Azure Platform Training Kit and Visual Studio.
12	To develop applications using Google App Engine by using Eclipse IDE

Assessment:

Term Work: Will be based on Continuous Assessment

1. Laboratory work will be based on the syllabus with minimum 10 experiments.

    Experiments 20 marks

    Attendance   05 marks

2. Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCALE331	Block chain Lab	02	01	25	30	20	75

Pre-requisite: Basic programming skill in Python/ Java Script/Java.

Lab Course Objectives: The course aim to

Sr. No.	Course Objective
1	Impart a thorough understanding of cryptographic algorithm and hash functions
2	Understand the concepts of Bitcoin and Smart Contract
3	Understand the concepts of Solidity language
4	Understand the deployment of Dapp in Ethereum

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO1	Implement encryption algorithms and hash functions	Applying
CO2	Construct a bitcoin blocks and validating	Applying
CO3	Construct a smart contract in Ethereum	Applying
CO4	Develop and deploy Dapp in Ethereum	Applying

Description:

Module	Detailed Contents	Hrs.
1	**Module: Cryptography:** Symmetric Encryption using Ceaser Cipher, Asymmetric Encryption using RSA, Hash Functions (SHA-256), Merkle Tree (Implementation in Python/Java Script/C++)	06
2	**Module:Cryptocurrency:** Concept of Bitcoin, block, blockchain, Immutable ledger, Public and Private Blockchain. (Implementation in Python/Java Script/C++)	06
3	**Module: Solidity Programming:** Introducing Solidity, Sample Code, Layout of Source File, Structure of a Contract, State Variables, Functions Types, Reference Types, Units, Special Variables and Functions, Expressions and Control Structures, Function Calls, Error Handling, Visibility for Functions and State Variable	06
4	**Module: Ethereum:** Ethereum Virtual Machine (EVM): Accounts, Transactions, Gas, Ether, Memory Dapp architecture: Developing a DApp, Compile and Deploy the Smart Contract, Publish the DApp, Connecting to DApp, Ganache Output for Transaction Migration	06
5	**Module: Case Study:** Use cases based on Hyper Ledger	02

Reference Books:

Reference No.	Reference Name
1	David H. Hoover, Kevin Solorio, and Randall Kanna, Hands-On Smart Contract Development with Solidity and Ethereum: From Fundamentals to Deployment, O'Reilly Publications, ISBN-13: 978-1492045267
2	Jimmy Song, Programming Bitcoin: Learn How to Program Bitcoin from Scratch, O'Reilly Publications, ISBN-13: 978-1492031499
3	RiteshModi, Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Packt Publications,
4	Chris Dannen, Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners, Apress

Web References:

Reference No	Reference Name
1	https://solidity.readthedocs.io/en/v0.6.7/
2	https://remix-ide.readthedocs.io/en/latest/#
3	https://www.sitepoint.com/solidity-for-beginners-a-guide-to-getting-started/
4	https://www.tutorialspoint.com/solidity/index.htm
5	https://bitcoin.org/en/getting-started
6	https://docs.python.org/3/library/hashlib.html

Suggested list of experiments:

Practical No.	Problem Statement
1	Implementation of Ceaser Cipher (Symmetric Encryption)
2	Implementation of RSA Algorithm (Asymmetric Encryption)
3	Implementation of SHA-256
4	Implementation of Binary Tree
5	Implement the creation of Bitcoin Block (Genesis Block)
6	Implement the creation of a Blockchain (Adding the blocks to the chain and validating)
7	Implement the creation of a public/private Blockchain
8	Implementation of an immutable Ledger
9	Simple Experiments using Solidity Program Constructs (if-then, while etc...)
10	Creation of smart contract in Ethereum
11	Creation of Dapp in Ethereum
12	Mini Project

Assessment:

Term Work: Will be based on Continuous Assessment

1. Laboratory work will be based on the syllabus with minimum 10 experiments.

   Experiments 20 marks

   Attendance   5 marks

2. Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCALE332	Deep Learning Lab	02	01	25	30	20	75

Prerequisite: Basic understanding of machine learning concepts. **Lab Course Objectives**

Sr.No.	Course Objective
1	To understand dataset and pre-processing to build neural network models.
2	To apply appropriate learning rules for each of the architectures and build several neural network models.
3	To learn different regularization and optimization techniques used in deep learning
4	To identify the problems, choose relevant deep learning algorithms and analyze the results for respective applications.

`Lab Course Outcomes:**

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate Tensor flow/Keras deep-learning workstations.	Understanding
CO2	Choose appropriate data preprocessing techniques to build neural network models.	Applying
CO 3	Analyze different regularization and optimization techniques used in deep learning.	Analyzing
CO 4	Build neural network models using deep learning algorithms-CNN and RNN to solve real world problems.	Creating

Description:

Module No	Detailed Contents	Hrs
I	**Introduction to Tensor flow/Keras-**Installation, Importing Libraries and Modules. **Self Learning Topic:-**Setting up a deep-learning workstation.	2
II	**Working with Dataset-**Loading the dataset, Splitting dataset into training and testing data sets. **Self Learning Topic:-**Data representations for neural networks	2
III	**Data Preprocessing Techniques**- Numerical Data, Feature Scaling, Handling Missing Values, Categorical Data and String Data Types, Encoding, Data Splitting. **Self Learning Topic: -** Outliers detection.	2
IV	**Artificial Neural Networks-** McCulloch-Pitts neuron, single layer perceptron network, multi-layer perceptron network, Back propagation network. **Self Learning Topic:-** Adaline Network	6
V	**Regularization Techniques-** Dataset Augmentation, Early Stopping, Dropout. **Self Learning Topic:-** Optimization techniques(any one)	2

VI	**Deep Neural Network Algorithm: Convolutional Neural Network(CNN)-** Introduction to convnets, Adding a classifier, Training the convnet on given data set, The convolution operation, The max-pooling operation, Evaluating the model, analysing and visualizing results. **Self Learning Topic: -** Pre-trained Convnet.	**6**
VII	**Deep Neural Network Algorithm-Recurrent Neural Network (RNN) -** Training the model with RNN layers, Evaluating the model, analyzing and visualizing results. **Self Learning Topic: -** Pre-trained RNN.	**6**

Reference Books:

Reference No	Reference Name
1	François Chollet, Deep Learning with Python, 2018 by Manning Publications Co. ISBN 9781617294433.
2	Deep Learning Tutorial Release 0.1, LISA lab, University of Montreal
3	Sebastian Raschka, Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python,3rd Edititon, Packet Publishing.

Web References:

Reference No	Reference Name
1	https://www.kaggle.com/learn/deep-learning
2	https://github.com/topics/deep-learning-tutorial
3	https://towardsdatascience.com/building-our-first-neural-network-in-keras-bdc8abbc17f5
4	https://machinelearningmastery.com/tutorial-first-neural-network-python-keras/
5	https://subscription.packtpub.com/book/big_data_and_business_intelligence/9781786464453/3
6	https://data-flair.training/blogs/learning-rules-in-neural-network/

Suggested list of experiments

Practical No.	Problem Statement
1	Introduction to Tensor flow /Keras -Importing Libraries and Modules.
2	Loading the dataset, Splitting dataset into training and testing data sets.
3	Implementation of Data preprocessing techniques.
4	Implementation of Artificial Neural Networks -McCulloch-Pitts neuron with ANDNOT function, single layer perceptron network, multi-layer perceptron network for an AND function, Back propagation Network for XOR function with Binary Input and Output.
5	Implementation of Regularization Techniques.
6	Implementation and analysis of Deep Neural network algorithm: Convolutional neural network (CNN) - Object identification and classification, image recognition.
7	Implementation and analysis of Deep Neural network algorithm: Recurrent neural network (RNN) - Character recognition and web traffic Image classification.

