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/ 𝟷𝟶 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)</u> from Academic Year 2020 – 21

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

Program Structure for
First Year Master of Computer Applications
UNIVERSITY OF MUMBAI (With Effect from 2020-2021)
Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MCA11	Mathematical Foundation for Computer Science 1	3	--	1	3	--	1	4
MCA12	Advanced Java	3	--	--	3		--	3
MCA13	Advanced Database Management System	3	--	--	3	--	--	3
MCA14	Software Project Management	3	--	1	3	--	1	4
MCAL11	Data Structure Lab using C and / C++	--	4	--	--	2	--	2
MCAL12	Advanced Java LAB	--	2	--	--	1	--	1
MCAL13	Advanced Database Management System LAB	--	2	--	--	1	--	1
MCAL14	Web Technologies	--	4	--	--	2	--	2
MCAP11	Mini Project – 1 A	--	2	--	--	1	--	1
	Total	12	14	2	12	07	2	21

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		CA	Test	Avg					
MCA11	Mathematical Foundation for Computer Science 1	20	20	20	80	3	25	--	125
MCA12	Advanced Java	20	20	20	80	3	--	--	100
MCA13	Advanced Database Management System	20	20	20	80	3	--	--	100
MCA14	Software Project Management	20	20	20	80	3	25	--	125
MCAL11	Data Structure Lab using C and / C++	--	--	--	--	--	50	50	100
MCAL12	Advanced Java LAB	--	--	--	--	--	25	50	75
MCAL13	Advanced Database Management System LAB	--	--	--	--	--	25	50	75
MCAL14	Web Technologies	--	--	--	--	--	50	50	100
MCAP11	Mini Project – 1 A	--	--	--	--	--	50	--	50
	Total	--	--	80	320	--	250	200	850

Program Structure for
First Year Master of Computer Applications
UNIVERSITY OF MUMBAI (With Effect from 2020-2021)

Semester II

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MCA21	Mathematical Foundation for Computer Science 2	3	--	1	3	--	1	4
MCA22	Artificial Intelligence and Machine Learning	3	--	--	3	--	--	3
MCA23	Information Security	3	--	--	3	--	--	3
MCAE24	Elective - 1	3	--	--	3	--	--	3
MCAE25	Elective - 2	3	--	1	3	--	1	4
MCAL21	Artificial Intelligence and Machine Learning Lab	--	2	--	--	1	--	1
MCAL22	Soft Skill Development Lab	--	2	--	--	1	--	1
MCALE23	Elective 1 Lab	--	2	--	--	1	--	1
MCAL24	Skill based Lab Course AWT Lab	--	4	--	--	2	--	2
MCAL25	Skill based Lab Course User Interface Lab	--	2	--	--	1	--	1
MCAL26	Skill based Lab Course Networking with Linux Lab	--	2	--	--	1	--	1
MCAP21	Mini Project 1-B	--	2	--	--	1	--	1
Total		**15**	**16**	**2**	**15**	**8**	**2**	**25**

Program Structure for
First Year Master of Computer Applications
UNIVERSITY OF MUMBAI (With Effect from 2020-2021)

Semester II

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.					
MCA21	Mathematical Foundation for Computer Science 2	20	20	20	80	3	25	--	125
MCA22	Artificial Intelligence and Machine Learning	20	20	20	80	3	--	--	100
MCA23	Information Security	20	20	20	80	3	--	--	100
MCAE24	Elective - 1	20	20	20	80	3	--	--	100
MCAE25	Elective – 2	20	20	20	80	3	25	--	125
MCAL21	Artificial Intelligence and Machine Learning Lab	--	--	--	--	--	25	50	75
MCAL22	Soft Skill Development Lab	--	--	--	--	--	50	--	50
MCALE23	Elective 1 Lab	--	--	--	--	--	25	50	75
MCAL24	Skill based Lab Course AWT Lab	--	--	--	--	--	50	50	100
MCAL25	Skill based Lab Course User Interface Lab	--	--	--	--	--	25	50	75
MCAL26	Skill based Lab Course Networking with Linux Lab	--	--	--	--	--	25	50	75
MCAP21	Mini Project 1-B	--	--	--	--	--	50	**--**	50
Total		**--**	**--**	**100**	**400**	**--**	**300**	**250**	**1050**

Elective 1

Sr. No.	Course Code	Course Name	Lab Course Code
1	MCAE241	Image Processing	MCALE231
2	MCAE242	Internet Of Things	MCALE232
3	MCAE243	Robotic Process Automation	MCALE233
4	MCAE244	Computer Vision	MCALE234
5	MCAE245	Embedded Systems	MCALE235

Elective 2

Sr. No.	Course Code	Course Name
1	MCAE251	Natural Language Processing
2	MCAE252	Geographic Information System
3	MCAE253	Design and Analysis of Algorithm
4	MCAE254	Digital Marketing and Business Analytics
5	MCAE255	Research Methodology

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

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: Internal assessment of Tutorials to be done separately and term work marks to be given out of 25 for those courses where tutorial is mentioned.

Program Structure for Bridge Course
(With Effect from 2020-2021)

For the graduates, not having graduation in Computer Science/Information Technology/ Computer Application, need to complete the bridge course in first year of MCA along with the semester I and II of MCA

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

Semester I

Course	Course Name	Teaching Scheme		Credits Assigned		
	Mathematical Foundation for Computer Science 1	**Contact Hours**				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
MCA11		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: Student must know

- ☐ Measures of central tendency and dispersion
- ☐ Set theory
- ☐ Basic principles of counting

Course Objectives: Learner/Student will learn and perform

Sr.No.	Course Objective
1	Statistical measures on various types of data
2	Correlation and regression techniques for estimation
3	Probability aspects to take proper decision
4	Application of discrete and continuous probability distributions
5	Various methods of hypothesis testing

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

Sr.No.	Outcome	Bloom Level
CO 1	Apply different statistical measures on various types of data	Applying
CO 2	Evaluate using regression analysis.	Evaluating
CO 3	Analyze different types of Probability and their fundamental applications and random variable.	Analyzing
CO 4	Apply probability distribution to real world problems	Applying
CO 5	Formulate and test the hypothesis for business problem using various methods	Creating

Module	Detailed Contents	Hrs
01	**Module: Skewness** Karl Pearson's coefficient of skewness, Bowley's coefficient of skewness. **Self Learning Topics:** Determining skewness of data related to real system and its graphical representation	04
02	**Module: Regression and correlation** Correlation: Karl Pearson's coefficient of correlation, Spearman's rank correlation coefficient. Regression: Linear and Non-linear regression (quadratic and cubic), Estimation using linear regression. **Self Learning Topics:** Apply correlation and regression on real world data and its graphical representation	08
03	**Module: Introduction to probability & conditional probability** Introduction to probability, Random experiment, Sample space, Events, Axiomatic Probability, Algebra of events. Conditional Probability, Multiplication theorem of Probability, Independent events, Bayes' Theorem **Self Learning Topics:** Applications based on Bayes' theorem	08
04	**Module: Random variable** Discrete random variable, Continuous random variable, Two-dimensional random variable, Joint probability distribution, Stochastic independence, Properties of Expectation and Variance, Covariance. **Self Learning Topics:** Study of various random variables and its independence.	08
05	**Module: Theoretical probability distributions** Binomial, Poisson, Normal. **Self Learning Topics:** Study of properties of standard normal variate.	07
06	**Module: Testing of hypothesis** Hypothesis testing, Type I and Type II errors. Tests of significance – single sample, Student's t-test, large sample test (z-test), Chi-Square test - test for independence of attributes. **Self Learning Topics:** Study of elementary sampling methods.	05

Reference Books:

Reference No	Reference Name
1	S C Gupta, Fundamentals of Statistics, Himalaya Publishing house, Seventh edition.
2	S.C.Gupta, V.K.Kapoor , S Chand , Fundamentals of Mathematical Statistics, Sultam and Chand sons publication, First Edition
3	Kishore Trivedi, Probability and Statistics with Reliability, Queuing, And Computer Science Applications, PHI ,First Edition
4	Hwei P. Hsu, Schaum's Outlines Probability, Random Variables & Random Process, Tata McGraw Hill, Third Edition
5	J.Susan Milton, Jesse C. Arnold, Introduction to Probability & Statistics, Tata McGraw Hill, Fourth Edition
6	Dr J Ravichandran ,Probability & Statistics for Engineers, Wiley
7	Dr Seema Sharma, Statistics for Business and Economics, Wiley
8	Ken Black, Applied Business Statistics, Wiley, Seventh Edition

Web References:

Reference No	Reference Name
1	IIT Kharagpur – Probability and Statistics by Dr. Somesh Kumar https://nptel.ac.in/courses/111105041/
2	IIT Madras – Introduction to Probability and Statistics by Dr. G. Srinivasan https://nptel.ac.in/courses/111/106/111106112/
3	IIT Kanpur – Descriptive Statitics with R Software by Prof. Shalabh https://nptel.ac.in/courses/111/104/111104120/
4	IIT Roorkee – Business Statistics by Prof. Mukesh Kumar Barua https://nptel.ac.in/courses/110/107/110107114/
5	MIT – Introduction to Probability and statistics by Jeremy Orloff and Jonathan Bloom https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/index.htm
6	An Introduction to Statistical Learning with Applications in R by Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani http://faculty.marshall.usc.edu/gareth-james/ISL/data.html

Tutorials:

SrNo	Topic	Hrs
1	Find Bowley's coefficient of skewness	1
2	Find Karl Pearson's coefficient of skewness	1
3	Calculate Karl Pearson's coefficient of correlation	1
4	To fit linear regression and estimate	1
5	Examples on addition and multiplication theorem of probability	1
6	Examples based on Bayes' theorem	1
7	Examples based on independence of discrete random variables.	1

8	Examples based on independence of continuous random variables.	1
9	Example on Poisson distribution	1
10	Example on normal distribution	1
11	Example on t-test	1
12	Example on Chi-square test	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. 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 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 the number of respective lecture hours as mentioned in the syllabus.

Course	Course Name	Teaching Scheme		Credits Assigned		
MCA12	Advanced Java	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:

1.Basic understanding of any Object Oriented Programming Language

2. Successfully completed Programming Concepts of Core Java course

Course Objectives: Learner/Student will learn and perform

Sr.No.	Course Objective
1	Learn the basic data structure operation using Java Collection Framework and understand Lambda expressions.
2	Build web applications using JSP and JSTL.
3	Understand Spring Framework and build Java EE applications and services.
4	Apply Data Access using Spring Framework
5	Understand how to simplify Spring applications using Spring Boot and spring Boot RESTful WebServices.

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

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate use of data structure and data manipulation concept using Java Collection Framework and Lambda expressions.	Creating
CO 2	Create JSP using standard actions, custom tags, Introduction to JSP Standard Tag Library (JSTL) and JSTL Tags.	Creating
CO 3	Understand and develop applications using Spring Framework, Lightweight Container and Dependency Injection with Spring.	Creating
CO 4	Develop applications using Aspect Oriented Programming with Spring.	Creating
CO 5	Apply JDBC Data Access with Spring and demonstrateData access operations with Jdbc Template and Spring.	Creating
CO 6	Create Spring Boot Web Application and Spring Boot RESTful WebServices.	Creating

Module	Detailed Contents	Hrs
01	**Collection and Generic :** Introduction to Generics , Generics Types and Parameterized Types, WildCards , Java Collection Framework, Collections (Basic Operations, Bulk Operations, Iteration) List, Set, Maps **Lambda Expressions** - Lambda Type Inference, Lambda Parameters, Lambda Function Body, Returning a Value,From a Lambda Expression, Lambdas as Objects. **Self learning topics** Collection Queues and Arrays	9
02	**Introduction Java EE Programming** JSP Architecture, JSP building blocks, Scripting Tags,implicit object,Introduction to Bean,standardactions,session tracking types and methods. Custom Tags, Introduction to JSP Standard Tag Library (JSTL) and JSTL Tags. **Self learning topics** Simple Application using Servlet	8
03	**Spring Frameworks:** Introduction to Spring Framework,POJO Programming Model, Lightweight Containers(Spring IOC container, Configuration MetaData, Configuring and using the Container) Dependency Injection with Spring- Setter Injection, Constructor Injection, Circular Dependency, Overriding Bean, Auto Wiring Bean Looksup, Spring Manage Beans) **Self learning topics** Bean Definition Profiles	6
04	**Spring and AOP** AspectOriented Programming with Spring, Types of advices, Defining Point Cut Designator,Annotations. **Self learning topics** AspectJ	5
05	**JDBC Data Access with Spring** Managing JDBC Connection, Configuring Data Source to obtain JDBC Connection, Data Access operations with JdbcTemplate and Spring, RDBMS operation classes , Modelling JDBC Operations as Java Objects **Self learning topics** JDBC Architecture and basic JDBC Program using DML operation	6
06	**Getting Started with Spring Boot** Spring Boot and Database, Spring Boot Web Application Development, Spring Boot RESTful WebServices. **Self learning topics** Understanding Transaction Management in Spring	6

Reference Books:

Reference No	Reference Name
1	Java 6 Programming Black Book, Wiley–Dreamtech ISBN 10: 817722736X ISBN 13: 9788177227369
2	Web Enabled Commercial Application Development using java 2.0, Ivan Byaross ISBN-10: 8176563560 / ISBN-13: 978-8176563567
3	Java Server Programming java EE6, Black book, Dreamtechpress. ISBN-10: 8177229362 / ISBN-13: 978-8177229363
4	Core Servlets and Java Server Pages :Vol I: Core Technologies 2/e , Marty Hall and Larry Brown, Pearson , ISBN: 9788131701638, 8131701638
5	Java Enterprise in a Nutshell, 3rd Edition A Practical Guide, Jim Farley, William Crawford,O'Reilly ISBN-13: 978-0596101428 / ISBN-10: 0596101422
6	Java EE 6 Server Programming For Professionals, Sharanam Shah and Vaishali Shah, SPD, ISBN-10: 9788184049411 / ISBN-13: 978-8184049411
7	Spring in Action, Craig Walls, 3rd Edition,Manning, ISBN 9781935182351
8	**Professional Java Development with the Spring Framework** by Rod Johnsonet al.John Wiley & Sons 2005 (672 pages) ISBN:0764574833
9	Beginning Spring , Mert Calıs kan and KenanSevindik Published by John Wiley & Sons, Inc. 10475 Crosspoint Boulevard Indianapolis, IN 46256 www.wiley.com

Web References:

Reference No	Reference Name
1	https://docs.oracle.com
2	Spring.io

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 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 the number of respective lecture hours as mentioned in the syllabus.

Course	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours		Credits Assigned		
		Theory	Tutorial	Theory	Tutorial	Total
MCA13	Advanced Database Management System	3	--	3	--	3
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
		CA	Test	AVG		
		20	20	20	--	80	100

Pre-requisite: Database Management System

Course Objectives Course is aim to

Sr. No.	Course Objective
1	Explain the concept of parallel, distributed & ORDBMS and understand their applications
2	Explain the architecture of Data Warehouse and perform ETL and data preprocessing tasks.
3	Understand Dimensional Modeling and OLAP architecture.
4	Analyze data, identify the problems ,choose relevant data mining models and algorithms for respective applications
5	Understand the optimization Algorithms used for training Models.
6	Understand concepts of web and text mining methods.

Course Outcomes:

Sr. No.	Outcome	Bloom Level
CO1	Demonstrate complex database systems like parallel, distributed & object oriented databases	Understanding
CO 2	Model data warehouse with ETL process and dimensional modeling and data analysis using OLAP operations.	Applying
CO 3	Discover association among items using Association rule mining.	Analyzing
CO 4	Evaluate different data mining techniques like classification, prediction, clustering, web and text mining to solve real world problems.	Evaluating

Module	Detailed Contents	Hrs
01	**Module: Parallel Database Distributed Database and ORDBMS:** Architecture for Parallel Databases, Types of Distributed Databases, Distributed DBMS Architecture, Storing Data in a Distributed DBMS. ORDBMS: Structured Data Types, Operations on Structured Data, Objects, OIDs and Reference Types, Object oriented versus Object relational database. **Self Learning Topics:** Mapping OODBMS to ORDBMS	05
02	**Module: Data warehousing and OLAP:** Data warehouse: Introduction to DW, DW architecture, ETL Process, Top-down and bottom-up approaches, characteristics and benefits of data mart. Dimensional Modeling: Star, snowflake and fact constellation schema. OLAP in the data warehouse: Major features and functions, OLAP models-ROLAP and MOLAP, Difference between OLAP and OLTP **Self Learning Topics:** Study any one DW implementation	06
03	**Module: Data Mining and Preprocessing:** Introduction to data mining, Knowledge discovery- KDD process. Data Preprocessing: Types of attributes, Data Cleaning - Missing values, Noisy data, data integration and transformations. Data Reduction - Data cube aggregation, dimensionality reduction, data compression, Numerosity reduction, discretization and concept hierarchy. **Self Learning Topics:** Application of data mining in Business Intelligence	05
04	**Module: Data Mining Algorithm- Association rules:** Association rule mining: support and confidence and frequent item sets, market basket analysis, Apriori algorithm,, Associative classification- Rule Mining. **Self Learning Topics:** Association Rule Mining applications	06
05	**Module: Data Mining Algorithm-Classification:** Classification methods: Statistical-based algorithms- Regression, Naïve Bayesian classification, Distance-based algorithm- K Nearest Neighbor, Decision Tree-based algorithms -ID3, C4.5,CART. **Self Learning Topics:** Comparative study of classification algorithms	08
06	**Module: Data Mining Algorithm-Clustering:** Clustering Methods: Partitioning methods- K-Means, Hierarchical-Agglomerative and divisive methods **Self Learning Topics:** Clustering algorithm applications	06
07	**Module: Web Mining and Text Mining:** Web Mining: web content, web structure, web usage. Text Mining: Text data analysis and Information retrieval, text retrieval methods. **Self Learning Topics:** Web Mining Applications	04

Reference Books:

Reference No	Reference Name
1	Ponniah, Paulraj, Data warehousing fundamentals: a comprehensive guide for IT professionals, John Wiley & Sons, 2004.
2	Dunham, Margaret H, Data mining: Introductory and advanced topics, Pearson Education India, 2006.
3	Gupta, Gopal K, Introduction to data mining with case studies, PHI Learning Pvt. Ltd., 2014.
4	Han, Jiawei, Jian Pei, and Micheline Kamber, Data mining: concepts and techniques, Second Edition, Elsevier, Morgan Kaufmann, 2011.
5	Ramakrishnan, Raghu, Johannes Gehrke, and Johannes Gehrke, Database management systems, Vol. 3, McGraw-Hill, 2003.
6	Elmasri, Ramez, and Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, 2008, (2015).
7	Silberschatz, Abraham, Henry F. Korth, and Shashank Sudarshan,Database system concepts, Vol. 5,McGraw-Hill, 1997.

Web References:

Reference No	Reference Name
1	https://www.guru99.com/data-mining-vs-datawarehouse.html
2	https://www.tutorialspoint.com/dwh/dwh_overview
3	https://www.geeksforgeeks.org/
4	https://blog.eduonix.com/internet-of-things/web-mining-text-mining-depth-mining-guide/

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 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 the number of respective lecture hours as mentioned in the syllabus.

Course	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
MCA14	**Software Project 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: Knowledge of Basic Programming Courses

Course Objectives: course aim to

Sr.No.	Course Objective
01	Understand the concepts of Software Engineering and Project Management.
02	Familiarize Project Management framework and Tools.
03	Apply knowledge of Project Life Cycle to implement the projects.
04	Apply the requirement specification and designing tools along with UML.
05	Understand the techniques of project scheduling & project implementation.
06	Learn software cost estimation and software quality assurance techniques.

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

Sr.No.	Course Outcome	Bloom Level
CO1	Define the key concepts of Software Project Management.	Remembering
CO2	Demonstrate understanding of the requirements Analysis and Application of UML Models.	Understanding
CO3	Make use of estimation logic for estimation of software size as well as cost of software.	Applying
CO4	Examine the need of change management during software development as well as application of quality tools.	Analyzing
CO5	Assess various factors influencing project management, quality assurance and risk assessment.	Evaluating
CO6	Develop process for successful quality project delivery.	Creating

Module	Detailed Contents	Hrs.
01	**Module: An Overview of Software Project Management:** Introduction to Project, Project Management, Difference between Software Engineering & Software Project Management. An Overview of IT Project Management: Define project, project management framework, The role of project Manager, Systems View of Project Management, Stakeholder management,Leadership in Projects: Modern Approaches to Leadership & Leadership Styles.	04

	Self Learning Topics: Evolving role of software.	
02	**Module: Software Process Models:** Project phases and the project life cycle, Waterfall Model, Evolutionary Process Model: Prototype and Spiral Model, Incremental Process model: Iterative approach, RAD model, Agile Development Model: Extreme programming, Scrum. **Self Learning Topics:** JAD &DevOps Model, Comparison among models.	05
03	**Module: Software Requirement Analysis and Design:** Types of Requirement, Feasibility Study, Requirement Elicitation Techniques: Interviews, Questionnaire, Brainstorming, Facilitated Application Specification Technique (FAST), Requirement Analysis and Design: Data Flow Diagram (DFD), Data Dictionary, Software Requirement Specification (SRS). **Object Oriented Analysis and Design:** UML Overview, The Nature and purpose of Models, UML diagrams(Use Case diagram, Activity Diagram, Class & Object Diagram, Sequence Diagram, State Transition Diagram, Deployment Diagram). **Self Learning Topics:** Comparison of Requirements Elicitation Techniques.	09
04	**Module: Software Project Planning & Software Cost Estimation:** Business Case, Project selection and Approval, Project charter, Project Scope management, Creating the Work Breakdown Structures (WBS). Software Estimation: Size Estimation: Function Point (Numericals). Cost Estimation: COCOMO (Numericals), COCOMO-II (Numericals)till Early design model. **Self Learning Topics:**COCOMO II Post- Architecture model.	07
05	**Module: Project Scheduling and Procurement Management**:Relationship between people and Effort: Staffing Level Estimation, Effect of schedule Change on Cost, Project Schedule, Schedule Control, Critical Path Method (CPM) (Numericals), Basics of Procurement Management, Change Management. **Self Learning Topics:** Degree of Rigor.	06
06	**Module: Software Quality Assurance:** **Software and System Quality Management:** Overview of ISO 9001, SEI Capability Maturity Model, McCalls Quality Model, Six Sigma, Formal Technical Reviews, Tools and Techniques for Quality Control, Pareto Analysis, Statistical Sampling, Quality Control Charts and the seven Run Rule. **Software Risk Management:** Identify IT Project Risk, Risk Analysis and Assessment, Risk Strategies, Risk Monitoring and Control, Risk Response and Evaluation. **Self Learning Topics:** Software ReliabilityMetrics, Reliability Growth Modeling.	08

07	**Module: The Project Implementation Plan and Closure:**	01
	The Project Implementation Plan and Closure : Project Implementation Administrative Closure.	
	Self Learning Topics: Ethics in Projects, Multicultural Projects.	

Reference Books:

Reference No.	Reference Name
1	Software Engineering, 5th and 7th edition, by Roger S Pressman, McGraw Hill publication.
2	Managing Information Technology Project, 6edition, by Kathy Schwalbe, Cengage Learning publication.
3	Information Technology Project Management by Jack T Marchewka Wiley India publication.
4	Software Engineering 3rd edition by KK Agrawal, Yogesh Singh, New Age International publication.
5	The Unified Modelling Language Reference manual, Second Edition, James Rambaugh,Iver Jacobson, Grady Booch, Addition- Wesley.
6	Object-Oriented Modeling and Design with UML, Michael Blaha, James Rumbaugh, PHI(2005).

Web References:

Reference No.	Reference Name
1	https://www.projectmanager.com
2	https://www.tutorialspoint.com
3	https://technologyadvice.com
4	https://www.javatpoint.com
5	https://www.geeksforgeeks.org

SPM : Tutorials

Sr. No.	Detailed Contents	Hrs.
01	Business Case for Project (Case study).	01
02	Software Requirement Specification (SRS Case Study).	01
03	Project Scheduling tools (any open source tools like Microsoft Projects): Creating a Project Plan or WBS, Establishing the Project Start or Finish Date, Entering Tasks.	01
04	Gantt chart, Critical Path Analysis.	01
05	Software Cost Estimation using COCOMO-I / COCOMO-II for Project.	01
06	UML Diagrams: Use Case Diagram.	01
07	UML Diagrams: Activity Diagram.	01
08	UML Diagrams: Class Diagram.	01

09	UML Diagrams: Sequence Diagram	01
10	UML Diagrams: State Chart Diagram.	01
11	UML Diagrams:Component Diagram.	01
12	UML Diagrams:Deployment Diagram.	01

Assessment:

Continuous Assessment: 20 marks

Following measures can be used for the continuous assessment as

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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.

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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	Contact Hours	Credits Assigned	Examination Scheme				
				Term Work	Practical	Oral	Total	
MCAL11	Data Structures Lab using C/C++	04	02	50	30	20	100	

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

Lab Course Objectives:

Sr. No.	Course Objective
1	Understand concepts of searching and sorting algorithms.
2	Impart a thorough understanding of linear and non-linear data structures
3	Choose the appropriate data structure for solving real world problems
4	Learn hashing techniques and collision resolution

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

Sr. No.	Outcome	Bloom Level
CO1	Implement searching and sorting algorithms	Applying
CO 2	Implement linear and non-linear data structures	Applying
CO 3	Choose the appropriate data structures to solve complex real life problems	Creating
CO 4	Analyze hashing techniques for data storage and retrieval	Analyzing

Description:

Module No	Detailed Contents	Hrs
01	**Module: Sorting Techniques:** Bubble Sort, Insertion Sort, Selection Sort, Shell Sort, Radix Sort **Self Learning Topics:** Quick sort	04
02	**Module: Searching and Hashing Techniques:** Linear search, Binary search, Methods for Hashing: Modulo Division, Digit Extraction, Fold shift, Fold Boundary, Linear Probe for Collision Resolution. **Self Learning Topics :** Direct and Subtraction hashing	08
03	**Module: Stacks:** Array implementation, Linked List implementation, Evaluation of postfix expression and balancing of parenthesis **Self Learning Topics:** Conversion of infix notation to postfix notation	06
04	**Module: Queue:**	08

	Linked List implementation of ordinary queue, Array implementation of circular queue, Linked List implementation of priority queue, Double ended queue		
	Self Learning Topics : Other queue applications		
05	**Module: Linked List:** Singly Linked Lists, Circular Linked List, Doubly Linked Lists : Insert, Display, Delete, Search, Count, Reverse(SLL), Polynomial Addition **Self Learning Topics :** Comparative study of arrays and linked list	10	
06	**Module: Trees:** Binary search tree : Create, Recursive traversal: preorder, postorder, inorder, Search Largest Node, Smallest Node, Count number of nodes, Heap: MinHeap, MaxHeap: reheapUp, reheapDown, Delete **Self Learning Topics:** Expression Tree, Heapsort	08	
07	**Module: Graphs:** Represent a graph using the Adjacency Matrix, BFS, Find the minimum spanning tree (using any method Kruskal's Algorithm or Prim's Algorithm) **Self Learning Topics :** Shortest Path Algorithm	08	

Reference Books:

Reference No	Reference Name
1	Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education Asia, Second Edition, ISBN No. 978-81-203-1177-0
2	Richard F Gilberg Behrouz A Forouzan , Data Structure A Pseudocode Approach with C, Cengage India, Second Edition, ISBN No. 978-81-315-0314-0
3	S. Lipchitz, Data Structures, Mc-Graw Hill Education, ISBN No. 978-12-590-2996-7
4	Ellis Horowitz, S. Sahni, D. Mehta, Fundamentals of Data Structures in C++, Galgothia Publication, ISBN No. 978-81-751-5278-6
5	Michael Berman, Data structures via C++, Oxford University Press, First Edition, ISBN No. 978-01-980-8952-0

Web References:

Reference No	Reference Name
1	https://www.digimat.in/nptel/courses/video/106106133/L25.html
2	https://www.youtube.com/watch?v=zWg7U0OEAoE
3	https://www.digimat.in/nptel/courses/video/106106145/L01.html
4	https://www.cs.auckland.ac.nz/software/AlgAnim/ds_ToC.html
5	https://nptel.ac.in/courses/106/101/106101208/

Suggested list of experiments

Practical No	Problem Statement
1	Implementation of different sorting techniques.
2	Implementation of searching algorithms.
3	Implementation of stacks(Using arrays and Linked List)
4	Implementation of Stack Applications like: a. Postfix evaluation

		b. Balancing of Parenthesis
5	Implement all different types of queues.	
6	Demonstrate application of queue (eg. Priority Queue, Breath First Search)	
7	Implementation of all types of linked lists.	
8	Demonstrate application of linked list (eg. Polynomial addition, Sparse matrix)	
9	Create and perform various operations on BST.	
10	Implementing Heap with different operations performed.	
11	Create a Graph storage structure (eg. Adjacency matrix)	
12	Perform various hashing techniques with Linear Probe as collision resolution scheme.	
13	Create a minimum spanning tree using any method Kruskal's Algorithm or Prim's Algorithm	
14	Implementation of Graph traversal. (DFS and BFS)	

15	Group project (3 to 4 members) to be given to work on one application to a real world problem like:
	    a) Bus routes of school buses for XYZ school
	    b) Voucher system for a canteen
	    c) Game like Sudoku solver
	    d) Car pooling application etc.	

Assessment:

Term Work: Will be based on Continuous Assessment

1. Laboratory work will be based on the syllabus with minimum 10 experiments and group project (refer Practical No. 15 in suggested list of experiments).

   Experiments   25 marks
   Group Project   15 marks
   Attendance   10 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
MCAL12	**Advanced Java Lab**	**02**	**01**	**25**	**30**	**20**	**75**

Pre-requisite: 1. Basic understanding of Core Java Programming.
2. Basics of web technology.

Lab Course Objectives: Students will be able to

Sr.No.	Course Objective
1	Write programs based on Java Generics, Collection framework and Lambda expressions.
2	Develop web applications using JSP and JSTL.
3	Demonstrate Data Access with Spring.
4	Build an application using Spring Framework.
5	Develop Spring applications using Spring Boot and spring Boot RESTful Web Services.