Assessment:

Term Work: Will be based on <u>Continuous Assessment</u>

1. Laboratory work will be based on the syllabus with minimum 10 experiments. The experiments should be completed in the allotted time duration.

Experiments 20 marks

Attendance   5 marks

2. Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on the suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCALE333	Game Development Lab	02	01	25	30	20	75

Pre-requisite: Understanding of Object Oriented Programming concepts and C#

Lab Course Objectives: Course aim to

Sr.No.	Course Objective
1	Learn Unity framework for Game Development
2	Implement object oriented programming concepts in Game Development
3	Demonstrate use of Game development components
4	Use gaming assets for designing 3D games

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Build Games using Object Oriented Programming Concepts	Applying
CO 2	Simplify Game Development Process using Unity Framework	Analyzing
CO 3	Develop state of art 2D games	Applying
CO 4	Plan creation of 3D games and Test them	Creating

Description:

Unit No	Detailed Contents	Hrs
1	**Module: Unity UI Basics** The Layout, Game Window, Toolbar, Selecting and Focusing, Snaps, 3d Objects **Self Learning Topics:** Exploring the Editor	04
2	**Module: Game Development Components** Game Objects,Models,Materials and Textures,Trrain,Environments,Lights and Cameras, Sound Effects	04

	Self Learning Topics: IDE components	
3	**Module: Unity C# Scripting** C# variables in Unity 3D ,C# numbers in Unity 3D,C# conditionals in Unity 3D,C# arrays & loops in Unity 3D ,C# functions & methods in Unity 3D, Object oriented programming & inheritance in C# for Unity **Self Learning Topics**: Software Development life cycle	06
4	**Module: Managing State and Transitions** Object Metadata, Processing the Auxiliary Objects, Handling Object Visibility, Handling Special Cases **Self Learning Topics**: State Machine	04
5	**Module: Physics and Special Effects** Games implementing the concepts of -Adding New Assets, Combining Physics and Keyframe Animation, Particle Systems, Other Special Effects,Collisions,Prefabs and animations, Unity Physics Joints, Unity 2D Effectors **Self Learning Topics:** Designing virtual world	04
6	**Module: Unity 3D Game** 3D Game Assets for your games in Unity, Unity 3D interface overview, Project creation & importing assets into Unity, Working with lighting & materials in Unity 3D,Altering shaders in Unity 3D,Switching build platforms in Unity 3D,Moving objects in Unity 3D,Coroutines & wait times in Unity 3D,Inheritance & reusability in Unity 3D ,Working with audio in Unity 3D **Self Learning Topics:** Extending your Unity 3D Game	04

Reference Books:

Reference No	Reference Name
1	Blackman, Sue. Beginning 3D Game Development with Unity 4: All-in-one, multi-platform game development. Apress, 2013. ISBN: 1430248998
2	Goldstone, Will. Unity game development essentials. Packt Publishing Ltd, 2009. ISBN: 184719818x
3	Murray, Jeff W. C# game programming cookbook for Unity 3D. CRC Press, 2014.
4	Paris Buttfield-addison , Jon Manning , Tim Nugent,Unity Game Development Cookbook: Essentials For Every Game, O'reilly Media, ISBN: 1491999152
5	Geig, Mike. Sams Teach Yourself Unity Game Development in 24 Hours. Pearson Education, 2014. ISBN-13: 978-0-672-33696-6
6	Norton, Terry. Learning C# by developing games with unity 3D. Packt Publishing Ltd, 2013. ISBN: 1849696586
7	Saunders, Kevin, and Jeannie Novak. Game development essentials: Game interface design. Cengage Learning, 2012. ISBN-13: 978-1-305-11054-0

Web References:

Reference No	Reference Name
1	www.unity.com
2	https://en.wikipedia.org/wiki/Video_game_development
3	https://www.gamedesigning.org/video-game-development/
4	https://github.com/Kavex/GameDev-Resources

Suggested list of experiments

Practical No	Problem Statement
1	Design of Amazing Racer Game
2	Design of Chaos Ball Game
3	Design of Captain Blaster Game
4	Design of zombie rush game
5	Design of Mini Golf
6	Design of PinBall Game
7	Design of DodgeBall Game
8	Design of Defender Game
9	Design of Gauntlet Runner game

*All experiments should be performed considering above list of games (any four)

Assessment:

Term Work: Will be based on Continuous Assessment

1. Laboratory work will be based on the syllabus with minimum 10 experiments.

   Experiments 20 marks

   Attendance   5 marks

2. Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCALE334	Ethical Hacking Lab	02	01	25	30	20	75

Pre-requisite: Basic understanding of fundamentals of any programming language

Lab Course Objectives: The Course aim to

Sr. No.	Course Objective
1	Study and understand how to gather and review information related using different foot printing techniques.
2	Study and understand network scanning, sniffing, and enumeration techniques, gather information using the different tools available and prevent hacking attacks.
3	Study different malware attacks, web servers, web applications and wireless network hacking, sql injection techniques, session hijacking and cryptography and use the tools to practically understand how the attacks take place.
4	Practically find and exploit vulnerabilities in a computer system using pen testing.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO1	Applying foot printing tools for information gathering issue.	Applying
CO 2	Applying tools for scanning networks, enumeration and sniffing.	Applying
CO 3	Applying tools for malware attacks, webserver and web applications, sql injection, session hijacking, wireless networking, cloud computing, cryptography.	Applying
CO 4	Developing malwares and attack tools	Creating
CO 5	Designing pen testing report.	Creating

Description:

Module No	Detailed Contents	Hrs
1	**Footprinting and Reconnaissance:** Performing footprinting using Google Hacking, website information, information about an archived website, to extract contents of a website, to trace any received email, to fetch DNS information.	02
2	**Scanning networks, Enumeration and sniffing:**	02

3	**Malware Threats: Worms, viruses, Trojans**: Use Password cracking, Dictionary attack., Encrypt and decrypt passwords, DoS attack, ARP poisoning in windows, Ifconfig, ping, netstat, traceroute, Steganography tools. **Self-Learning Topics:** using additional hacking tools.	06
4	**Developing and implementing malwares :** Creating a simple keylogger in python, creating a virus, creating a trojan. **Self-Learning Topics:** Additional implementation of hacking tools.	06
5	**Hacking web servers, web applications:** Hacking a website by Remote File Inclusion, Disguise as Google Bot to view hidden content of a website, to use Kaspersky for Lifetime without Patch	02
6	**sql injection and Session hijacking** : SQL injection for website hacking, session hijacking. **Self Learning Topics:** using additional of hacking tools.	02
7	**Wireless network hacking, cloud computing security, cryptography :** Using Cryptool to encrypt and decrypt password, implement encryption and decryption using Ceaser Cipher. **Self-Learning Topics:** implementing additional encryption algorithms.	04
8	**Pen testing** : Penetration Testing using Metasploit and metasploitable,	02

(top of page, first row cut off: "Use port scanning. network scanning tools, IDS tool, sniffing tool and generate reports.")