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

Sr. No.	Outcome	Bloom Level
CO1	Demonstrate use of data structure and data manipulation concept using Java Collection Framework and Lambda expressions.	Applying
CO 2	Build JSP web application using standard actions, custom tags and JSTL Tags.	Creating
CO 3	Develop application using Spring Framework, Lightweight Containers and Dependency Injection with Spring.	Applying
CO 4	Develop applications using Aspect Oriented Programming with Spring.	Applying
CO 5	Build JDBC application with Spring using JdbcTemplate.	Creating
CO 6	Develop Spring Boot Web Application and Spring Boot RESTful web services.	Creating

Description:

Module	Detailed Contents	Hrs
01	**Module: Java Collections and Generics**: Programs based on Generic classes and Java Collection Framework List, Set and Map, Wildcards and Lambda expressions.	4

	Self Learning Topics: Collection Queues and Arrays		
02	**Module: Introduction Java EE Programming:** Programs based on JSP elements, Standard Actions, JSP Directives, Implicit objects, Error handling in JSP, Session tracking – Cookies and Session, Custom tags, JSTL tags. **Self Learning Topics:** Simple Application using Servlet	4	
03	**Module: Spring Framework**: Programs based on using Spring Framework, dependency injection. **Self Learning Topics:** Bean Definition Profiles	4	
04	**Module: Aspect Oriented Programming**: Programs based on Spring AOP – Before, After, Around, After Returning and After Throwing advice, PointCuts. **Self Learning Topics:** AspectJ	4	
05	**Module: JDBC Data Access with Spring using Oracle/ MySQL database**: Programs based of Spring JDBC, JdbcTemplate, PreparedStatementCallback, ResultSetExtractor and RowMapper interface. **Self Learning Topics:** Basic JDBC Program using DML operation	6	
06	**Module: Getting Started with Spring Boot:** Programs based on Spring Boot, RESTful Web Services with Spring Boot. **Self Learning Topics:** Understanding Transaction Management in Spring	4	

Reference Books:

Reference No.	Reference Name
1	Java 6 Programming Black Book, Wiley–Dreamtech
2	Web Enabled Commercial Application Development using java 2.0, Ivan Byaross
3	Java Server Programming java EE6, Black book, Dreamtech Press.
4	Core Servlets and Java Server Pages: Vol. I: Core Technologies 2/e , Marty Hall and Larry Brown, Pearson
5	Java Enterprise in a Nutshell, 3rd Edition A Practical Guide, Jim Farley, William Crawford, O'Reilly
6	Java EE 6 Server Programming For Professionals, Sharanam Shah and Vaishali Shah, SPD
7	Spring in Action, Craig Walls, 3rd Edition, Manning
8	Professional Java Development with the Spring Framework, Rod Johnson et al., John Wiley & Sons
9	Beginning Spring, Mert Caliskan and Kenan Sevindik, John Wiley & Sons
10	Spring Recipes A Problem Solution Approach, Gary Mak, Josh Long and Daniel Rubio, Apress

Web References:

Reference No	Reference Name
1	https://docs.oracle.com
2	https://spring.io/

Suggested list of experiments

Practical No	Problem Statement
1.	**Assignments on Java Generics** 1. Write a Java Program to demonstrate a Generic Class. 2. Write a Java Program to demonstrate Generic Methods.

		3. Write a Java Program to demonstrate Wildcards in Java Generics.
2.		**Assignments on List Interface**
		1. Write a Java program to create List containing list of items of type String and use for---each loop to print the items of the list.
		2. Write a Java program to create List containing list of items and use ListIterator interface to print items present in the list. Also print the list in reverse/ backword direction.
3.		**Assignments on Set Interface**
		1. Write a Java program to create a Set containing list of items of type String and print the items in the list using Iterator interface. Also print the list in reverse/ backword direction.
		2. Write a Java program using Set interface containing list of items and perform the following operations:
		a. Add items in the set.
		b. Insert items of one set in to other set.
		c. Remove items from the set
		d. Search the specified item in the set
4.		**Assignments on Map Interface**
		Write a Java program using Map interface containing list of items having keys and associated values and perform the following operations:
		a. Add items in the map.
		b. Remove items from the map
		c. Search specific key from the map
		d. Get value of the specified key
		e. Insert map elements of one map in to other map.
		f. Print all keys and values of the map.
5.		**Assignments on Lambda Expression**
		1. Write a Java program using Lambda Expression to print "Hello World".
		2. Write a Java program using Lambda Expression with single parameters.
		3. Write a Java program using Lambda Expression with multiple parameters to add two numbers.
		4. Write a Java program using Lambda Expression to calculate the following:
		a. Convert Fahrenheit to Celcius
		b. Convert Kilometers to Miles.
		5. Write a Java program using Lambda Expression with or without return keyword.
		6. Write a Java program using Lambda Expression to concatenate two strings.
6.		**Assignments based on web application development using JSP**
		1. Create a Telephone directory using JSP and store all the information within a database, so that later could be retrieved as per the requirement. Make your own assumptions.
		2. Write a JSP page to display the Registration form (Make your own assumptions)
		3. Write a JSP program to add, delete and display the records from StudentMaster (RollNo, Name, Semester, Course) table.
		4. Design loan calculator using JSP which accepts Period of Time (in years) and Principal Loan Amount. Display the payment amount for each loan and then list the loan balance and interest paid for each payment over the term of the loan for the following time period and interest rate:
		a. 1 to 7 year at 5.35%
		b. 8 to 15 year at 5.5%
		c. 16 to 30 year at 5.75%
		5. Write a program using JSP that displays a webpage consisting Application form for change of Study Center which can be filled by any student who wants to change his/ her study center. Make necessary assumptions
		6. Write a JSP program to add, delete and display the records from StudentMaster (RollNo, Name, Semester, Course) table.
		7. Write a JSP program that demonstrates the use of JSP declaration, scriptlet, directives, expression, header and footer.
7.		**Assignment based Spring Framework**
		1. Write a program to print "Hello World" using spring framework.
		2. Write a program to demonstrate dependency injection via setter method.

		3. Write a program to demonstrate dependency injection via Constructor.
8.		**Assignment based Aspect Oriented Programming**
		1. Write a program to demonstrate Spring AOP – before advice.
		2. Write a program to demonstrate Spring AOP – after advice.
		3. Write a program to demonstrate Spring AOP – around advice.
		4. Write a program to demonstrate Spring AOP – after returning advice.
		5. Write a program to demonstrate Spring AOP – after throwing advice.
		6. Write a program to demonstrate Spring AOP – pointcuts.
9.		**Assignment based Spring JDBC**
		1. Write a program to insert, update and delete records from the given table.
		2. Write a program to demonstrate PreparedStatement in Spring JdbcTemplate
		3. Write a program in Spring JDBC to demonstrate ResultSetExtractor Interface
		4. Write a program to demonstrate RowMapper interface to fetch the records from the database.
10.		**Assignment based Spring Boot and RESTful Web Services**
		1. Write a program to create a simple Spring Boot application that prints a message.
		2. Write a program to demonstrate RESTful Web Services with spring boot.

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 the suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL13	Advanced Database Management System Lab	02	01	25	30	20	75

Pre-requisite: Database Management System, SQL.

Lab Course Objectives

Sr.No.	Course Objective
1	Understanding functioning of advanced databases like distributed and ORDBMS.
2	Understand ETL process performed to create data warehouse.
3	Understand basic OLAP Operations.
4	Understand the data mining process and important issues around data cleaning.
5	Identify the problems, choose relevant data mining algorithms and analyze the results for respective applications.

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

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate distributed and ORDBMS concepts	Applying
CO 2	Perform ETL operations used in the building data warehouse.	Applying
CO 3	Demonstrate and analysis various OLAP operations.	Analyzing
CO 4	Implement and evaluate different data mining techniques like classification, prediction, clustering and association rule mining in R	Evaluatin

Description:

Module No	Detailed Contents	Hrs
1	**Distributed Database** : Implementation of Partitions: Range, List. Self-Learning Topics : Hash Partition, Composite partition	2
2	**OLAP with Oracle** : Analytical Queries Self-Learning Topics: Cume_list, Percent_rank	4
3	**ORDBMS** : Implementation of, • Abstract Data Type • Reference Self-Learning Topics: Nested ADT, Inheritance	2
4	**ETL through Pentaho** : ETL Transformation with Pentaho Self-Learning Topics: Any two more transformation operation in Pentaho beyond the syllabus	4
5	**Basics Of R and Data Acquisition** : Introduction to R, Data Types and Objects, Reading and writing data, Reading data from the console Packages, Loading packages, Attach, and detaching data. Loading Data from different Data Source Self-Learning Topics: Operators, Conditional Statements and Loops, Functions, Loading data from Relational Databases, XML	2
6	**Preprocessing in R** : Data preprocessing techniques in R Self-Learning Topics:Sorting, Date Conversion	2
7	**Data Mining - Classification using R-Programming** : Implementation and Analysis of -Regression, Classification Models Self-Learning Topics: Implement One classification algorithm in weka	6
8	**Data Mining - Clustering and Association using R-Programming** : Implementation of Market Basket Analysis and Clustering. Self-Learning Topics: Implementation clustering, association in Weka	4

Reference Books:

Reference No	Reference Name
1	John M. Quick, "Statistical Analysis with R"", PACKT Publishing, 2015ISBN NO: 9781849512084, 9781849512084
2	G.K. Gupta, "Introduction to data mining with case studies", PHI Learning Publishing, ISBN: 9788120350021, 8120350022

Web References:

Reference No	Reference Name
1	http://cookbook-r.com
2	https://www.r-project.org/about.html
3	"Statistical Analysis with R - a quick start", Oleg Nenadic, Walter Zucchini, September 2004, http://www.statoek.wiso.uni-goettingen.de /mitarbeiter /ogi /pub /r_workshop.pdf
4	https://www.rstudio.com/
5	http://www.r-project.org/doc/bib/R-books.html

Suggested List of Experiments	
Practical No.	**Problem Statement**
1	Implementation of Data partitioning through Rang and List partitioning
2	Implementation of Analytical queries like Roll_UP, CUBE, First, Last , Lead ,Lag,Rank AND Dense Rank
3	Implementation of ORDBMS concepts like ADT(Abstract Data Types), Reference
4	Implementation of ETL transformation with Pentaho like Copy data from Source (Table/Excel/ Oracle) and store it to Target (Table/Excel/ Oracle) , Adding sequence,Adding Calculator Concatenation of two fields, Splitting of two fields, Number Range, String Operations, **Sorting data,** Implement the merge join transformation on tables, Implement data validations on the table data.
5	Introduction to R programming and Data acquisition Install packages , Loading packages Data types, checking type of variable, printing variable and objects (Vector, Matrix, List, Factor, Data frame, Table) cbind-ing and rbind-ing, **Reading and Writing data.** setwd(), getwd(), data(), rm(), Attaching and Detaching data. Reading data from the consol. Loading data from different data sources.(CSV, Excel).
6	Implementation of Data preprocessing techniques like, Naming and Renaming variables, adding a new variable. Dealing with missing data. Dealing with categorical data. Data reduction using subsetting
7	Implementation and analysis of Linear regression through graphical methods.
8	Implementation and analysis of Classification algorithms like Naive Bayesian, K-Nearest Neighbor, ID3 , C4.5
9	Implementation and analysis of Apriori Algorithm using Market Basket Analysis.
10	Implementation and analysis of clustering algorithms like K-Means , Agglomerative

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 the suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL14	Web Technologies	04	02	50	30	20	100

Pre-requisite: Basic understanding of fundamentals of Web Technologies and JavaScript

Lab Course Objectives Course aim to

Sr.No.	Course Objective
1	Create simple websites based on Node.js features
2	Demonstrate database connectivity and operations
3	Make applications making use of Angular.js concepts
4	Construct Angular.js Forms and Single Page Applications

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

Sr.No.	Outcome	Bloom Level
CO1	Build simple websites making use of various Node.js features	Applying
CO 2	Design a dynamic web application enabled with database connectivity	Creating
CO 3	Use the fundamentals of Angular.js Filters, Directives and Controllers to build applications	Applying
CO 4	Develop Forms and Single page applications (SPA)	Creating

Description:

Module No	Detailed Contents	Hrs
1	**Introduction to Node.js** : What is Node.js, Advantages of Node.js, Node.js Process Model, Traditional Web Server Model, Setup Development Environment: Installation of Node.js on Windows, Working in REPL, Node JS Console *Self-Learning Topics: W3C Architecture*	2
2	**Node.js Modules, Events & Functions** : Standard Callback Pattern, Event Emitter Pattern, Event Types, Event Emitter API, Creating an Event Emitter, Defer Execution of a Function, Cancel Execution of a Function, Schedule/Cancel repetitive execution of a Function, Block/Escape Event Loop *Self-Learning Topics: Additional Events*	6
3	**File Handling& HTTP Web Server** : File Paths, fs Module, Opening a file, Reading from a file, Writing to a file, Closing a file. HTTP request/response object, Headers, Piping, Shutting down the server *Self-Learning Topics:TCP server*	12
4	**Databases** : Connect and Communicate with a MySQL Database, Adding data to the database, Reading data	4

	Self-Learning Topics: Working with any other database		
5	**Angular JS Basics :** Introduction to AngularJS, MVC Architecture, Conceptual Overview:Setting up the Environment,First Application, Understanding ng attributes, Expressions: Number and String Expressions, Object Binding and Expressions,Working with Arrays *Self-Learning Topics: Comparison of Angular and React js*	6	
6	**Filters, Directives** : Built-In Filters, Uppercase and Lowercase Filters, Currency and Number Formatting Filters,OrderBy Filter, Introduction to Directives, Directive Lifecycle, Conditional Directives,Styles Directives, Mouse and Keyboard Events Directives, Using Angular JS built-in directives: app, init, model *Self-Learning Topics: Creating a custom filter and a custom directive*	8	
7	**Controllers** : Understanding Controllers, Programming Controllers & $scope object, Adding Behavior to a Scope Object, Passing Parameters to the Methods, Having Array as members in Controller Scope. *Self-Learning Topics: Nested Controllers*	6	
8	**Forms and SPA (Single Page Application):** Working with Simple Angular Forms, Working with Select and Options, Input Validations, Using CSS classes, Form Events, Custom Model update triggers, Custom Validation. Introduction to SPA, Creating HTML Template, Configuring Route Provider, Creating Single Page Application *Self-Learning Topics: Animations*	8	

Reference Books:

Reference No	Reference Name
1	Powell TA, Powell TA. HTML & CSS: the complete reference. New York: McGraw-Hill; 2010. ISBN No. 9780071496292
2	Haverbeke M. Eloquent Javascript: A modern introduction to programming. No Starch Press; 2018. ISBN No. 9781593279509
3	Teixeira P. Professional Node.js: Building Javascript based scalable software. John Wiley & Sons; 2012. ISBN No. 9781118185469
4	Brown E. Web development with node and express: leveraging the JavaScript stack. O'Reilly Media; 2014. ISBN No. 9781491949306
5	Karpov V, Netto D. Professional AngularJS. John Wiley & Sons; 2015. ISBN No. 9781118832073
6	Dayley B. Learning AngularJS. Pearson Education; 2014. ISBN No. 9780134034546
7	Seshadri S, Green B. AngularJS: Up and Running: Enhanced Productivity with Structured Web Apps. O'Reilly Media; 2014. ISBN No. 9781548785710

Web References:

Reference No	Reference Name
1	https://nptel.ac.in/courses/106106222/
2	https://learn.shayhowe.com/html-css/
3	https://www.w3schools.com/nodejs/
4	https://www.coursera.org/learn/server-side-nodejs
5	https://www.coursera.org/learn/single-page-web-apps-with-angularjs
6	https://docs.angularjs.org/tutorial
7	https://www.freecodecamp.org/news/want-to-learn-angular-heres-our-free-33-part-course-by-dan-wahlin-fc2ff27ab451/

Suggested list of experiments

Practical No	Problem Statement
1	Create an application to demonstrate Node.js Modules
2	Create an application to demonstrate various Node.js Events
3	Create an application to demonstrate Node.js Functions
4	Using File Handling demonstrate all basic file operations (Create, write, read, delete)
5	Create an HTTP Server and perform operations on it
6	Create an application to establish a connection with the MySQL database and perform basic database operations on it
7	Create an application using Filters
8	Create an application to demonstrate directives
9	Demonstrate controllers in Angular.js through an application
10	Demonstrate features of Angular.js forms with a program
11	Create a SPA (Single Page Application)

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	Pract.	Oral	Total
MCAP11	**Mini Project – 1 A**	**02**	**01**	**50**	-	--	**50**

Pre-requisite: NIL

Lab Course Objectives: The course is aimed to

Sr. No.	Course Objective
1	Conceptualize knowledge with emphasis on team work, effective communication, critical thinking and problem solving skills.
2	Adapt to a rapidly changing environment by having learned and applied new skills and new technologies.
3	Acquaint with the process of applying basic computer applications and provide solutions to the problems in various application domains.