Reference Books:

Reference No	Reference Name
1	Matt Walker, All-In-One-CEH-Certified-Ethical-Hacker-Exam-Guide.
2	Manthan Desai, Basics of ethical hacking for beginners
3	SunitBelapure& Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives.
4	Alana Maurushat, Ethical hacking
5	TutorialsPoint professionals, Ethical Hacking.

Web References:

Reference No	Reference Name
1	https://www.tutorialspoint.com/ethical_hacking/ethical_hacking_arp_poisoning.htm
2	https://technicalustad.com/steganography-tools/
3	https://resources.infosecinstitute.com/dos-attacks-free-dos-attacking-tools/#gref
4	https://www.greycampus.com/opencampus/ethical-hacking/enumeration-and-its-types
5	https://www.youtube.com/watch?v=LUGkIvcQmGE
6	https://www.youtube.com/watch?v=zWg7U0OEAoE

Suggested list of experiments

Practical No	Problem Statement
1	Use software tools/commands to perform footprinting /information gathering and generate analysis report.
2	Use software tools/commands to perform network scanning and sniffing and generate analysis report.
3	Use software tools/commands to perform malware attacks and other cyber attacks and generate analysis report.
4	Implementation of keyloggers, viruses and trojans.
5	Use of software tools/commands for web servers and web applications hacking and generate analysis report.
6	Use of software tools/commands for performing sql injection and session hijacking and generate analysis report.
7	Use of software tools/commands to encrypt and decrypt password, implement encryption and decryption using Ceaser Cipher.
8	Using Metasploit and metasploitable for penetration testing.

Assessment:

Term Work: Will be based on Continuous Assessment

Laboratory work will be based on the syllabus with minimum 10 experiments.

Experiments   20 marks

Attendance   5 marks

Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCALE335	Quantum Computing Lab	2	1	25	30	20	75

Pre-requisite: Basic understanding of fundamentals of JavaScript

Lab Course Objectives : The Course aim to

Sr. No.	Course Objective
1	Learn the basics of Quantum Logic gates
2	Demonstrate the use of quantum arithmetic
3	Implement the model of quantum computation
4	Use QC-Engine to implement basic quantum algorithms.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO 1	Understand the various Quantum Logic gates	Understanding
CO 2	Design QC programs using quantum arithmetic	Applying
CO 3	Develop QC applications based on the quantum computing model	Applying
CO 4	Compare basic quantum computing algorithms	Evaluating

Description:

Module No	Detailed Contents	Hrs
1	**QC Engine** : Introduction to the QC Engine, Installation, Writing QC Engine Code *Self-Learning Topics: Practice QC Engine Code*	2 hrs
2	**One Qubit** : QPU Instructions: NOT, HAD, READ, WRITE, ROOT-of-NOT; Random bit, Combining QPU Operations *Self-Learning Topics: Quantum Spy Hunter*	6 hrs
3	**Multiple Qubits** : Reading a Qubit in a Multi-Qubit Register, Visualizing Larger Number of Qubits, QPU Instruction: CNOT, CPHASE, SWAP, CSWAP *Self-Learning Topics: Conditional Operation*	6 hrs
4	**Quantum Teleportation** : Create an entangled pair, Prepare the payload, Link payload and entangled pair, Put the payload into superposition, READ both Qubits, Receive and Transform, Verify the result *Self-Learning Topics: How is teleportation actually used?*	4 hrs
5	**Quantum Arithmetic & Logic** : QPU Arithmetic: How to build Increment & Decrement operators, Adding Two Quantum Integers; More Complicated Math: Quantum Conditional Execution. *Self-Learning Topics: Logical Operators*	6 hrs
6	**Quantum Application – Real Data** : Represent complicated data types in a QPU register, Encode non-integer numerical data in a QPU register, QRAM *Self-Learning Topics: Vector Encodings*	2 hrs

Reference Books:

Reference No	Reference Name
1	Kaye P, Laflamme R, Mosca M. An introduction to quantum computing. Oxford university press; 2007. ISBN No. 0198570007
2	Johnson, Eric R., NicHarrigan, and Mercedes Gimeno-Segovia. Programming Quantum Computers: Essential Algorithms and Code Samples. O'Reilly; 2019. ISBN No. 1492039683
3	Nielsen MA, Chuang I. Quantum computation and quantum information. Cambridge University Press; 2012. ISBN No. 9780511976667
4	Silva V. Practical Quantum Computing for Developers. Apress; 2018. ISBN No. 9781484242179
5	Rieffel EG, Polak WH. Quantum computing: A gentle introduction. MIT Press; 2011. ISBN No. 9780262526678
6	Aaronson S. Quantum computing since Democritus. Cambridge University Press; 2013. ISBN No. 9780521199568

Web References:

Reference No	Reference Name
1	https://cra.org/ccc/wp-content/uploads/sites/2/2018/11/Next-Steps-in-Quantum-Computing.pdf
2	https://www.ibm.com/quantum-computing/
3	https://eandt.theiet.org/content/articles/2019/04/quantum-for-dummies-the-basics-explained/
4	https://www.cl.cam.ac.uk/teaching/1718/QuantComp/
5	https://nptel.ac.in/courses/104104082/

Suggested list of experiments

Practical No	Problem Statement
1	Programming with One Qubit: Random bit, Random byte
2	Programming with One Qubit: Root-of-not, Quantum Spy Hunter
3	Programming with Multiple Qubits: Separable qubits, Entangled qubits
4	Programming with Multiple Qubits: Phase Kickback, Swap Test
5	Basic Teleportation
6	Quantum Arithmetic and Logic Programming: Increment & Decrement, Adding Two Quantum Integers
7	Quantum Arithmetic and Logic Programming: Add Squared, Quantum Conditional Execution.
8	Quantum Applications: Programs on QRAM

Assessment:

Term Work: Will be based on Continuous Assessment
    1. Laboratory work will be based on the syllabus with minimum 10 experiments.

                Experiments   20 marks
                Attendance   5 marks

    2. Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL34	Mobile Computing Lab	04	02	50	30	20	100

Pre-requisite: Basic understanding on java programming and xml

Lab Course Objectives: Course aim to

Sr.No	Course Objective
1	Understand the Application development skills of Android and its Components.
2	Learn various Android application with different layouts and rich user interactive interfaces.
3	Develop Android application related to server-less database like SQLITE
4	Impart a thorough understanding of Dart and Flutter Programming

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate their understanding of the fundamental details of android and its components	Understanding
CO 2	Implement various android applications using different layouts & rich user interactive interfaces	Applying
CO 3	Demonstrate their skills of using SQLite database for android application database	Applying
CO 4	Demonstrate their ability to develop programs with dart programming and flutter	Applying

Description:

Module No.	Detailed Contents	Hours
1	**Module:** Introduction to Android and it's components Creating an android application Creating the activity, Design user interface with Views, Working with intents, fragments, services and different types of layouts components. Displaying picture and menus using views. **Self-Learning Topics:** The android platform, the layers of android, Four kinds of android components, understanding the androidManifest.xml file	06
2	**Module:** Basic Controls and UI Components Text view, Radio button, Checkbox, Image Button, Edit Text, Slider and other controls **Self-Learning Topics:** Methods of all control clas	04
3	**Module:** Data base Connectivity Persistence data using the file system (external, internal, SD card), working with shared preferences, Working with content providers, CRUD operation using SQLite	08

	database connection. **Self-Learning Topics:** Interface of Database	
4	**Module:** Graphics and animation, Multimedia Drawing graphics in android, creating animations with androids graphics API, Playing audio & video. **Self-Learning Topics:** Capturing media and photos, SMS and E-Mail messaging	06
5	**Module:** Location Based Services Display Maps, Getting location data, Monitoring a Location, Building location tracker. **Self-Learning Topics:** Difference between geocoding and reverse geocoding	04
6	**Module:** REST API integration Consuming Web services using HTTP (htttpurlconnection), Consuming using JSON services usingasynctask to perform network operations, Socket Programming, working with okhttp, Retrofit and Volley, publishing Android application on Google play store. **Self-Learning Topics:**Classes used for dealing with JSON messages and for performing background asynchronous tasks.	08
7	**Module:** Introduction to Dart and Flutter Introduction to structure of Dart Language, oops concept and classes & packages in Dart Programming, Introduction to Flutter, Flutter User Interface using widgets, Types of Widgets, Flutter List , Navigation, Effects, Building Layout. **Self-Learning Topics:** Deployment of android application on the play store	08
8	**Module:** Data Handling Understanding JSON Format, Using Database classes to write, read and serialize JSON, Flutter Form, Styling and Managing Widgets. **Self-Learning Topics:** Database connective details	06
9	**Module:** Case Study on IOS app Development Introduction swift programming concept, objective c. **Self-Learning Topics:** Some Idea of IOS	02

Reference Books:

Reference No	Reference Name
1	Wei-Meng Lee ,BEGINNING Android™ 4 Application Development , John Wiley & Sons Crosspoint Boulevard Indianapolis ,ISBN: 978-1-118-24067-0
2	Reto Meier, Professional Android™ Application Development ,Wiley Publishing, ISBN: 978-0-470-56552-0,www.wiley.com
3	ZigurdMednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura, Programming Android , Gravenstein Highway North, Sebastopol, CA 95472.ISBN=9781449316648
4	W. Frank Ableson, RobiSen, Chris King, C. Enrique Ortiz, Dreamtech Press Android in action, Third Edition, ISBN 9781617290503
5	Alessandro Biessek Flutter for Beginners: An Introductory Guide to Building Cross-platform Mobile Applications with Flutter and Dart 2 Packt Publishing Ltd. ISBN. 9781788990523

6	Marco L. Napoli Beginning Flutter: A Hands On Guide to App Development John Wiley &Sons,ISBN:- 1119550823, 9781119550822
7	Rap Payne Beginning App Development with Flutter: Create Cross-Platform Mobile Apps Apress, ISBN 978-1-4842-5181-2

Web References:

Reference No	Reference Name
1	https://android.google.com
2	https://codelabs.developers.google.com/codelabs/first-flutter-app-pt1/#0
3	https://flutter.dev/docs/reference/tutorials https://flutter.dev/docs/get-started/learn-more
4	https://opensourceforu.com/?s=Flutter
5	https://developer.apple.com/library/archive/referencelibrary/GettingStarted/DevelopiOSAppsSwift/
6	https://developer.apple.com/ios/
7	https://www.apple.com/in/ios/ios-13/

Suggested list of experiments

Practical No	Problem Statement
1	Android program using various UI components
2	Android program using different layouts and views
3	Android program based on Intents
4	Android program for notifications and alert box
5	Android program to perform CRUD operation using SQLite DB
6	Android program using Shared Preferences, Internal and External Storage
7	Android program to work with graphics and animation
8	Android program to work with google maps and locations
9	Android program to work with images and videos
10	Android program based on RestAPI
11	Flutter program using layout widgets and state management
12	Flutter program to work with SQLite Database
13	Flutter program based on RestAPI

Assessment:

Term Work: Will be based on Continuous Assessment

1.   Laboratory work will be based on the syllabus with minimum 10 experiments.
        Experiments 40 marks
        Attendance   10 marks
2.   Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL35	**Software Testing & Quality Assurance Lab**	**02**	**01**	25	30	20	75

Pre-requisite: Core Java, Web Technologies like HTML, CSS, XML, XPATH, DOM and JavaScript.

Lab Course Objectives: The Course aim to

Sr.No.	Course Objective
1	Understand the basic concepts in Software Testing.
2	Understand the essential characteristics, requirements and usage of Automation tool like Selenium Web Driver.
3	Understand Test Ng and automation framework basics.
4	Understand the basic concepts of software quality assurance.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Apply manual software testing techniques to test a software application	Applying
CO 2	Implement Selenium tool to perform automation testing.	Applying
CO 3	Implement TestNg frameworks to test the application.	Applying
CO 4	Demonstrate validation checks and regression testing on the application.	Applying

Description:

Module	Detailed Contents	Hrs
1	**Testing Basics** : Study of Review, Construction of Control Flow Graph & Writing Test Cases with case studies. Unit Testing, Integration Testing & System Testing.	4

	Self Learning Topics: Requirement analysis and derive test scenarios Review of Project Document, Case Study.	
2	**Introduction to Selenium :** Introduction to automation Testing, Selenium latest version, Installation, Selenium WebDriver First Script. **Self Learning Topics:** Record and run a test case in Selenium IDE	2
3	**Selenium Web Driver Commands :** Implementing Web Drivers on Multiple Browser (chrome, Firefox),handling multiple frames Browser command, navigation Commands and find element command with Example. Locator (id, css selector, Xpath), synchronization in selenium, Handling Alerts using selenium web driver, types of alerts. Action Classes in selenium , Handling Drop Down, List Boxes, Command Button, radio buttons & text boxes. Waits command in selenium. **Self Learning Topics:** Implementation of web driver on safari	8
4	**TestNg Framework** : What is testNg? Installing Testng, TestNg Test, writing test cases using testNg, testNg annotation, Testing .xml **Self Learning Topics:** Parameters and dependencies from xml	6
5	**Automation Framework Basics** : Introduction to basic types, linear scripting, library architecture framework, data driven Framework. **Self Learning Topics:** Keyword Driven Framework	4
6	**Quality Assurance** : Introduction to software quality assurance, Validation checks and Regression Testing **Self Learning Topics:** Audits, ISO, QMSCase study	2

Reference Books:

Reference No	Reference Name
1	Software Testing Foundations, 4th Edition: A Study Guide for the Certified Tester Exam (Rocky Nook Computing) Fourth Edition,Andreas Spillner, Tilo Linz and Hans Schaefer.
2	Selenium WebDriver, Pearson, Rajeev Gupta, ISBN 9789332526297.
3	Selenium WebDriver Practical Guide - Automated Testing for Web Applications Kindle Edition ,SatyaAvasarala ,ISBN-13: 978-1782168850
4	Testng Beginner's Guide, Packt Publishing Ltd.VarunMenon, ISBN 1782166017, 9781782166016

Web References:

Reference No	Reference Name
1	https://www.toolsqa.com/selenium-tutorial/
2	https://www.guru99.com/selenium-tutorial.html
3	https://www.techlistic.com/p/selenium-tutorials.html

Suggested list of experiments

Practical No	Problem Statement
1	Take a review and write test cases for any known application.
2	Implement Web Drivers on Chrome & Firefox Browsers.
3	Demonstrate handling multiple frames in selenium
4	Implement Browser command and navigation Commands.
5	Implement the find element command
6	Demonstrate the Locator(id,css selector, path)
7	Demonstrate synchronization in selenium
8	Demonstrate different types of alerts
9	Demonstrate : ☐ Handling Drop Down, ☐ List Boxes
10	Demonstrate ☐ Command Button, ☐ Radio buttons & text boxes. ☐ Waits command in selenium
11	Demonstrate action classes in Selenium
12	Installation of TestNg , running testNg and TestNg annotations
13	Demonstrate data driven Framework.
14	Demonstrate Validation testing
15	Perform regression testing

Note: At least 12-14 programs

Assessment:

Term Work: Will be based on Continuous Assessment

1.   Laboratory work will be based on the syllabus with minimum 10 experiments.

Experiments   20 marks

Attendance   5 marks

2.   Practical will be evaluated by the subject teacher and documented according to a rubric

End Semester Practical Examination:

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Pract.	Oral	Total
MCAP31	Mini Project – 2 A	02	01	50	-	--	50

Pre-requisite:

Lab Course Objectives: The course is aim to

Sr. No.	Course Objective
1	Acquaint with the process of identifying the needs and converting it into the problem.
2	Adapt to a rapidly changing environment by having learned and applied new skills, new technologies and provide solutions to the problems in various application domains.
3	Conceptualize knowledge with emphasis on team work, effective communication, critical thinking and problem solving skills.
4	Inculcate the process of innovation, self-learning and research.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Demonstrate the ability to produce a technical document.	Understanding
CO2	Identify problems based on environmental, societal & research needs.	Applying
CO3	Apply Knowledge and skills to analyze and interpret data by applying appropriate research methods to solve societal problems in a group.	Applying
CO4	Design and evaluate solutions for complex problems.	Creating
CO5	Build small groups to work effectively in team on medium scale computing projects.	Creating
CO6	Create value addition for the betterment of the individual and society	Creating

Guidelines for Mini Project:

1. Students shall form a group of 2 to 3 students.
2. Students should do survey and identify needs, which shall be converted into problems in consultation with the faculty Supervisor/Guide/HOD/Internal Committee of faculties. The project contact hours shall be allotted in the time table and 2 hours workload shall be considered for the guide/ supervisor.
3. Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4. A log book to be prepared by each group, wherein the group can record weekly work progress, Guide/Supervisor can verify and record notes/comments.
5. Faculty may give inputs during mini project activity; however, focus shall be on self-learning.
6. Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with Guide/ Supervisor.
7. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8. The solution to be validated with proper justification and project report to be compiled in standard format of University of Mumbai.

Assessment of Mini Project:

I) Term work (25 Marks):
☐ The progress of the mini project to be evaluated on a continuous basis.
☐ In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
☐ Distribution of Term work marks shall be as below;
  o Marks awarded by guide/supervisor based on log book   : 10
  o Self contribution and use of skill set in project   : 10
  o Quality of Project report   : 05

II) Mini Project Internal Examination (25 Marks):
☐ Report should be prepared as per the guidelines issued by the University of Mumbai.
☐ The students shall present a seminar on Mini project and demonstrate their understanding of need/problem.
☐ Mini Project shall be evaluated through a presentation and demonstration of working model by the student project group to a panel of examiner at Institute level.
☐ Mini Project shall be assessed based on following points:
- Quality of survey/ need identification.
- Clarity of Problem definition based on need.
- Innovativeness in solutions.
- Feasibility of proposed problem solutions and selection of best solution.
- Cost effectiveness.
- Societal impact.
- Full functioning of working model as per stated requirements.
- Effective use of skill sets.
- Contribution of an individual as a member or leader.
- Clarity in written and oral communication.

Semester IV

Program Structure for
Second Year Master of Computer Applications
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MCAI41	Internship	--	40	--	15	15
MCAR42	Research Paper	1	--	1	--	1
MCAM43	Online Course- (MOOC)	4#	--	4	--	4!
MCAS44	Institute Social Responsibility*	--	--	--	--	2*
Total		**5**	**40**	**5**	**15**	**20+2***

Course Code	Course Name	Examination Scheme			
		Internal Assessment		University Assessment	
		Mid term Presentation I	Mid term Presentation II	Final Presentation	Total
MCAI41	Internship	25	25	200	250
MCAR42	Research Paper	25	25	--	50
Total		**50**	**50**	**200**	**300**

Work load only for students

! Credits transferred from MOOC courses

* Credits allotted in semester IV based on the (ISR) work done in semesters I II III

Note:

- The Online Course- 1 (MOOC) has to be completed before the completion of the MCA course (it can be done in the Semester 1 to 4 but to be accounted in semester 4).
- Maximum one workload for faculty members for Research paper to be considered.
- Maximum two workload for faculty members for Internship projects to be considered.

Course Code	Course Name	Group	Contact Hours	Credits Assigned	
				Presentation	Total
			40	15	15

MCAI41	Internship	P	Examination Scheme			
			Internal Assessment		University Assessment	Total
			Presentation I	Presentation II	End Sem. Final Presentation	
			25	25	200	250

Pre-requisite: Software Project Management, Database Management, Software Development Technologies/Programming Languages, Software tools.

Course Objectives: The course aim to

Sr. No.	Course Objective
01	Prepare students to excel in computer applications to succeed in industry/ technical professions.
02	Train students with good computing breadth so as to comprehend, analyze, design and create computing solutions for the real life problems.
03	Learn professional skills and international relationships in a professional environment.
04	Design a system, component or process as per needs and specification of the clients.

Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Demonstrate skills to use modern tools, software and equipment to analyze problems.	Understanding
CO2	Develop an exposure to real life organizational and environmental situations.	Analyzing
CO3	Apply SDLC phases in developing software projects and in writing the project document.	Applying
CO4	Create computing solutions for the real life problems as per the requirements of the domain.	Creating
CO5	Adapt professional and interpersonal ethics.	Creating

Assessment:

Internal Assessment Test: 50 marks

Internal Assessment consists of two presentations of 25 marks each.
The final marks should be the sum of the two presentations.

Rubrics have to be followed during project evaluation.

Course Code	Course Name	Assessment (University/ Institute)	Teaching Scheme (Contact Hours)	Credits Assigned	
			Presentation	Presentation	Total
			01	01	01

Course Code	Course Name	Assessment (University/ Institute)	Examination Scheme		
			Internal Assessment		Total
MCAR42	Research Paper	Institute	Mid term Presentation I	Mid term Presentation II	
			25	25	50

Pre-requisite: Nil

Course Objectives: The course is aimed to

Sr. No.	Course Objective
01	Understand analytic approach towards choosing a research paper and acquiring research skills.
02	Access relevant data and present new ideas related to area of research.
03	Adhere to ethical standard of research.
04	Understand what constitutes plagiarism and how to use proper citation styles.

Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Show data coherently, effectively and counter-hypothesis.	Understanding
CO2	Apply experience in preparation of research material for publication or presentation.	Applying
CO3	Identify relevant previous work that supports their research.	Applying
CO4	Analyze data and synthesize research findings.	Analyzing
CO5	Create research paper.	Creating

Following are the guidelines for Research Paper, MCA Sem.- IV:

- A Student shall do a in depth study in the specialized area by doing a survey of published technical literature and write a research paper in IEEE format (6-9 pages or 2000 to 3000 words) during second year (final year) of MCA program.

- The research topic must be approved from the Institute. The institute should set up a committee/Supervisor/Research Guide to scrutinize the topics and finalize the same
- The research paper may be written in a group of maximum 2 students under the guidance of Supervisor/Research Guide.
- The research paper must be published/presented in national/international conference or national/ international journal.