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	Apply software project management skills during project work.	Applying
CO3	Build small groups to work effectively in team on medium scale computing projects.	Creating
CO4	Design and evaluate solutions for complex problems.	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 II

Course Code	Course Name	Teaching Scheme		Credits Assigned		
MCA21	Mathematical Foundation for Computer Science 2	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: Basic knowledge of Mathematics and Statistics

Course Objectives: The course aim to

Sr.No	Course Objective
1	Study the formulation of Linear programming problems and obtain the optimum solution using various methods.
2	Solve the transportation, assignment problems and obtain their optimal solution
3	Use competitive strategy for analysis and learn to take decisions in various business environments
4	Understand queuing and simulation models and analyze their performance in real world systems

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

Sr.No.	Outcome	Bloom Level
CO1	Formulate mathematical model for a broad range of problems in business and industry.	Creating
CO 2	Apply mathematics and mathematical modeling to forecast implications of various choices in real world problems	Applying
CO 3	Think strategically and decide the optimum alternative from various available options	Evaluating
CO 4	Evaluate performance parameters of a real system using various methods	Evaluating

Modul e No	Detailed Contents	Hrs
01	**Linear Programming Problem**: Introduction, Formulation of linear programming problem and basic feasible solution: graphical method, Simplex method, artificial variables, Big M method, Two Phase method. **Self Learning Topics:** special cases of LPP	10
02	**Transportation Problem**: Definition of Transportation Problem, Initial basic feasible solution: North-West Corner method, Least Cost method, Vogel's Approximation method, optimum solution: MODI method. **Self Learning Topics:** optimization using stepping stone method	6
03	**Assignment Problem & Travelling Salesman Problem**: Definition of assignment Problem : Hungarian method (minimization and maximization), Travelling Salesman Problem : Hungarian method. **Self Learning Topics:** Simple applications in daily life	6
04	**Game Theory & Decision Making** : Rules of Game Theory, Two person zero sum game, solving simple games (2x2 games), solving simple games (3x3 games) Decision making under certainty, under uncertainty,Maximax Criterion,Maximin Criterion, Savage Minimax Regret criterion, Laplace criterion of equal Likelihoods, Hurwicz criterion of Realism **Self Learning Topics:** Decision tree for decision-making problem.	7
05	**Queuing Models**: Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1 : $\Box$ /FCFS, M/M/1 : N/FCFS. **Self Learning Topics:** Understanding Kendle's notation in queuing theory	5
06	**Simulation**: Introduction to simulation, steps in simulation, advantages of simulation, limitations of simulation, applications of simulation, Monte-Carlo method: simple examples, single server queue model. **Self Learning Topics:** Generation of pseudo random numbers and their properties.	6

Reference Books:

Reference No	Reference Name
1	Hamdy A. Taha, University of Arkansas, "Operations Research: An Introduction", Pearson, 9th Edition, ©2011, ISBN-13: 9780132555937
2	Sharma, S.D. and Sharma, H. , "Operations Research: Theory, methods and Applications",KedarNath Ram Nath, 2010, 15, reprint

3	J. K. Sharma, "Operations Research : Theory And Applications" , Macmillan India Limited, 2006 (3 Edition),ISBN 1403931518, 9781403931511
4	S. C. Gupta, "Fundamentals of Statistics" – Himalaya Publishing House, 2017, 7th edition, ISBN 9350515040, 9789350515044
5	Prem Kumar Gupta & D S Hira, S. Chand publications , "Operations Research", 7/e, ISBN-13: 978-8121902816, ISBN-10: 9788121902816
6	A. Ravindran, Don T. Phillips, James J. Solberg, "Operations Research: Principles and Practice", 2nd Edition, January 1987, ISBN: 978-0-471-08608-6
7.	Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research , McGraw-Hill, 2001,Edition7, illustrated,ISBN 0071181636, 9780071181631
8.	Jerry Banks, John S. Carson, Barry L. Nelson, Contributor Barry L. Nelson "Discrete-event System Simulation",Prentice Hall, 1996, Edition 2, illustrated, ISBN 0132174499, 9780132174497

Web References:

Reference No	Reference Name
1	Operations Research, Prof.Kusum Deep, IIT-MADRAS, https://nptel.ac.in/courses/111/107/111107128/
2	Introduction to Operations Research, Prof. G. Srinivasan, IIT-ROORKEE, https://nptel.ac.in/courses/110/106/110106062/
3	Fundamentals of Operations Research, Prof. G. Srinivasan, IIT-MADRAS, https://nptel.ac.in/courses/112/106/112106134/
4	Modeling and simulation of discrete event systems,Prof.P. Kumar Jha, IIT-ROORKEE, https://nptel.ac.in/courses/112107220/
5	Game Theory, Prof. K. S. MallikarjunaRao, IIT-BOMBAY, https://nptel.ac.in/courses/110/101/110101133/
6	Decision Modelling, Prof. BiswajetMahanty, IIT-KHARGPUR, https://nptel.ac.in/courses/110105082/
7	Karmarkar's Method: https://www.youtube.com/watch?v=LWXXhBIlj0o
8	Karmarkar's Method : https://en.wikipedia.org/wiki/Karmarkar%27s_algorithm

Tutorials:

Sr. No.	Topic	Hr
1	Linear programming problem using graphical method	1
2	Linear programming problem using simplex method	1
3	Linear programming problem using Big M method	1
4	Finding the basic feasible solution using Vogel's Approximation Method	1

5	Finding the optimal solution using Modi Method	1
6	Assignment Problem using Hungarian method	1
7	Travelling salesman Problem using Hungarian method	1
8	Solving Two person zero sum game	1
9	Decision Making Under Uncertainty	1
10	Queuing system - (M/M/1):(FCFS /infinity)	1
11	Queuing system - (M/M/1): (FCFS/N)	1
12	Monte-Carlo Method	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. 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
MCA22	Artificial Intelligence And Machine Learning	3	--	3	--	3
		Examination Scheme				
		Theory			Term Work	End Sem Exam	Total
		CA	Test	AVG			
		20	20	20	--	80	100

Pre-requisite: Basics of data mining and Mathematical foundations of computerscience-MCA11

Course Objectives The course aim to

Sr.No.	Course Objective
1	Understand different AI concepts
2	Elucidate knowledge of Artificial Intelligence techniques for problem solving
3	Understand Artificial intelligence search strategies and neural networks
4	Provide an insight into the fundamentals of Machine Learning Techniques
5	Become familiar with regression methods, classification methods, clustering methods
6	Become familiar with methods to improve the learnin

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

Sr.No.	Outcome	Bloom Level
CO1	Interpret Artificial Intelligence concepts intelligence concepts	Understanding
CO 2	Apply Artificial intelligence techniques for problem solving	Applying
CO 3	Analyze the fundamentals of machine learning, the learning algorithms and the paradigms of supervised and un-supervised learning	Analyzing
CO 4	Identify methods to improve machine learning results for better predictive performance	Applying

Modul e	Detailed Contents	Hrs
1	**Module1:Introduction:** Artificial Intelligence, Application of AI, AI Problems, Problem Formulation, Intelligent Agents, Types of Agents, Agent Environments, PEAS representation for an Agent, Architecture of Intelligent agents. Reasoning and Logic, Prepositional logic, First order logic, Using First-order logic, Inference in First-order logic, forward and Backward Chaining **Self-Learning topics: Expert systems**	6
2	**Module2: Search Strategies:** Solving problems by searching, Search- Issues in The Design of Search Programs, Un-Informed Search- BFS, DFS; Heuristic Search Techniques: Generate-And- Test, Hill Climbing, Best-First Search, A* Algorithm, Alpha beta search algorithm, Problem Reduction, AO*Algorithm, Constraint Satisfaction, Means-Ends Analysis **Self-Learning topics: Tabu search**	8
3	**Module3:Artificial Neural Networks** : Introduction, Activation Function, Optimization algorithm- Gradient decent, Networks- Perceptrons, Adaline, Multilayer Perceptrons , Backpropogation Algorithms Training Procedures, Tuning the Network Size **Self-Learning topics: Maxnet algorithm**	6
4	**Module4: Introduction to ML**: Machine Learning basics, Applications of ML,Data Mining Vs Machine Learning vs Big Data Analytics. Supervised Learning- Naïve Base Classifier, , Classifying with k-Nearest Neighbour classifier, Decision Tree classifier, Naive Bayes classifier. Unsupervised Learning - Grouping unlabeled items using k-means clustering, Association analysis with the Apriori algorithm Introduction to reinforcement learning **Self-Learning topics: Density Based Clustering,K-medoid**	4
5	**Module5:Forecasting and Learning Theory :** Non-linear regression, Logistic regression, Random forest, Baysian Belief networks, Bias/variance tradeoff, Tuning Model Complexity, Model Selection Dilemma Clustering **:** Expectation-Maximization Algorithm, Hierarchical Clustering, Supervised Learning after Clustering, Choosing the number of clusters, Learning using ANN **Self-Learning topics: Maximum Likelihood Estimation**	6

6	**Module6:Kernel Machines & Ensemble Methods**	8
	Introduction, Optimal Separating Hyperplane, Separating data with maximum margin, Support Vector Machine (SVM), Finding the maximum margin, The Non-Separable Case: Soft Margin Hyperplane, Kernel Trick, Defining Kernels	
	Ensemble Methods : Mixture Models, Classifier using multiple samples of the data set, Improving classifier by focusing on error, weak learner with a decision stump, Bagging , Stacking, Boosting ,Implementing the AdaBoost algorithm, Classifying with AdaBoostBootstrapping and cross validation	
	Self-Learning topics: SMO Algorithm	
7	**Module7:Dimensionality Reduction**: Introduction, Subset Selection, Principal Components Analysis, Multidimensional Scaling, Linear Discriminant Analysis.	2
	Self-Learning topics; Feature selection – feature ranking and subset selection	

Reference Books:

Reference No	Reference Name
1	George F Luger, Artificial Intelligence, Fifth Edition-2009, Pearson Education Publications ,ISBN-978-81-317-2327-2
2	Stuart Russell, Peter Norvig ,Artificial Intelligence – A Modern Approach, , Pearson Education / Prentice Hall of India, 3rd Edition, 2009 .ISBN- 13: 978-0136042594
3	Elaine Rich, Kevin Knight, S.B. Nair, Artificial Intelligence, 3rd Edition, Tata McGraw Hill-2008., ISBN 10: 0070087709 / ISBN 13: 9780070087705
4	Anandita Das ,Artificial Intelligence and Soft Computing for Beginners-,2nd Edition, ShroffPublication, ISBN- 9789351106159
5	Nils J. Nilsson, —Artificial Intelligence: A new Synthesis, Morgan Kaufmann Publishers, Harcourt Asia Pvt. Ltd., 2000, ISBN-1-55860-535-5
6	Kumar Satish ,Neural Networks, Second edition Tata McGraw Hill-,2013, ISBN1259006166, 9781259006166
7	EthemAlpaydın, Introduction to Machine Learning, PHI, Third Edition, ISBN No. 978-81-203- 5078-6. (this can be made the text book)
8	Peter Harrington, Machine Learning in Action . Manning Publications , April 2012 ,ISBN 9781617290183
9	Tom Mitchell, Machine Learning, Mcgraw-Hill, First Edition, ISBN No. 0-07-115467-1.
10	Christopher M. Bishop, Pattern Recognition and Machine Learning, Mcgraw-Hill, ISBN No. 978-81-322-0906-5

11	ShaiShalev-Shwartz and Shai Ben David ,Understanding Machine Learning From Theory to Algorithms, Cambridge University Press, First Edition, ISBN No. 978-1-107-05713-5

Web References:

Reference No	Reference Name
1	nptel.ac.in-A first course in Artificial Intelligence-Deepak Khemani,
2	nptel.ac.in -Introduction to machine learning – BalaramanRavindran, IIT Madras
3	Tutorial point.com/machine_learning_with_python/index.htm

Assessment:

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**
MCA23	**Information Security**	**3**	**--**	**3**	**--**	**3**
		Examination Scheme				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	**Test**	**AVG**		
		20	**20**	**20**	**--**	**80**	**100**

Pre-requisite: Computer Networks

Course Objectives: The course aim to

Sr. No.	Course Objective
1	Understand the concepts of Information Security, cryptography and its applications
2	Familiarize various authentication and integrity techniques available
3	Understand firewalls and intrusion detection systems.
4	Familiarize relevant security parameters in the web, internet, database and operating systems

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

Sr. No.	Outcome	Bloom Level
CO1	Discuss the requirement of information security , private and public key algorithms and to examine the mathematics of cryptography	Understanding
CO 2	Analyze authentication and integrity techniques available	Analyzing
CO 3	Interpret the importance of firewalls and intrusion detection systems and signatures.	Understanding
CO 4	Relate to the security issues and technologies used in the web, internet, database and operating system	Understanding

Module No.	Detailed Contents	Hrs
1	**Introduction** : Introduction to Information Security, principles, services and attacks, functional requirements of security, current trends in security	03

	Self learning topics:	
	Need for security, Security approaches	
2	**Cryptography and Authentication:**	**10**
	Cryptography: Concept: Symmetric and Asymmetric Cryptography. Mathematics of cryptography: Modular Arithmetic Additive Inverse, Multiplicative Inverse, Euclidean Algorithm and Extended Euclidean Algorithm.	
	Stream Cipher and Block Cipher, Concept of Confusion and Diffusion. Modes of Operation of Block Cipher: ECB, CBC, OFB, CFB , DES, RSA, Numerical on RSA	
	Authentication: Types of authentication, Biometric Authentication and Third Party Authentication using KDC and Kerberos Version 5, Mutual authentication ,reflection attack	
	Self learning topics:	
	Variations of DES – 2DES and 3DES , Symmetric and Asymmetric Key Cryptography together	
3	**Digital certificates and integrity**	**8**
	Digital Signature: Concept, Compare Digital Signature with Public Key Cryptography, Digital Signature Schema.	
	Public Key Infrastructure (PKI): Private key management, Public Key Cryptography Standards (PKCS). Digital Certificate Creation Steps,X.509 Certificate, Certificate Revocation	
	Integrity: Message Integrity, Hash functions Properties Algorithm:MDC,MAC,HMAC,MD5, SHA -512	
	Self learning topics:	
	PKIX model, Data integrity threats	
4	**Internet and web security**	**8**
	SSL, IPSec, Email Security- PGP, Email attacks	
	Web services Security: web app versus web service concept, WS-Security, SOAP web service, SAML assertion, Browser attacks, web attacks targeting users, obtaining user or website data.	
	Self learning topics:	
	SET , SSL Vs SET, S/MIME	