The paper structure should follow the IEEE format:
The following points are to be included in the Research Paper presentation:
1. Introduction
2. Literature Review
3. Problem Definition
4. Objective/Scope
5. Research Methodology
6. Analysis & Findings
7. Limitations & Future Scope
8. Conclusion

Reference:
1. James D. Lester , Writing Research Papers: A Complete Guide (10th Edition).
2. How to Write a Great Research Paper, Book Builders, Beverly Chin, July 2004, Jossey-Bass.
3. Kothari C. R. (2004), "Research Methodology, Methods and techniques" (2nd edition), New Delhi: New age International (p) Ltd.

Web References:
1. https://www.ieee.org/publications_standards/publications/authors/author_guide_interactive.pdf
2. http://www.fcsresearch.org/index.php?option=com_content&view=article&id=83&Itemid=166
3. https://www.ece.ucsb.edu/~parhami/rsrch_paper_gdlns.htm
4. http://nob.cs.ucdavis.edu/classes/ecs015-2007-02/paper/citations.html

Assessment:
Internal Assessment: 50 marks

Internal Assessment consists of two presentations of 25 marks each.

The marks distribution of two presentations is as given below:

Presentation I (Mid Term)	Marks	Presentation II (Mid Term)	Marks
Abstract, Introduction	05	Research Methodology	05
Literature Review	05	Analysis, Findings & Conclusion	10
Objectives/Scope	10	Publication	05
Presentation	05	Presentation	05
Total	**25**	**Total**	**25**

These two presentations should be taken at Institute level by Committee/Supervisor/Research Guide.

Rubrics have to be followed during research paper evaluation.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MCAM43	Online Course-MOOC	4#	--	4	--	4!

Online Course- MOOC:

1. **Credits (4):**
   a. MOOC may be taken in any of semesters 1-4 but accounted for in semester 4 only.
2. **What may be credited as MOOC:**
   a. MOOC credits: Swayam, NPTEL, Smart Indian Hackathon, e-Yantra Competitions/MOOC
   b. Evaluation options:
      i. Grade (A-F) given by MOOC provider
      ii. Competition grade + college evaluation (if training FDP available)
   c. Evaluation basis:
      i. Smart India Hackathon - Only finalists get a grade based on evaluation by a college pane.
      ii. Swayam: as per Swayam evaluation guidelines
      Note: All Swayam courses are not 4 credits. For credits less than 4, e-Yantra mini competition can be combined with those courses to fulfill required credits.
      iii. e-Yantra: as per e-Yantra competition (optional/"opt-in") grade
   d. Other options may be added basis our experience with these options

For information:

e-Yantra offers MOOCs that can make a grade available upon request - this is an additional certificate over and above the usual "Merit," "Completion" and "Participation" certificates e-Yantra gives. Similarly the competition may be seen as a MOOC + project with a grade certificate as an extra.

- **Software Foundation Lab (MOOC 1 & 2)**

  - Equips students with skills to be a strong developer and researcher.
  - Includes Linux skills, Shell scripting, Latex, Python (extensive), AWK, Lex, SED (Stream editors), etc.
  - Mode: Hands-on assignments auto-evaluated by Gradefast - a system developed at IITB. Scalable and tested extensively and at scale in the e-Yantra competition.
  - MCQs for self-assessment after each module.
  - Optional mini-project at end.
  - e-Yantra can give grade for course
  - Basis merit and overall performance, student eligible for e-Yantra Internship Program.
- **Embedded Systems and Robotics Course**
  - Teaches principles of microcontrollers as an 8 week hands-on crash course.
  - Optional simulators give the same feel with skills directly translatable into real hardware.
- **Others:**
  - Image Processing and Computer Vision (IPCV), Internet of Things (IoT), Machine learning and Neural Network, 3D modeling & design using Blender, V-REP (simulator), Robotic Operating System (ROS), Control System design, etc.
  - These have successfully been deployed in training for e-Yantra Robotics Competition (eYRC) themes.

○ Strong hands-on component in each case with the project.

Course Code	Course Name	Contact Hours	Credits Assigned
MCAS44	Institute Social Responsibility (ISR)	30 hours in the span of two years	02

Course Objective: The course is aimed to inculcate social awareness, values and environmentally responsible behavior among students.

Course Outcome: Learner/student will be able to create awareness among individuals towards institutional & individual social responsibility for societal development.

About Institute Social Responsibility (ISR) :

Institute Social Responsibility (ISR) refers to the continuous commitment by institutions to conduct them in an ethical manner and contribute towards the socioeconomic development of the society at large.

Social responsibility is an ethical theory, in which individuals are accountable for fulfilling their civic duty; the actions of an individual must benefit the whole of society. Social responsibility is a duty every individual has to perform so as to maintain a balance between economic growth and the welfare of society and the environment.

Social responsibility means sustaining the equilibrium between the two. It pertains not only to organizations but also to everyone whose action impacts the environment. This responsibility can be passive, by avoiding engaging in socially harmful acts, or active, by performing activities that directly advance social goals. As individuals we can make our small contributions to society by doing social activities, individual or in association with Institute/Social organizations/NGOs/Clubs etc.

Guidelines for ISR Activity:
- A teacher can be given responsibility as ISR coordinator, relaxation of 1 hour load can be given to the teacher.
- ISR coordinator is responsible to maintain the records of ISR activities and the students participating in the activity.
- Students shall participate in Social work activities individually or in association/collaboration with Institute/ Social organizations/NGOs/Clubs etc. with prior permission of ISR coordinator
- A Student shall complete at least 30 hours Social activities under the guidance of ISR Coordinator/HOD/Principal/Director between MCA Semester 1 to Semester 4 (preferably between semester 1 to semester 3).
- Certificate of Participation given by concern Institute/NGO/Social organization/Private or Government organization/Club etc shall be verified by ISR coordinator.
- 2 credits will be awarded on the completion of 30 hours ISR work which is certified by ISR coordinator.

Suggestive list of Activities for social concern among students but not limited to:

- Computer Literacy Programs for ZP School Students/ Villagers/ Farmers etc.
- Donation of used books.
- Visits and Help to Orphanage/Old homage.
- Public Awareness Programs for Health, Road Safety, Organ Donation, Global Warming, Plastic Eradication , Aids/Cancer/Corona Awareness
- River/Beach Cleanliness Drive.
- Voter Registration Drive.
- Blood Donation Camps.
- Disaster Management Program.
- Swachha Bharat Abhiyan.
- E Waste Collection and Disposal.
- Tree Plantation Drives.
- Anti Addiction Program.
- Yoga, Meditation, Self Defense Programs for Children.
- Programs for Physically Challenged People.

Program Structure for
Bridge Course - Master in Computer Applications
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Course Code	Course Name	Group	Teaching Scheme (Contact Hours)			Credits Assigned			
			Theory	Pract.	Tut.	Theory	Pract.	Tut	Total
MCABR1	Programming with C++	ICT	3	--	--	--	--	--	--
MCABR2	Data Structures	ICT	3	--	--	--	--	--	--
MCABR3	Operating Systems	ICT	3	--	--	--	--	--	--
MCABR4	Computer Networks	ICT	3	--	--	--	--	--	--
MCABR5	Discrete Mathematics	M	3	--	--	--	--	--	--
	Total		15		-	-	-	-	-

Course Code	Course Name	Group	Examination Scheme							
			Theory					Pract		
			Internal Assessment			End Sem.	Exam. Duration	Pract	Oral	Total
			CA	Test	Avg.		In Hrs			
MCABR1	Programming with C++	ICT	20	20	20	80	3	--	--	100
MCABR2	Data Structures	ICT	20	20	20	80	3	--	--	100
MCABR3	Operating Systems	ICT	20	20	20	80	3	--	--	100
MCABR4	Computer Networks	ICT	20	20	20	80	3	--	--	100
MCABR5	Discrete Mathematics	M	20	20	20	80	3	--	--	100
	Total									500

Course	Course Name	Teaching Scheme			Credits Assigned			
		Contact Hours						
		Theory	Pract	Tut	Theory	Practical	Tut.	Total
		03	--	--	--	--	--	--
MCABR1	Programming with C++	Examination Scheme						
		Theory			End Sem Exam	Term Work	Practical	Oral	Total
		CA	Test	AVG					
		20	20	20	80	--	--	--	100

Pre-requisite: Nil

Course Outcomes:

Sr. No.	Course Outcome	Bloom Level
CO1	Comprehend Object oriented programming concepts and their application	Remembering
CO2	To write applications using C++.	Understanding
CO3	Implement programming concepts to solve bigger problems	Evaluating

Module	Detailed Contents	Hrs
01	Module: Programming Basics& Introduction to C++: • Introduction to Programming, Programming Paradigms, • Programming Languages and Types. • Introduction to Object Oriented Programming- OOP concepts,Advantages, Applications • Control Structures, Operators and Expressions • Structure of a C++ program, Execution flow, Classes and Objects, Access modifiers, Data Members, Member Functions, • Inline Functions, Passing parameters to a Function(pass by Value, Pass by Address, Pass by Reference), Function with default arguments, Function Overloading, Object as a Parameter, Returning Object • Static data members and functions, Constant Data members and functions • Constructors- Default, Parameterized, Copy, Constructor Overloading, Destructors • Arrays, Array as a Class Member, Array of Objects, Strings- Cstyle strings and String Class	08

	Module: Operator Overloading and Pointers:	
02	- Operator Functions-Member and Non Member Functions, - Friend Functions Overloading Unary operators Overloading binary operators(Arithmetic, Relational, Arithmetic Assignment, equality), Overloading Subscript operator - Type Conversion Operators- primitive to Object, Object to primitive, Object to Object Pointer and Address of Operator, Pointer to an Array and Array of Pointers, Pointer arithmetic, Pointer to a Constant and Constant Pointer, Pointer Initialization, Types of Pointers(void, null and dangling), Dynamic Memory Allocation, Advantages and Applications of pointers	08
03	Module: Inheritance and Polymorphism - Inheritance Concept, Protected modifier, Derivation of Inheritance- Public, Private and Protected, Types of Inheritance-Simple, Multilevel, Hierarchical, Multiple, Hybrid - Constructors and Inheritance, Function Overriding and Member hiding - Multiple Inheritance, Multipath inheritance – Ambiguities and solutions - Polymorphism, Static and Dynamic Binding, Virtual Functions, Pure Virtual Functions, Virtual destructors, - Abstract Classes, Interfaces	08
04	Module: Streams and Exceptions - Files, Text and Binary Files, Stream Classes, File IO using Stream classes, File pointers, Error Streams, Random File - Access, Manipulators, Overloading Insertion and extraction operators - Error handling, Exceptions, Throwing and catchingexceptions, Custom Exceptions, Built in exceptions	08

Reference Books:

Reference No	Reference Name
1	The Complete Reference C, 4th EditionHerbertSehlidt,TataMcgraw Hill
2	Object Oriented Programming in C++,4th Edition,RobertLafore,SAMSTechmedia
3	The Complete Reference-C++,4th Edition. Herbert Schildt,Tata McGraw-Hill
4	The C++ Programming Language, 4th edition,BjarneStroustrup,AddisonWesly

Web References:

Reference No.	Reference Name
1	https://dev.mysql.com
2	www.github.com

Course	Course Name	Teaching Scheme			Credits Assigned			
MCABR2	**Data Structures**	Contact Hours			Theory	Practical	Tut.	Total
		Theory	Pract	Tut				
		03	--	--	--	--	--	--
		Examination Scheme						
		Theory			End Sem Exam	Term Work	Practical	Oral	Total
		CA	Test	AVG					
		20	20	20	80	--	--	--	100

Pre-requisite: Nil

Course Outcomes:

Sr. No.	Course Outcome	Bloom Level
CO1	Effectively choose the data structure that efficiently model the information in a Problem	Remembering
CO2	Describe how Linear data structures are represented in memory and used by algorithms and their applications	Understanding
CO3	Identify the benefits of Non-linear Data Structures and their applications	Understanding

Module	Detailed Contents	Hrs
01	Introduction toData Structures& Algorithms: • Introduction of Data structures, Abstract Data Types, • Performance Analysis: Space Complexity, Time Complexity, • Asymptotic Notations (Big O, Omega, Theta), Performance • measurement, Divide and Conquer, Back Tracking Method, • Dynamic programming	05
02	Sorting andsearchingalgorithms: • Bubble sort, Insertion sort, Radix Sort, Selection sort, shell Sort, • Linear Search, Sequentialsearch, Binary search	05
03	Hashing • Different Hashing Techniques, Address calculationTechniques, • Common hashing functions, • Collision resolutiontechniques: Linear probe, Quadratic probe, Key offset. • Rehashing, Double hashing, Link list addressing.	05
04	Linear DataStructures: • Stack Definition, Operations, Implementation of Stacks(Array and Linked list) • Queue: Definition, Operations, Implementation of simplequeue (Array and Linked list) • Types of queues: Circular • Types of Linked List: Singly, Doubly and Circular Linked listDefinition, Operations (Insert, delete, traverse, count, search)	10

	Non-linearData Structures:	
05	• Tree Definition and concepts, • General Tree • Binary Tree • Traversal of a binary tree, • Conversion of general tree into binary tree, • Huffman tree, Expression tree • Binary Search Tree- Definition, Operation, Implementation	10

Reference Books:

Reference No	Reference Name
1	Richard F Gilberg Behrouz A Forouzan , "Data Structure A Pseudocode Approach withC". Second edition
2	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introductionto ALGORITHMS", PHI, India Second Edition.
3	Shaum"s Outlines Data Structure Seymour Lipschutz TMH

Course	Course Name	Teaching Scheme			Credits Assigned			
MCABR3	**Operating System**	Contact Hours			Theory	Practical	Tut.	Total
		Theory	Pract	Tut				
		03	--	--	--	--	--	--
		Examination Scheme						
		Theory			End Sem Exam	Term Work	Practical	Oral	Total
		CA	Test	AVG					
		20	20	20	80	--	--	--	100

Pre-requisite: Nil

Course Outcomes:

Sr. No.	Course Outcome	Bloom Level
CO1	Classify different styles of operating system designs	Remembering
CO2	Analyze process management, I/O management, memory management functions of Operating System	Understanding
CO3	Employ process scheduling and disk scheduling algorithms	Understanding