5	**Firewall and IDS**	6
	Firewall: Introduction, Characteristic ,Types :Packet Filter, Stateful and Stateless Packet Filter, Attacks of Packet Filter, Circuit Level and Application Level Firewall, Bastion Host, Firewall Configurations.	
	Intrusion: What is Intrusion, Intruders, Intrusion Detection, Behavior of Authorized user and Intruder, Approaches for Intrusion Detection: Statistical Anomaly Detection and Rule based Detection. Audit Record and Audit Record Analysis.	
	Self learning topics:	
	Virtual Private Network (VPN)	
6	**Database and OS Security**	5
	Introduction to database, Security requirements of database, sensitive data, Database access control, inference, Security in operating systems: Operating System Structure, Security Features of Ordinary Operating Systems, Operating System Tools to Implement Security Functions, Rootkit: Phone Rootkit, Sony XCP Rootkit, TDSS Rootkits.	
	Self learning topics:	
	Cryptographic Toolkits, Denial of Service attack	

Reference Books:

Reference No	Reference Name
1	AtulKahate, "Cryptography and Network Security", McGraw Hill
2	Kaufman C., Perlman R., and Speciner, "Network Security", Private Communication in a public world, 2nd ed., Prentice Hall PTR.,2002
3	Cryptography and Network Security, Behrouz A Forouzan
4	Cryptography and Network Security: Principles and Practice, William Stallings
5	Computer Security :William Stallings , Edition 6
6	Security in Computing fifth edition Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies
7	Network Security sand Cryptography: Bernard Menezes, CENGAGE Learning
8	Network Security bible, Eric Cole
9	Cryptography And Information Security, V. K. Pachghare

10	Information Systems Security: Security Management, Metrics, Frameworks and Best practices: Nina Gobole
11	The complete reference Information Security by Mark Rhodes-ousley

Web References:

Reference No	Reference Name
1	https://link.springer.com/content/pdf/10.1007%2F978-1-4302-6383-8_16.pdf
2	docs.oracle.com/cd/B19306_01/server.102/b14220/security.htm
3	https://www.w3.org/Security/security-resource
4	https://www.sophos.com/en-us/labs/security-threat-report.aspx
5	https://www.tutorialspoint.com/cryptography/data_integrity_in_cryptography.htm
6	https://www.unf.edu/public/cop4610/ree/Notes/PPT/PPT8E/CH15-OS8e.pdf

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. Weight age 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**
MCAE241	**Image Processing**	3	--	3	--	3
		Examination Scheme				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	Test	AVG			
		20	20	20	--	80	100

Pre-requisite:

☐ Probability and Statistics
☐ Linear algebra, Differential equation and Calculus
☐ Basic Programming Skills

Course Objectives : Course aim to

Sr.No.	Course Objectives
1	Study the fundamental concepts of Digital Image processing and to discuss mathematical transforms .
2	Study image enhancement techniques and explore DCT and DFT techniques
3	Expose students to various image enhancement, restoration methods and morphological operations.
4	Analyze Image Data Compression and morphological Operation
5	Explain various Applications of Image Processing

Course Outcomes:

Sr.No.	Course Outcomes	Bloom Level
CO1	Explain the fundamental concepts of a digital image processing System	Understanding
CO 2	Apply techniques for enhancing digital images	Applying
CO3	Examine the use of Fourier transforms for image processing in the frequency domain	Analyzing
CO4	Compare various Image compression standards and morphological Operation	Analyzing
CO5	Identify various Applications of Image Processing	Understanding

Module	Detailed Contents	Hrs
1	**Introduction to Image Processing Systems:** Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model Vidicon and Digital Camera working principles Brightness, contrast, hue, saturation, mach band effect, **Colour image fundamentals**-RGB, CMY, HSImodels 2D sampling,quantization. **Self Learning Topic:** Image acquisition techniques used in a digital camera, Structure of a 24-bit bmp colour image.	6

2	**Image Enhancement in the Spatial domain:** Spatial domain methods: point processing- intensity transformations, **histogram** processing, image subtraction, image averaging Spatial filtering- smoothing filters, sharpening filters Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter. **Self Learning Topic:** Interpretation of various image attributes by plotting their histograms , Applications of filters in various domains.	7
3	**Discrete Fourier Transform:** Discrete Fourier Transform: Introduction , DFT and its properties, FFT algorithms ñ direct, divide and conquer approach, 2-D DFT &FFT**Image Transforms :** Introduction to Unitary Transform, DFT, Properties of **2-D** DFT, FFT, IFFT, Walsh transform, Hadamard Transform, Discrete Cosine Transform, Discrete Wavelet Transform: Haar Transforms, KL Transform **Self Learning Topics:** Signals, Fourier Transform, Color space and Transformation.	8
4	**Image Restoration and Image Segmentation:** Image degradation, Classification of Image restoration Techniques, Image restoration Model, Image Blur, Noise Model : Exponential, Uniform, Salt and Pepper, Image Restoration Techniques : Inverse Filtering, Average Filtering, Median Filtering. **The detection of discontinuities** - Point, Line and Edge detections: Prewit Filter, Sobel Filter, Fri-Chen Filter Hough Transform, Thresholding Region based segmentation Chain codes, Polygon approximation, Shape numbers. **Self Learning Topics:** Difference between image enhancement and restoration/ The use of motion in Segmentation.	8
5	**Image Data Compression and morphological Operation:** Need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding, dictionary based compression, transform Based compression, Image compression standards- JPEG &MPEG,vector quantization, wavelet based image compression.**Morphological Operation:** Introduction, Dilation, Erosion, Opening, Closing **Self-Learning Topics:** Image File format, Morphological filters for gray-level images.	7
6	**Applications of Image Processing:** Case Study on Digital Watermarking, Biometric Authentication (Face, Finger Print, Signature Recognition), Vehicle Number Plate Detection and Recognition, Object Detection using Correlation Principle, Person Tracking using DWT, Handwritten and Printed Character Recognition, Contend Based Image Retrieval, Text Compression. **Self-Learning Topics:** Industrial applications.	4

Reference Books:

Reference No	Reference Name
1	R.C.Gonzalez&R.E.Woods, Digital Image Processing, Pearson Education, 3rd edition, ISBN. 13:978-0131687288

2	S. Jayaraman Digital Image Processing TMH (McGraw Hill) publication, ISBN- 13:978-0-07- 0144798
3	Gonzalez, Woods & Steven, Digital Image Processing using MATLAB, Pearson Education, ISBN-13:978-0130085191
4	William K. Pratt, "Digital Image Processing", John Wiley, NJ, 4th Edition,200
5	Sid Ahmed M.A., "Image Processing Theory, Algorithm andArchitectures", McGraw-Hill, 1995.Umbaugh, "Computer Vision".
6	Anil K.Jain,Fundamentals of Digital Image Processing,Prentice Hall of India,2nd Edition,2004.

Web References:

Reference no	Reference name
1	https:// www.ict.gnu.ac.in › sites › files › subject syllabus pdf
2	https:// www.gtu.ac.in › syllabus › sem7
3	https:// www.nptel.ac.in › content › syllabus_pdf
4	https:// www.ktuweb.com › page_showdoc › dopage=syllabus
5	https://www.cse.iitkgp.ac.in › syllabus
6	https:// www.vit.edu › images › btech_syllabus_entc_16-17
7	https:// www.iitkgp.ac.in › fac-profiles › showprofile
8	https:// www.cse.iitb.ac.in › ~ajitvr › cs663_fall2018

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		
MCAE242	Internet of Things	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: 1. Knowledge of Computer Networks.

            2. Basics of Cloud.

Course Objectives: The Course aim to

Sr.No.	Course Objective
1	Explain the basics of IoT, M2M, IoT enabling technologies, characteristics of IoT systems and IoT levels.
2	Explain different state of art IoT reference models and architectures as well as Architecture Reference Model (ARM) for IoT.
3	Explain the IoT protocols, IoT security aspects and generic design methodology.
4	Discuss IoT applicability in various domains along with the concept of Web of Thing (WoT) and Cloud of Thing (CoT).

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

Sr.No.	Outcome	Bloom Level
CO1	Compare M2M and IoT; discuss applicability of IoT enabling technologies, characteristics of IoT systems and IoT levels.	Understanding
CO 2	Explain different state of art IoT reference models and architectures as well as Architecture Reference Model (ARM) for IoT	Understanding
CO 3	Analyze various protocols for IoT, IoT security aspects and generic design methodology	Analyzing
CO 4	Develop cloud based and web based IoT Model for specific domains.	Applying

Module	Detailed Contents	Hrs

	Module: Introduction to IoT and M2M:
	
	 ☐ Definition & Characteristics of IoT
	 ☐ Physical Design of IoT- Things in IoT
	 ☐ Logical Design of IoT- IoT Functional Blocks , IoT Communication Models , IoT Communication APIs
	 ☐ IoT Enabling Technologies- Wireless Sensor Networks , Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems
	 ☐ IoT Levels & Deployment Templates- IoT Level-1 ,IoT Level-2, IoT Level-3
	 ☐ M2M to IoT – The Vision :
	   ☐ Introduction
	   ☐ From M2M to IoT
	     o A brief background**,**
	     o M2M communication,
	     o Differing characteristics
	 Self Learning Topics:
	
	 ☐ IoT Level-4, IoT Level-5, IoT Level-6
	 ☐ M2M to IoT – A Market Perspective
	 ☐ M2M to IoT – An Architectural Overview
		6

2	**Module: IoT Architecture:**
	
	 ☐ Introduction
	 ☐ State of the Art
	   o European Telecommunications Standards Institute M2M/oneM2M
	   o International Telecommunication Union Telecommunication sector view
	   o Internet Engineering Task Force architecture fragments
	   o Open Geospatial Consortium architecture
	 ☐ Architecture Reference Model
	   o Introduction,
	   o Reference model and architecture,
	   o IoT reference model
	     ☐ IoT domain model, Information model, Functional model, Communication model, Safety, privacy, trust, security model
	   o IoTReference Architecture
	     ☐ Introduction, Functional view, Information view, Deployment and operational view
	
	 Self Learning Topics: Other relevant architectural views
		12

3	**Module: IoT Protocols and Security:** ☐ IoT Protocols : Protocol Standardization for IoT Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols – IEEE 802.15.4, BACnet Protocol, Modbus,	6

	KNX, Zigbee Architecture, Network layer, APS layer.	
	☐ IoT Security: Need for IoT Security,IoTVulnerabilities, Elements of IoT Security, IoT Security best practices, Threat Modeling an IoT system **Self Learning Topics:** Basics of Internet Protocols, Basic understanding of cryptography	
4	**Module: IoT Platform Design Methodology:** ☐ Purpose and requirement specification ☐ Process specification ☐ Domain model specification ☐ Information model specification ☐ Service specifications ☐ IoT level specification ☐ Functional view specification ☐ Operational view specification ☐ Device and component integration ☐ Application development **Self Learning Topics:** Basics of DFD, UML Modeling	**4**
5	**Module: Domain SpecificIoTs:** ☐ HomeAutomation 　o　Smart Lighting 　o　Smart Appliances 　o　Intrusion Detection 　o　Smoke/Gas Detectors ☐ Cities 　o　Smart Parking 　o　Smart Lighting 　o　Smart Roads 　o　Structural Health Monitoring 　o　Surveillance 　o　Emergency Response ☐ Environment 　o　Weather Monitoring 　o　Air Pollution Monitoring 　o　Noise Pollution Monitoring 　o　Forest Fire Detection 　o　River Floods Detection ☐ Energy 　o　Smart Grids 　o　Renewable Energy Systems 　o　Prognostics ☐ Retail 　o　Inventory Management 　o　Smart Payments 　o　Smart Vending Machines ☐ Agriculture 　o　Smart Irrigation 　o　Green House Control ☐ Industry	**6**

	o Machine Diagnosis & Prognosis o Indoor Air Quality Monitoring **Self Learning Topics:** Case Study on Logistics and Health & Lifestyle	
6	**Module: Web of Things and Cloud of Things:** ☐ Web of Things: Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence. ☐ Cloud of Things: Grid/SOA and Cloud Computing, Cloud Middleware, Cloud Standards – Cloud Providers and Systems, Mobile Cloud Computing, The Cloud of Things Architecture. **Self Learning Topics:**Basics of Web and Cloud.	6

Reference Books:

Reference No	Reference Name
1	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler,VlasiosTsiatsis, Catherine Mulligan, Stefan Aves and StamatisKarnouskos, David Boyle, ELSEVIER
2	Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014
3	IoT Security for Dummies, Lawrence Miller, John Wiley & Sons Ltd.
4	Practical Internet of Things Security, Brian Russell, Drew Van Duren, PACKT publishing
5	The Internet of Things in the Cloud:A Middleware Perspectiv,By Honbo Zhou
6	Rethinking the Internet of Things A Scalable Approach to Connecting Everything, Francis daCosta, Apress
7	Getting Started with the Internet of Things, CunoPfister
8	The Internet of Things: Connecting Objects,HakimaChaouchi

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		
MCAE243	Robotic Process Automation	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: 1. Software Engineering

2. Basics of Computer Science

Course Objectives: The course aim to

Sr. No.	Course Objective
1	Explain the concepts of Robotic Process Automation
2	Explain the process methodologies for BOT development
3	Apply knowledge BOT development for intelligent automation
4	Explore various RPA tools with their specifications

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

Sr. No.	Course Outcome	Bloom Level
CO1	Define the key concepts of Robotic Process Automation and evolution.	Remembering
CO2	Demonstrate development of BOT with specific tools	Understanding
CO3	Apply RPA implementation cycle considering security and scaling	Applying
CO4	Examine specifications of RPA tools and justify applications of appropriate tool for problem.	Analyzing
CO5	Assess performance of BOTs in context of intelligent automation	Evaluating

Module No.	Detailed Contents	Hrs
1	**Module: Introduction to RPA:** ☐ What is RPA, ☐ Flavors of RPA, ☐ History of RPA, ☐ Benefits of RPA, ☐ Current Status of RPA Utilisation and Value, ☐ Levels of RPA, ☐ Skills Required for RPA, ☐ RPA Lifecycle, ☐ RPA Use Cases **Self Learning Topics:** ☐ Evolution of RPA, ☐ RPA compared to BPA, BPM and BPO,	5
2	**Module: Process Methodologies and Planning:** ☐ Lean, ☐ Six Sigma, ☐ Applying Lean and Six Sigma to RPA, ☐ Planning:ROI for RPA, ☐ Agile technology for RPA ☐ Relationship between RPA and Workload Automation **Self Learning Topics:** Other relevant architectural views	5
3	**Module: BOT Development** ☐ Analysis of Business Process and development of BOT, ☐ Activities, Flowcharts and sequences, Log Message, loops and conditions, ☐ Common UIPath Functions, ☐ Best practices for BOT Development, ☐ Evaluating BOT Performance ☐ Error Handling **Self Learning Topics:** Learning UiPath Studio	8
4	**Module: Deployment, Monitoring and Data Preparation for RPA** ☐ Testing, Monitoring ☐ Type of Data for RPA, ☐ Data Process and Types of Algorithms, ☐ Managing RPA Implementation Cycle **Self Learning Topics:** Security, Scaling for RPA	6

	Module: Intelligent Automation & BOT Management	
5	□ Cognitive Automation, □ Intelligent Process Automation or IPA, □ Examples of cognitive RPA □ Web Scrapping □ Types of BOTs, □ Examples of BOTs, **Self Learning Topics:** Difference between RPA BOT and ChatBOTs	6
6	**Module: Security of BOT:** □ Security Challenges for RPA □ Secured BOT Development and Secured BOT Deployment, □ secured BOT architecture design, □ security requirements through threat modeling **Self Learning Topics:** Risks for RPA.	2
7	**Module: RPA Technologies & Case Studies** □ RPA Tools: UIPath, BluePrism, WorkFusion, Nice, □ Open Source RPA , □ Resilient Automation □ Case studies of RPA implementation **Self Learning Topic: RPA Best Practice**	8

Reference Books:

Reference No	Reference Name
1	Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", 1st Edition, 2019
2	Mathias Kirchmer, Peter Franz and Danny Bathmaker, "Value-Driven Robotic Process Automation Enabling Effective Digital Transformation" , October 2019
3	Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks and Become an RPA Consultant", May 2018.
4	GerardusBlokdyk, "Robotic Process Automation Rpa A Complete Guide - 2020 Edition", 1st Edition, 5STARCooks, 2019.
5	Alok Mani Tripathi, " Learning Robotic Process Automation", 2018, Packt Publishing
6	Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide", November 2018, Packt Publishing

Web References:

Reference No.	Reference Name
1	https://resources.automationanywhere.com/articles

2	https://www.automationanywhere.com/in/solutions
3	https://www.infobeans.com/robotic-process-automation-lifecycle
4	https://university.automationanywhere.com/rpa-courses/
5	https://www.uipath.com/blog/the-evolution-of-rpa-past-present-and-future
6	https://university.automationanywhere.com/rpa-learning-trails/business-analyst/
7	https://www.chatbot.com/blog/6-types-of-bots-that-can-serve-your-clients/
8	https://university.automationanywhere.com/?ReturnUrl=%2fcourse%2f1324366%2fmodule%2f3719818%2fScorm%3fLPId%3d0&LPId=0
9	https://university.automationanywhere.com/?ReturnUrl=%2fcourse%2f1324366%2fmodule%2f3719818%2fScorm%3fLPId%3d0&LPId=0
10	https://university.automationanywhere.com/rpa-learning-trails/automation-anywhere-university-essential-level-prep-courses-mba-students/
11	https://university.automationanywhere.com/rpa-learning-trails/automation-anywhere-university-essential-level-prep-courses-mba-students/
12	https://university.automationanywhere.com/rpa-learning-trails/technical-support-specialist/
13	https://university.automationanywhere.com/rpa-learning-trails/automation-anywhere-secure-bot-developer/
14	https://www.onesourcevirtual.com/resources/blogs/technology-and-innovation/prepare-for-robotic-process-automation-with-lean-six-sigma.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
MCAE244	Computer Vision	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 Computer Graphics and Image Processing*

Course Objectives: The course aim to

Sr. No.	Course Objective
01	Learn basic concepts and applications of computer vision.
02	Learn image processing techniques
03	Use and implement feature detection mechanism
04	Understand advanced concepts leading to object and scene categorization from images.

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

Sr.No.	Course Outcome	Bloom Level
CO1	Explain Concepts and Applications of Computer Vision	Understanding
CO2	Apply image processing techniques to design Computer Vision applications	Applying
CO3	Implement algorithms of face recognition and motion detection	Analyzing
CO4	Provide solutions to real world computer vision problems	Creating

Module No.	Detailed Contents	Hrs.
1	**Module: Introduction to Computer Vision** Definition of Computer Vision, Easy Vs Hard Problems, Computer Vision System, Components of a vision system, Applications of Computer vision, Image Sources for computer Vision, Image structure and Pixels, Frameworks for Computer Vision	06

	Self Learning Topics: Computer vision in Finance		
2	**Module: Basic Image Handling and Processing** Geometric primitives and transformations, Plotting images, points and lines, Image contours and histograms, Histogram equalization, Interactive annotation, Gray level transforms, Image Transformations, Image Derivatives **Self Learning Topics:**Image Denoising		07
3	**Module: Local Image Descriptors and Image Mappings** Line Detection-Hough Transforms, Harris corner detector, Edge Detection, SIFT - Scale-Invariant Feature Transform, Matching Geotagged Images, Homographies, Warping images, Creating Panoramas :Camera Models and Augmented reality, Light effects **Self Learning Topics:**Drawing on Images		07
4	**Module: Exploring Structure from Motion** Structure from Motion concepts, Estimating the camera motion from a pair of images, Reconstructing the scene , Reconstruction from many views , Refinement of the reconstruction, Visualizing 3D point clouds, Object Recognition and Bag-of-Words Models **Self Learning Topics:**Object Classification		07
5	**Module: Face Detection and Tracking** Face detection, Pedestrian detection, Face recognition, Eigenfaces, Viola-Jones Algorithm, Haar-like Features, Integral Image, Training Classifiers, Adaptive Boosting (Adaboost) **Self Learning Topics:** Measuring features		07
6	**Module: Convolutional Nerual Networks for CV** CNN Advantages,Architecture,Layers,TrainingCNNs,Build your own CNN,CNN applications **Self Learning Topics: Dogs and cats case study**		06

Reference Books:

Reference No.	Reference Name
1	Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010. ISBN:1848829345
2	Solem, Jan Erik. Programming Computer Vision with Python: Tools and algorithms for analyzing images. " O'Reilly Media, Inc.", 2012.ISBN: 144934193
3	Demaagd, Kurt. Practical Computer Vision with SimpleCV: Making Computers See in Python. 2012.ISBN: 9781449337865

4	Jähne, Bernd, Horst Haussecker, and Peter Geissler, eds. Handbook of computer vision and applications. Vol. 2. San Diego: Academic press, 1999.ISBN: 0123797713
5	Jähne, Bernd, and Horst Haußecker. "Computer vision and applications." A Guide for Students and Practitioners (2000). ISBN:7302269157
6	Baggio, Daniel Lélis. Mastering OpenCV with practical computer vision projects. Packt Publishing Ltd, 2012.ISBN: 1849517827
7	Khan, Salman, et al. "A guide to convolutional neural networks for computer vision." Synthesis Lectures on Computer Vision 8.1 (2018).ISBN: 1681730219

Web References:

Reference No.	Reference Name
1	http://groups.csail.mit.edu/vision/
2	https://medium.com/readers-writers-digest/beginners-guide-to-computer-vision-23606224b720
3	https://vision.in.tum.de/research
4	Deeplearning.ai
5	http://www.cs.cmu.edu/afs/cs/project/cil/ftp/html/vision.html

Assessment:

Assessment:

Continuous Assessment: 20 marks

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

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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**
MCAE24 5	**Embedded Systems**	**3**	**--**	**3**	**--**	**3**
		Examination Scheme				
		Theory		**Term Work**	**End Sem Exam**	**Total**
		CA	**Test**	**AVG**		
		20	**20**	**20**	**--**	**80**	**100**

Pre-requisite:

☐ Computer Organisation & Architecture
☐ Operating Systems
☐ C / C++ / Java Programming

Course Objectives : The course aim to

Sr.No.	Course Objective
1	Introduce students to the features, applications of embedded systems
2	Develop an understanding of the design challenges of embedded systems
3	Understand the basic architecture of 8051 microcontroller
4	Introduce students to Embedded C programming
5	Enable students to develop basic programs for embedded systems using Embedded C.

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

Sr.No.	Outcome	Bloom Level
CO1	Explain hardware and software design requirements of Embedded Systems	Understanding
CO 2	Discuss the architecture of 8051 processor	Understanding
CO 3	Describe 8051 Processor Addressing modes and instruction sets	Understanding
CO 4	Use Embedded C for writing basic programs for embedded systems	Applying
CO 5	Examine the use of various Embedded C programming constructs for writing programs for embedded systems.	Analysing

Module	Detailed Contents	Hrs
1	**Fundamentals of Embedded Systems :** Introduction, Features, Applications of Embedded Systems, Subsystems in an Embedded System. Design Considerations of Embedded Systems : Design Challenges, Common Design Metrics, Design Trade offs and Performance Classification of Computer Architecture : Basic operation of a computer system, CPU Architecture, Microprocessor, Microcomputer. Introduction to Real Time Operating Systems **Self learning topics;** Embedded systems classifications and their usage.	7
2	**Microcontrollers**: Evolution and Uses in Embedded Systems and its Advantages. Architecture of 8051 Microcontroller : Introduction, Block Diagram, Registers, Internal Memory, Counters, I/O Ports, Basic Concepts in Serial I/O **Self learning topics:** Overview of ATOM / ARM Processor	6
3	**8051 Processor Addressing modes and Instruction Set :** Assembly language programming in 8051, Data Types, Addressing Modes, Arithmetic and Logical Operators Interfacing 8051 with external devices : LED's and SSD. **Self learning topics:** Operating systems used for designing embedded systems	6
4	**Embedded C Programming : Introduction :** Introduction to Embedded C, Difference between C & Embedded C, Programming style, Basic structure of the program. Keywords & Identifiers, Data type & its memory representation, Arrays and strings , Input and Output. **Self learning topics;** Practice programming Exercises	6
5	**Embedded C Programming : Operators and control structures :** Types of Operators, Bitwise Operators Decision making with if statement, If….else statement, Switch statement, and GOTO statement, The While and Do – While statements, For statement **Self learning topics:** Practice programming Exercises	6

6	**Embedded C Programming : Functions :** Why Functions, Types of Functions, A Multi functional program, Return values & their types. **Self learning topics :** Practice programming Exercises	5
7	**Case Study** : Use of Embedded systems is designing various commercial applications / appliances : Home Automation Systems, Washing machine etc.	4

Reference Books:

Reference No	Reference Name
1	K V K Prasad, "Embedded/Real Time Systmes : Concepts, Design and Programming", Dreamtech Press
2	Steve Furber, "ARM System-on-chip Architecture", 2e, Addison Wesley
3	Tammy Noergaard, "Embedded System Architecture : A comprehensive Guide for Engineers and Programmers", Newnes (Elsevier)
4	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill
5	Raj Kamal, "Embedded Systems : Architecture, Programming and Design", 2e, Tata McGraw Hill
6	K Uma Rao, AndhePallavi, "The 8051 and MSP430 Microcontrollers : Architecture, Programming and Applications, Wiley
7	Bahadure, Chandrakar, " Microcontrollers and Embedded System Design", Wiley
8	Raj Kamal, "Embedded Systems : Architecture, Programming and Design", Tata McGraw Hill.

Web References: ww.nptel.ac.in

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

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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 and may have 4 sub-questions of 5 marks each.

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		
MCAE251	Natural Language Processing	Contact Hours		Theory	Tutorial	Total
		Theory	Tutorial	3	1	4
		3	1			
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
		CA	Test	AVG		
		20	20	20	25	80	125

Pre-requisite:
- Probability
- Python programming
- Data structure & Algorithms

Course Objectives: The course aim to

Sr.No.	Course Objective
1	Understand natural language processing and to learn how to apply basic algorithms in this field.
2	Get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
3	Implement a rule based system to tackle morphology/syntax of aLanguage
4	Compare and contrast use of different statistical approaches for different types of applications
5	Design a tag set to be used for statistical processing keeping an application in mind, design a Statistical technique for a new application
6	Design an innovative application using NLP components

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

CO No.	Outcome	Bloom Level
CO1	Understand the computational properties of natural languages and the commonly used algorithms for processing linguistic information.	Understanding
CO 2	Understand the information retrieval techniques using NLP	Understanding
CO 3	Apply mathematical techniques that are required to develop NLP applications.	Applying

CO 4	Analyze various NLP algorithms and text mining NLP applications	Analyzing
CO 5	Design real world NLP applications such as machine translation, text categorization, text summarization, information extraction by applying NLP techniques.	Creating

Module No.	Detailed Contents	Hrs
1	**Module: Introduction** History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP **Self learning topics:** Empirical laws	4
2	**Module: Word Level Analysis** Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST Porter stemmer. N –Grams- N-gram language model, **Self learning topics:**N-gram for spelling correction	8
3	**Module:Syntax analysis** Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy **Self learning topics:** Conditional Random Field (CRF).	8
4	**Module:Semantic Analysis** Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Robust Word Sense Disambiguation (WSD),Dictionary based approach **Self learning topics:**WordNet	10
5	**Module: Text Summarization, Text Classification** Text summarization- LEXRANK , Optimization based approaches for summarization , Summarization evaluation, Text classification **Self learning topics:** NLKT , Naïve Bayes Theorem	6

6	**Module: Sentiment Analysis and Opinion Mining** Sentiment Analysis introduction , Sentiment Analysis - Affective lexicons, Learning affective lexicons, Computing with affective lexicons, Aspect based sentiment analysis **Self learning topics:** Named Entity Recognition	4

Reference Books:

Reference No	Reference Name
1	Dan Jurafsky and James Martin. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, Second Edition, 2009.
2	Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
3	Christopher D.Manning and HinrichSchutze, ― Foundations of Statistical Natural Language Processing ―, MIT Press, 1999.
4	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
5	Daniel M Bikel and ImedZitouni ― Multilingual natural language processing applications‖ Pearson, 2013
6	Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) ― The Handbook of Computational Linguistics and Natural Language Processing ― ISBN: 978-1-118-
7	Brian Neil Levine, An Introduction to R Programming
8	Niel J le Roux, SugnetLubbe, A step by step tutorial : An introduction into R application and programming

Web References:

Reference No	Reference Name
1	https://youtu.be/xvqsFTUsOmc
2	https://www.coursera.org/learn/language-processing
3	https://nptel.ac.in/courses/106/105/106105158/
4	https://youtu.be/IIaYk2hIYKk
5	https://www.udemy.com/course/natural-language-processing/?trk=profile_certification_title&utm_source=adwords&utm_medium=udemyads&utm_campaign=DSA

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.

Tutorial

Sr. No.	Detailed Content	Hours
1	NLP processing of any one Indian regional language	4
2	Web mining using NLP (fetching web pages and extracting the human language data from them) for sentiment analysis	4
3	Using NLP to complete analytical tasks such as generating document abstracts	4

Course Code	Course Name	Teaching Scheme			Credits Assigned		
MCAE252	Geographic Information System	**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: The course aim to

Sr.No.	Course Objective
1	Understand the concepts of Geographic Information System.
2	Examine the motive of Vector Data Model
3	Discuss the design of Raster Data Model
4	Demonstrate the Terrain Mapping, View shade and Watershed Analysis outline.
5	Apply knowledge of Geocoding and Dynamic Segmentation
6	Determine the available of Remote Sensing Techniques.