Module	Detailed Contents	Hrs

	Introduction Operating System & Process and Thread Management:	
01	Introduction Operating System & Process and Thread Management: • Introduction to System Software & operating System • Overview of all system softwares: Compiler, Assembler, Linker, Loader, Operating system, OS services and Components, Types of OS-Batch, multiprocessing, multitasking, timesharing, Distributed OS ,Real time OS, virtual machines, • System Calls ,types of System calls, Buffering, Spooling • Process and Thread Management: - Concept of process and threads, Process states, Process management, Context switching, Interaction between processes and OS, • Multithreading, CPU scheduling algorithms, multiprocessor scheduling algorithms, • Real timescheduling algorithms	10
02	Concurrency Control: • Concurrency and Race Conditions, • Mutual exclusion requirements, Software and hardware solutions, • Semaphores, Monitors, Classical IPC problems and solutions, Deadlock, Characterization, Detection,Recovery, Avoidance and Prevention	10
03	Memory Management: • Memory Management: Memory partitioning, Swapping, • Paging, Segmentation, Virtual memory, Overlays, Demandpaging, Performance of Demand paging, • Virtual memory concepts, • Page replacement algorithms, Allocationalgorithms	04
04	Mass Storage Structure & File systems: • Mass Storage Structure: Secondary-Storage Structure, Disk structure, Disk scheduling, Disk management, • Swap-space management, Disk reliability, Stable storage implementation, • Introduction to clock, Clock hardware, Clock software • File concept, File support, Access methods, • Allocation methods, Directory systems, File protection, • Free space management	10
05	Protection & Security: • Protection- Goals of protection, • Domain of protection, Access matrix, Implementation of access matrix, Revocation of access rights • Security- The security problem, Authentication, One-Timepasswords, Threats	06

Reference Books:

Reference No	Reference Name
1	Operating System Concepts (9th Ed) by Silberschatz and Galvin, Wiley, 2000.

2	Operating Systems (5th Ed) – Internals and Design Principles by William Stallings, Prentice Hall, 2000.	
3	Modern Operating Systems by Andrew S Tanenbaum, Prentice Hall India, 1992.	
4	Operating Systems (3rd edition) by Gary Nutt, NabenduChaki, SarmishthaNeogy, Pearson	

Course	Course Name	Teaching Scheme			Credits Assigned			
MCABR4	**Computer Networks**	Contact Hours			Theory	Practical	Tut.	Total
		Theory	Pract	Tut	03	--	--	--
		03	--	--				
		Examination Scheme						
		Theory			End Sem Exam	Term Work	Practical	Oral	Total
		CA	Test	AVG					
		20	20	20	80	20	--	--	100

Pre-requisite: Nil

Course Outcomes:

Sr. No.	Course Outcome	Bloom Level
CO1	Comprehend the basic concepts of computer networks and data communication	Remembering
CO2	Analyze basic networking protocols and their use in network design	Understanding
CO3	Explore various advanced networking concepts.	Understanding
CO4	To explore basic networking models.	Understanding

Module	Detailed Contents	Hrs

01	Basics of Digital Communication: • Introduction to digital communication, • Signal propagation, Signal types, Signal parameters , Switching & forwarding, Transmission impairments, Attenuation, • Delay distortion, Noise, Effects of limited bandwidth, • Data rate limits-Nyquist"s theorem and Shannon"stheorem Network Organization and Models: • Basics of computer Network, topology & types of topologies, types of networks(LAN, MAN, WAN), • Concept of Intranet & Extranet, Ad-Hoc Networks, types of communications (Asynchronous and synchronous) , modes of communications (simplex, half duplex, full duplex), Protocols, • Networking models, ISO-OSI Reference Model, Design issues of the layer ,Internet Model (TCP/IP), • Comparison of ISO-OSI & TCP/IPModel	6
02	Networking Devices: Connectivity Devices : Passive & Active Hubs, Repeaters, Switches (2-Layer Switch, 3-Layer switch(Router), • Bridges (Transparent Bridges, Spanning Tree, Bridges, • Source Routing Bridges) , Brouters, Gateways Application, Presentation & Session Layer: • Principles of Application Layer Protocols, The Web and HTTP, FTP, Telnet, Electronic Mail in the Internet • (SMTP, MIME, POP3, IMAP), DNS, Introduction toSNMP.	06
03	Transport layer: • Transport-Layer Services, port addressing, • Multiplexing and Demultiplexing, • Principles of Reliable Data Transfer, • Congestion Control, TCP"s Congestion Control. • Quality of Service : Introduction, Queue Analysis, QoS Mechanisms, Queue management Algorithms, Feedback, • Resource, Reservation.	06
04	Network layer: • Network Service Model, Data gram & Virtual Circuit , • Routing Principles, The Internet Protocol,(ipv4 & ipv6) , • IP addressing and subnetting, Routing Algorithms., • Hierarchical Routing, Routing in the Internet: Intra andinter domain routing; Unicast Routing Protocols RIP, • OSPF, BGP, Multicast Routing Protocols : MOSPF,DVMRP. • ATM Networks: Need for ATM, ATM Layers, ATM adaptation Layers, IP over ATM, Multi protocol Labelswitching (MPLS), Drawbacks of traditional routingmethods, Idea of TE, TE and Different Traffic classes	10

05	Data LinkLayer: • Data Link Layer, Error Detection and CorrectionTechniques, • Multiple Access Protocols, LAN Addressesand ARP & RARP , PPP: The Point-to-Point Protocol , • Ethernet standards – IEEE 802.3, 802.5, FDDI, 802.6. Physical layer: • Physical Layer, • Types of media wired and wireless media	10

Reference Books:

Reference No	Reference Name
1	Computer Networking: A Top-Down Approach Featuring the Internet , J. F. Kurose andK. W. Ross, Seventh Edition, Addison-Wesley.
2	Computer Networks: Principles, Technologies and Protocols for Network design, N.Olifer and V. Olifer, Wiley India
3	Data Communication and Networking, B. A. Forouzan, Fourth Edition, McGraw Hill.
4	Computer Networks, Andrew Tenenbaum, Fifith Edition, PHI .

Course	Course Name	Teaching Scheme			Credits Assigned			
		Contact Hours						
		Theory	Pract	Tut	Theory	Practical	Tut.	Total
MCABR5	**Discrete Mathematics**	03	--	01	--	--	--	--
		Examination Scheme						
		Theory			End Sem Exam	Term Work	Practical	Oral	Total
		CA	Test	AVG				
		20	20	20	80	--	--	--	100

Pre-requisite: Nil

Course Outcomes:

Sr. No.	Course Outcome	Bloom Level
CO1	To Understand the fundamental ideas of Discrete Mathematics	Remembering
CO2	Develop mathematical and logical thinking	Understanding

Module	Detailed Contents	Hrs
01	Mathematicallogic: • Propositions and logical operations, Conditional Statements , • Methods of Proof , Mathematical Induction, • MathematicalStatements , • Logic and Problem Solving, Normal Forms Sets andRelations: • Set operations and functions, Product sets and partitions, • Relations and digraphs,	20

	• Paths in Relations and Digraphs, • Properties of Relations , Equivalence Relations, Operationson Relations, Partially Orders Sets, Hasse diagram		
02	Graphs: • Graph, Representation of Graph, Adjacency matrix, • Adjacency list, Euler paths and Circuits, Hamiltonian Pathsand Circuits	10	
03	Modeling usingdifferenceequation: • Recurrence relation - Fibonacci series, Tower of Hanoi • Lines in a plane Homogenous linear equations with constantcoefficients, • Particular Solution, Total Solution, Divide andConquer Recurrence Relations	10	

Reference Books:

Reference No	Reference Name
1	Discrete Mathematics and Its Applications 4th Edition , Kenneth H. Rosen, McGraw Hill
2	Discrete Mathematical structures 4th Edition, Kolman, Busby, Ross, PHI