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

Sr. No.	Course Outcome	Bloom Level
CO1	Define the key concept of Geographic Information System	Remembering
CO 2	Examine the various aspects of vector data model by survey and discover of concepts.	Analyzing
CO 3	Elaborate and estimate raster data model by designing and developing effective plan.	Creating
CO 4	Demonstrate understanding of the Terrain Mapping, View shade and Watershed Analysis in contrast by explaining main ideas.	Understand
CO 5	Experiment of Geocoding and Dynamic Segmentation by applying facts and techniques.	Applying
CO 6	Present and explain importance of remote sensing by evaluating recommended set of criteria	Evaluating

Module	Detailed Contents	Hrs.
1	**Principles of GIS:** Introduction: Components of GIS, History of GIS, Elements of GIS, Applications of GIS, Integration of GIS with Web and Mobile Technology	6

2	**Vector Data Model:** Representation of Spatial Features, Topology- TIGER, Importance of Topology, Georelational Data Model-Coverage, Coverage Data Structure, Sapefile, Object Based Data Model- Classes and Class Relationships, Interface, Geodatabase, Topology Rules, Representation of Composite Features- TIN, Regions, Routes	6
3	**Raster Data Model:** Elements of the Raster Data Model- Cell Value, Cell Size, Cell Depth, Raster Bands, Spatial Reference, Satellite Images- Landsat, SPOT, Digital Globe, Sentinel, Terra Satellite, Digital Elevation Models- Optical Sensor, InSAR, LiDAR. Raster Data Structure- Cell-by-Cell Encoding, Run-Length Encoding, Quadtree, Header File	6
4	**Terrain Mapping, Viewshade and Watershed Analysis:** Terrain Mapping- Contouring, Vertical Profiling, Hill Shading, Hypsometric Tinting, Perspective View, Viewshade Analysis- Line-of-Sight Operation, Raster-Based Operation, Raster-Based, TIN-Based, Cumulative, Watershed Analysis- Filled DEM, Flow Direction, Flow Accumulation, Stream Network, Stream Links, Areawide Watershed, Point-Based Watersheds	6
5	**Geocoding and Dynamic Segmentation:** Geocoding, Variations of Geocoding, Application of Geocoding- Location Based Services, Business Application, Wireless Emergency Services, Crime Mapping and Analysis, Public Health, Dynamic Segmentation- Routes, Events, Applications of Dynamic Segmentation: Data Management, Data Display, Data Query, Data Analysis	6
6	**Principles of Remote Sensing:** **Introduction:** Definitions, concepts and types of remote sensing, evolution, stages and advantages of remote sensing, spatial data acquisition, Electromagnetic spectrum, electromagnetic radiation, wavelength regions of electromagnetic radiation, types **Remote Sensing Technologies:** Thermal Remote Sensing – Thermal radiation principles; Precision remote sensing – spatial, spectral and temporal precision; Passive and Active Microwave Remote Sensing **Applications of Remote Sensing:** Applications of remote sensing in agriculture. Applications of remote sensing in forestry, Applications of remote sensing in oceans and coastal monitoring.	10

Reference Books:

Reference No.	Reference Name
1	Remote Sensing and GIS - Bhatta B, Oxford
2	Integrated Coastal and Ocean Management – BilianaCicin-Sain Gunnar Kullenburg, Island Press
3	Remote Sensing and GIS – Anji Reddy, BS Publication
4	Introduction to Geographic Information Systems - Tsung Chang Kang , McGraw-Hill
5	An Introduction to Geographical Information Systems D. Ian Heywood, Sarah Cornelius, Steve Carver, Pearson Prentice Hall, 2006

| 6 | Concepts And Techniques Of Geographic Information Systems 2nd Edition by Chor Pang Lo (Author), Albert K.W. Yeung (Author). PHI |

Web References:

Reference No.	Reference Name
1	https://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/
2	https://gisgeography.com/satellite-maps/
3	https://www.esri.com/en-us/what-is-gis/overview
4	https://gisgeography.com/gis-applications-uses/
5	http://sparcindia.com/gis-case-studies/
6	https://gisgeography.com/geoprocessing-tools/
7	https://bharatmaps.gov.in/

GIS: Tutorials

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 GIS Tools and Techniques	
2	Case studies can be chosen in the area like application of GIS in Industrial Establishments, Mining, Forestry and Environment, Power Utilities, Pipeline Utilities, Transportation and Logistics, Water Resources, Agriculture, Governance, Risk Management, Education Healthcare.	12
3	Presentations based on various GIS concepts can also be included in discussion to understand the application of GIS in real world.	

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		
		Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
MCAE253	Design and Analysis of Algorithm	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: MCAL11 - Data Structures Lab using C/C++

Course Objectives: The course aim to

Sr.No.	Course Objective
1	Analyze asymptotic notations
2	Analyze various problem solving techniques
3	Analyze different algorithmic design paradigms.
4	Interpret approximation algorithms.

Course Outcomes: On Successful Completion of course learner/students will be able to

Sr.No.	Outcome	Bloom Level
CO1	Analyze the time and space complexity of various algorithms.	Analyzing
CO2	Analyze divide and conquer, greedy and dynamic programming strategies.	Analyzing
CO3	Analyze backtracking, branch and bound and string matching algorithm.	Analyzing
CO4	Explain NP hard NP complete problem.	Understanding

Module No.	Detailed Contents	Hrs
1	**Module: Introduction :** Notion of an Algorithm , Fundamentals of Algorithmic Problem Solving, Fundamentals of the Analysis of Algorithmic Efficiency, Asymptotic Notations and their properties. Analysis Framework, Mathematical analysis for Recursive and Non-recursive algorithms, Substitution method and growth of function.	06
2	**Module:Divide And Conquer**: Divide and Conquer Methodology, Binary Search, Merge sort, Quick	08

	sort, Heap Sort, Multiplication of Large Integers, Closest- Pair and Convex- Hull Problems **Self Learning Topics:** Optimal storage on tape		
3	**Module: Greedy Technique**: Introduction, Control Abstraction for Greedy Algorithms, Fractional knapsack, Minimum cost spanning tree(Kruskal, Prims) , Single source shortest path (Dijkstra's algorithm) **Self Learning Topics:** Huffman Coding	06	
4	**Module: Dynamic Programming:** Introduction, Control Abstraction for Dynamic Programming, Knapsack (0/1), Matrix chain multiplication, Longest common subsequence, All pair shortest path (Floyd Warshall) **Self Learning Topics:** DFS and BFS	06	
5	**Module: Backtracking And Brach And Bound:** Introduction to Backtracking, n-Queen problem, Graph colouring problem, Hamiltonian cycle. Branch and Bound, LIFO Search and FIFO search, Least cost search, 15 puzzles, Travelling Salesman Problem. **Self Learning Topics:** Subset Sum Problem	08	
6	**Module: Approximation Algorithms:** NP Hard and NP –complete problem, set covers, Natural algorithms **Self Learning Topics:** Study of open ended problems	02	
7	**Module: String Matching:** Brute force string matching, Knutt-Morris-Pratt algorithm, Rabin-Karp algorithm, Naïve string matching, Finite automata, Boyer Moore algorithm **Self Learning Topics:** Study of applications of string matching	04	

Reference Books:

Reference No.	Reference Name
1	Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, ―Introduction to Algorithms, Third Edition, PHI Learning Private Limited, 2012 **ISBN** 978-0-262-03384-8.
2	AnanyLevitin, ―Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012 **ISBN** 978 0 13 231681 1
3	Ellis Horowitz, SartajSahni and SanguthevarRajasekaran - Computer Algorithms/ C++, Second Edition, Universities Press, 2007 **ISBN**: 9788173716126
4	S. Sridhar ―Design of Algorithms and Analysis, Oxford university press, 2014.
5	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, ―Data Structures and Algorithms, Pearson Education, Reprint 2006
6	Harsh Bhasin, ―Algorithms Design and Analysis, Oxford university press, 2016.
7	Parag H. Dave, Himanshu B. Dave, "Design and Analysis of Algorithms", 1st Edition, 2008, ISBN: 8177585959, Pearson Education.

Tutorials:

Sr.No.	Detailed Contents	Hrs
1	Find time complexity of given code (e.g. using substitution theorem, master theorem etc)	01
2	Problems on recurrence relation	01
3	Comparative analysis of various sorting techniques	02
4	Problem solving on greedy techniques	01
5	Problem solving on dynamic techniques	02
6	Problem solving on backtracking and branch and bound	02
7	Problem solving on string matching	01
8	Case study of trending services (like but not limited to uber, zomato, olx, nature basket, packers and movers etc)	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		
MCAE254	Digital Marketing and Business Analytics	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: The course aim to

Sr. No.	Course Objective
01	Examine and explore the role and importance Digital Marketing in the current business scenario.
02	Familiarize with the various Digital Marketing Tools.
03	Apply Digital Marketing tools for formulating a Digital Marketing Strategy.
04	Understand Digital Marketing Campaigns using various Tools and measure their effectiveness.

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

Sr. No.	Course Outcome	Bloom Level
CO1	Understand the role of Digital Marketing	Remembering
CO2	Demonstrate use of various Digital Marketing Tools.	Understanding
CO3	Discuss key element of Digital Marketing Strategy.	Applying
CO4	Understand use of Digital Marketing Tools for Digital Marketing Campaigns	Analyzing
CO5	Assess / Measure the effectiveness of the Digital Marketing Campaigns.	Evaluating
CO6	Demonstrate practical skills using common digital marketing tools like SEO, SEM, Content Marketing…	Creating

Module No.	Detailed Contents	Hrs.
1	**Module: Fundamentals of Digital Marketing:** Digital Marketing. Digital Marketing Strategy. Skills Required in Digital Marketing, Digital Marketing Plan, **Digital Marketing:** Introduction to Display Marketing, Types of Display Ads, Buying Models, Display Plan, Analytics Tools. Dignified Digital Marketing – Ethics and Data Privacy **Self Learning Topics:** What makes a Good Ad? Programmatic Digital Advertising, YouTube Advertising	04
2	**Module: Search Engine Advertising**	05

	Introduction, Understanding Ad Placement, Understanding AdRanks, Creating First Ad Campaign, Enhance Your Ad Campaign, Performance Reports. **Social Media Marketing** Building a Successful Strategy **Facebook Marketing** Facebook Marketing for Business, Anatomy of an Ad Campaign, Adverts, Facebook Insights, Other Marketing Tools, Other Essentials **Self Learning Topics:** Campaign Management, Running Campaigns, Lead Generation, Qualified Leads	
3	**Module: LinkedIn Marketing** Importance of LinkedIn Presence, LinkedIn Strategy, Sales Leads Generation Using LinkedIn, Content Strategy, LinkedIn Analytics, Targeting, Ad Campaign **Twitter Marketing** Getting Started with Twitter, Building a Content Strategy, Twitter Usage, Twitter Ads, Twitter Analytics, Twitter Tools and Tips for Marketers **Self Learning Topics:**	**09**
4	**Module: Instagram** **Mobile Marketing** Mobile Usage, Mobile Advertising, Mobile Marketing Toolkit, Mobile Marketing Features, Campaign Development Process, Mobile Analytics **Self Learning Topics:** Addressing the Diversity in India through Mobile	**07**
5	**Module: SEO** Search Engine, Concept of Search Engine Optimization (SEO), SEO Phases, On Page Optimization, Off Page Optimization, Social Media Reach, Maintenance **Self Learning Topics:** SEM	**06**
6	**Module: Web Analytics** Data Collection, Key Metrics, Making Web Analytics Actionable, Multi-Channel Attribution, Types of Tracking Codes, Mobile Analytics, Universal Analytics, Competitive Intelligence **Self Learning Topics:** Interpretation of various Charts available in Google Analytics. How to connect Offline with Online.	**08**

Reference Books:

Referenc e No.	Reference Name
1	Digital Marketing, Seema Gupta, McGraw Hill Education (India) Private Limited
2	Social Media& Mobile Marketing: Includes Online Worksheets Puneet Singh Bhatia ,ISBN: 9788126578078
3	Digital Marketing for Dummies, Ryan Deiss& Russ Henneberry, John Wiley & Son, Inc.
4	Social Media Marketing All-In-One, Jan Zimmerman, Deborah Ng, John Wiley & Sons Inc.

5	Epic Content Marketing, Joe Pulizzi, McGraw Hill Education
6	Youtility, Jay Baer, Gildan Media, LLC
7	Hit Makers : The Science Age of Dice of Popularity in an Age of Distraction, Derek Thompson, Penguin Press
8	The Art of SEO, Eric Enge, Stephan Spencer, Jessie Stricchiola, O'Reilly Media Inc,
9	Digital Marketing 2020, Danny Star,

Tutorial

Sr. No.	Detailed Contents	Hrs
01	Digital Marketing – Case Study : Ariel Fashion Shoot	01
02	Display Advertising – Case Study : Anything for Jetta	01
03	Search Engine Advertising – Case Study : Kotak Services	01
04	Social Media Marketing – Case Study : The Fall and Rise of Maggie	01
05	Facebook Marketing – Case Study : Tata DoCoMo	01
06	Facebook Marketing – Case Study : ICICI Bank – Building India's Most Social Bank on Facebook	01
07	LinkedIn Marketing – Case Study : Mercedes Benz, DELL	01
08	Twitter Marketing – Case Study : Mercedes-Benz (2011)	01
09	Instagram – Case Study : H & M	01
10	Mobile Marketing – Case Study : Philips Airfryer	01
11	SEO – Case Study : Barclays Business Banking SEO Campaign	01
12	Web Analytics – Case Study : Conversion Tracking through URL Builder – A Hotel Brand	01

Note: The Case Studies mentioned above are indicative and not limited to. The Teacher has the flexibility of taking similar Case Studies taking into consideration the current scenario and technological changes.

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		
		Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	1	3	1	4
MCAE255	Research Methodology	**Examination Scheme**				
		Theory		Term Work	End Sem Exam	Total
		CA	Test	AVG		
		20	20	20	25	80	125

Pre-requisites:

Basic knowledge of Mathematics for Data Analysis, Software, Internet

Course Objectives: The course aim to

Sr.No.	Course Objective
1	Understand Research and Research Process and their types
2	Acquaint students with identifying problems for research
3	Explain the various research strategies and apply them to various research problems

Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate knowledge of research concepts and processes	understanding
CO 2	Perform literature reviews, prepare the key elements of a research proposal	Applying
CO 3	Compare and contrast quantitative and qualitative research	analyzing
CO 4	Define and develop a possible research interest area using specific research design	applying
CO 5	Explain the rationale for research ethics, and its importance	understanding
CO 6	Demonstrate enhanced writing skills	Applying

Module	Detailed Contents	Hrs

01	**Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences, Objectives of Research , Issues and Problems in Research , **Self Learning Topics** : Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	8
02	**Research types and Design** : Basic Research , Applied Research , Descriptive Research, Analytical Research , Empirical Research ,Qualitative and Quantitative Approaches **Research Design** – Meaning, Types and Significance , Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors **Self Learning Topics** : types of Sampling	8
03	**Research Methodology** Meaning of Research Methodology ,Stages in Scientific Research Process: Identification and Selection of Research Problem , Formulation of Research Problem , Review of Literature , Formulation of Hypothesis , Formulation of research Design , Sample Design , Data Collection , Data Analysis , Hypothesis testing and Interpretation of Data , Preparation of Research Report **Self Learning Topics** : types of Hypothesis	8
04	**Formulating Research Problem** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization , Interpretation, and analysis Validity Testing **Self Learning Topics** : importance of interpretation	5
05	**Ethics :** Ethical Issues , Ethical Committees , Commercialization , copy right , royalty , Intellectual Property rights and patent law , Track Related aspects of intellectual property Rights, Reproduction of published material , Plagiarism, Citation and Acknowledgement ,Reproducibility and accountability. **Self Learning Topics :** Steps of patent filing	5
06	**Testing & Report writing** Preparation of the report on conclusion reached , , Suggestions and Recommendation	5

Reference Books:

Reference No	Reference Name
1	Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2	Kothari, C.R.(2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi.

3	Pruzan, Peter , Research Methodology, The Aims, Practices and Ethics of Science , ISBN 978-3-319-27167-5
4	Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors
5	Wadehra, B.L.2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
6	Kumar Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Web References:

 https://www.wisdomjobs.com/e-university/research-methodology-tutorial-355.html
https://academicguides.waldenu.edu/library/srmo/tutorials

Research Methodology Tutorial

Sr. No.	Detailed Content	Hrs
1	Defining a Research Problem in the area of interest	1
2	Literature Review of the Research Problem - Case Study	1
3	Research Design of the problem - Case Study	1
4	Sampling Design of the problem - Case Study	1
5	Measurement And Scaling Techniques to be used - Case Study	1
6	Formation of hypothesis Methods Of Data Collection for the research problem - Case Study	1
7	Processing And Analysis Of Data for the research problem - Case Study	2
8	Hypothesis testing - Case Study	1
9	Interpretation & Report Writing - Case Study	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

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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	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL21	Artificial Intelligence & Machine Learning	2	1	25	30	20	75

Pre-requisite: Basic understanding of mathematical, data mining concepts and any programming Language.

Lab Course Objectives:

Sr. No.	Course Objective
1	Understand problem solving concepts of artificial intelligence.
2	Impart a thorough understanding of basic machine learning algorithms and its applications.
3	Demonstrate dimensionality reduction techniques for feature extraction and selection.
4	Build model using appropriate machine learning algorithms for real world problems.

Lab Course Outcomes: On the successful completion of the course, students will be able to

Sr. No.	Outcome	Bloom Level
CO1	Apply the basic concepts of artificial intelligence and its applications.	Applying
CO 2	Experiment with basic and ensemble the machine learning algorithms and its applications.	Analyzing
CO 3	Analyze dimensionality reduction techniques for feature extraction and selection.	Analyzing
CO 4	Develop models using appropriate machine learning algorithms for real world problems.	Creating

Description:

Module	Detailed Contents	Hrs
1	**Logic programming with Prolog:** To specify relationships among objects and properties of objects**,** problem solving. **Self Learning Topic: -** Define rules defining implicit relationships between objects.	2
2	**Introduction to Python Programming:** Learn the different libraries - NumPy, Pandas, SciPy, Matplotlib, Scikit Learn.	4

	Self Learning Topic: - Milk, Shogun.	
3	**Supervised Learning:** Linear Regression predicts a real-valued output based on an input value, Logistic regression- the notion of classification, the cost function for logistic regression, and the application of logistic regression, KNN-classification. **Self Learning Topic: -** Evaluation metrics like MSE, Accuracy, Confusion Matrix, Precision, Recall, ROC curve.	4
4	**Dimensionality Reduction:** Features Extraction, Feature selection, Normalization, Transformation, Principal Components Analysis-visualizations of complex datasets. **Self Learning Topic:** - LDA (Linear Discriminant Analysis).	4
5	**Unsupervised Learning:** K-Means clustering algorithm, K-medoid clustering algorithm. **Self Learning Topic:** Other Clustering Algorithms.	2
6	**Classifying data using Support Vector Machines (SVMs):** SVM-RBF kernels. **Self Learning Topic**: -SVM-Kernels-Polynomial kernel.	2
7	**Bagging Algorithm:**Decision Tree,different ensemble techniques like bagging, boosting, stacking and voting, Random Forest- bagging, Attribute bagging and voting for class selection. **Self Learning Topic: -** Extra Trees.	4
8	**Boosting Algorithms:** AdaBoost, Stochastic Gradient Boosting, Voting Ensemble. **Self Learning Topic**: - AdaBoost as a Forward Stage wise Additive Model.	2
9	**Deployment of Machine Learning Models:** simple Web API. **Self Learning Topic**: Python Flask library.	2

Reference Books:

Reference No	Reference Name
1	Aurelian Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition.
2	Paul J. Deitel, Python Fundamentals.
3	Stuart Russell, Peter Norvig ,Artificial Intelligence – A Modern Approach, , Pearson Education / Prentice Hall of India, 3rd Edition, 2009.
4	EthemAlpaydın, Introduction to Machine Learning, PHI, Third Edition, ISBN No. 978-81-203- 5078-6.
5	Peter Harrington, Machine Learning in Action. Manning Publications, April 2012ISBN 9781617290183.
6	Introduction to Computer Programming using Python, John V Guttag
7	Core Python Programming, R. NageswaraRao

Web References:

Reference No	Reference Name
1	https://talentsprint.com/pages/artificial-intelligence-machine-learning-iiit-h-program/program-details.pdf
2	https://learning.oreilly.com/library/view/learning-robotics using/9781783287536/cover.html
3	http://www.qboticslabs.com
4	https://subscription.packtpub.com/book/big_data_and_business_intelligence
5	https://scikit-learn.org/0.16/modules/generated/sklearn.lda.LDA.html
6	https://machinelearningmastery.com/ensemble-machine-learning-algorithms-python-scikit-learn/
7	https://www.coursera.org/learn/machine-learning#syllabus
8	https://data-flair.training/blogs/python-ml-data-preprocessing/

Suggested list of experiments

Practical No	Problem Statement
1	Implementation of Logic programming using LISP /PROLOG-DFS for water jug problem / BFS for tic-tac-toe problem/ Hill-climbing to solve 8- Puzzle Problem.
2	Introduction to Python Programming: Learn the different libraries - NumPy, Pandas, SciPy, Matplotlib, Scikit Learn.
3	Implementation of Linear Regression, Logistic regression, KNN- classification.
4	Implementation of dimensionality reduction techniques: Features Extraction and Selection, Normalization, Transformation, Principal Components Analysis.
5	Implementation of K-Means and K-medoid clustering algorithm.
6	Implementation of Classifying data using Support Vector Machines (SVMs).
7	Implementation of Bagging Algorithm: Decision Tree, Random Forest.
8	Implementation of Boosting Algorithms: AdaBoost, Stochastic Gradient Boosting, Voting Ensemble.
9	Deployment of Machine Learning Models.

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
MCAL22	Soft Skills Development Lab	02	01	50	--	--	50

Pre-requisite: Decent working knowledge of the English language (including Grammar) is a must, keeping in mind that most business/management transactions in India and internationally are conducted in the English language

Lab Course Objectives: Course aim to

Sr. No.	Course Objective
1	Inculcate the essential skills that professionals need to distinguish themselves and make a positive impact on their work and social lives
2	Provide better understanding of corporate culture and to improve their etiquettes, interpersonal skills and professional image
3	Develop holistically and ensure comprehensive learning.

Lab Course Outcomes:

Sr. No.	Outcome	Bloom Level
CO1	Develop interpersonal skills that help in communication, teamwork, leadership and decision making.	Applying
CO 2	Methodically study, formulate and interpret different facets of organizational behavior.	Evaluating
CO 3	Develop holistic leaders and technocrats helping in individual and organizational growth.	Creating

Description:

Module No	Detailed Contents	Hrs
1	**Soft Skills Introduction:** Soft-Skills Introduction What is Soft Skills? Significance of Soft-Skills – Soft-Skills Vs. Hard Skills - Selling Soft- Skills – Components of Soft Skills – Identifying and Exhibiting Soft-Skills **SelfLearning Topics:** Types of Soft, Hard Skills	02
2	**Communication** : Concept and meaning of communication, methods of communication, verbal and non-verbal communication, techniques to improve communication. Communication in a business organization: Internal (Upward, Downward, Horizontal, Grapevine). External Communication, 7 C's of communication. Active Listening, Differences between Listening and Hearing, Critical Listening, Barriers to Active Listening, Improving Listening, Intercultural sensitivies, Business etiquette when dealing with people from different nationalities Practical (Role plays, case studies)	03

	Self LearningTopics : Problems/Barriers in communication	
3	**Written/ Business Communication** : Written Communication: Principles of Correspondence, language and style in official letter (full block format, modified block format), Business letters (enquiry to complaints and redressal), Application letter, CV writing, , E-mail etiquette, Documentation of Meetings, Notice, Agenda, Minutes of Meetings. Practical (Practice on CV, Business Letters, Applications, Notice, Agenda, Minutes of Meetings) **Self Learning Topics:** Impact of modern Technology on Business Communication the paperless office, use of modern devices	**04**
4	**Presentation Skills** : Presentation techniques, Planning the presentation, Structure of presentation, Preparation, Evidence and Research, Delivering the presentation, handling questions, Time management. Visual aids. Practical - Presentation by students in groups of maximum 3 on Organizational Behavior topics allocated by faculty. Topics have to cover – 1. Personality: Meaning, Personality Determinants, Traits, Personality types and its, impact on career growth, 2. Individual / Organizational Decision Making. 3.Attitude: Meaning, Components of Attitude, changing attitude and its impact on career growth 4. Perception and Values. 5. Motivation and Leadership: Concept, Importance. 6. Goal setting: SMART (Specific, Measurable, Attainable, Realistic, Timely) Goals, personal and professional goals 7. Time and Self-Management. 8. Learning in a group, Understanding Work Teams, Dynamics of Group Behavior, Techniques for effective participation 9. Etiquette- General & Business Etiquette, Body language 10. Emotional intelligence of self and SWOC 11. Threats v/s Challenges 12. Dos and Donts of a presentation/ meetings Online & offline.(presenter & members) **Self LearningTopics :** Voice modulation, Tone, Pitch,Knowledge and self confidence	**08**
5	**Effective Public Speaking** : Public Speaking, Selecting the topic for public speaking, Understanding the audience, Organizing the main ideas, Language and Style choice in the speech, Delivering the speech,Voice Clarity. Practical (Extempore) **Self LearningTopics :** Preparation, Attire, Posture and Delivery techniques	**03**
6	**Group Discussions** : Group Discussion Skills, Evaluation components, Do's and Don'ts.	**03**

	Practical (Group Discussions) **SelfLearningTopics: --**		
7	**Interview Techniques** : Interview Techniques, Pre-Interview Preparation, Conduct during interview, Verbal and non-verbal communication, common mistakes. Preparation of CV. Practical (Role plays, mock interviews, Telephonic Interviews, Body Language, Facial Expression) **SelfLearningTopics :** Sample communications and exercises, audio-visual presentations	**03**	

Reference Books:

Reference No	Reference Name
1	Business Communication (Revised Edition),Rai&Rai , Himalaya Publishing House.
2	Soft skills: an integrated approach to maximise Personality, Chauhan&Sharma,Wiley India publications.
3	Business Communication: A practice oriented approach, Kalia and ShailjaAgarwal.
4	Business Communication – Meenakshi Raman, Prakash Singh, Oxford Publication
5	Stephen Robbins & Judge Timothy: Organization Behavior, Pearson Education
6	K. Aswathappa – Organizational Behavior: Text, cases & games, Himalaya Publishing House.
7	Pareek, Udai, Understanding Organizational Behaviour, Oxford University Press, New Delhi.
8	Taylor & Chandra, "Communication for Business: A Practical Approach," Pearson
9	Doctor & Doctor, "Business Communication," Sheth Publishers.

Sugested list of experiments

Practical No	Problem Statement
1	Role Plays
2	Management Activities/Games
3	Case Studies
4	Presentations
5	Extempore Public Speaking
6	Group Discussions
7	Mock Interviews

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   40 marks
   Attendance   10 marks
2. Practical will be evaluated by the subject teacher and documented according to a rubric

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCALE231	Image Processing Lab	2	1	25	30	20	75

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

Lab Course Objectives

Sr.No.	Course Objective
1	To Understand basics of Digital Image Processing concepts and implement basic techniques for handling images
2	To understand tools that can be used to implement image processing algorithms
3	To implement various techniques for image enhancement, segmentation and some basic morphological operations

Lab Course Outcomes

Sr.No	Outcome	Bloom Level
CO1	Understand different image file formats and their structure	Understanding
CO 2	Explain how Digital images are manipulated using various image enhancement techniques	Understanding
CO 3	Learn the signal processing algorithms and techniques in image enhancement and image restoration.	Applying
CO 4	Implement digital transforms	Creating
CO 5	Be able to understand and implement certain image compression techniques.	Understanding

Description:

Module	Detailed Contents	Hrs
I	**Image Enhancement** : Spatial domain and Frequency domain techniques **Self Learning Topics:** color image enhancement	4
II	**Discrete Fourier Transform:** To find DFT/FFT forward and Inverse Transform of Image. **Self Learning Topics:** Image transforms	5
III	**Discrete cosine Transform** : To find DCT forward and Inverse Transform of Image. **Self Learning Topics**: Sine Image Transforms	4

IV	**Image Segmentation and Image Restoration** : The detection of discontinuities - Point, Line and Edge detections, Hough Transform, Thresholding, Region based segmentation Chain codes. **Self Learning Topics:** Image segmentation techniques.	5
V	**Image Data Compression :** Fundamentals of compression, Basic compression Methods. **Self Learning Topics:** Difference between lossy and lossless compression	4
VI	**Morphological Operation** : Morphological operations: Dilation, Erosion, Opening, Closing. **Self Learning Topics:** Erosion, Dilation, Hit or Miss operation.	4

Reference Books:

Reference No	Reference Name
1	R.C.Gonzalez & R.E.Woods, Digital Image Processing, Pearson Education, 3rd edition, ISBN. 13:978-0131687288
2	S. Jayaraman Digital Image Processing TMH (McGraw Hill) publication, ISBN- 13:978-0-07- 0144798
3	Gonzalez, Woods & Steven, Digital Image Processing using MATLAB, Pearson Education, ISBN-13:978-0130085191
4	William K. Pratt, "Digital Image Processing", John Wiley, NJ, 4th Edition,200
5	Sid Ahmed M.A., "Image Processing Theory, Algorithm andArchitectures", McGraw-Hill, 1995.Umbaugh, "Computer Vision".
6	Anil K.Jain,Fundamentals of Digital Image Processing,Prentice Hall of India,2nd Edition, 2004.

Web References:

Reference No.	Reference Name
1	https:// www.ict.gnu.ac.in › sites › files › subject syllabus pdf
2	https:// www.gtu.ac.in › syllabus › sem7
3	https:// www.nptel.ac.in › content › syllabus_pdf
4	https:// www.ktuweb.com › page_showdoc › dopage=syllabus
5	https://www.cse.iitkgp.ac.in › syllabus
6	https:// www.vit.edu › images › btech_syllabus_entc_16-17
7	https:// www.iitkgp.ac.in › fac-profiles › showprofile
8	https:// www.cse.iitb.ac.in › ~ajitvr › cs663_fall2018

Suggested list of experiments

Practical No	Problem Statement
1	Program to display image using read and write operation
2	Program to enhance image using image arithmetic and logical operations.
3	Program to implement Image Negative,
4	Program to implement Thresholding of an Image

5	Program to Implement smoothing or averaging filter in spatial domain
6	Program to produce the Histogram, Equalized Histogram, and Equalized image of an input image
7	Program for smooth an image using low pass filter in frequency domain
8	Program for sharpen the image using high pass filter in frequency domain
9	Program to find DFT/FFT forward and Inverse Transform of Image
10	Program to find DCT forward and Inverse Transform of Image
11	Program to find Edges using Prewit/ Sobel/ Fri-chen / Robert operators
12	Program to find edges using canny Edge Detection
13	Program to implement Huffman coding technique for image compression

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
MCALE232	Internet of Things Lab	02	01	25	30	20	75

Pre-requisite: 1. Knowledge of C and C++ Programming.

        2. Basics of Cloud.

Lab Course Objectives: The Course aim to

Sr. No.	Course Objective
1	Learn basic electronic components and to get familiar with arduino software/hardware and arduino simulator.
2	Interface various I/O devices and sensors with arduino.
3	Interface IoT device with cloud.
4	Develop skills required to build real-life IoT based projects.

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Identify basic electronic components and make use of arduino software/hardware and arduino simulator.	Applying
CO 2	Experiment with various I/O devices and sensors with Arduino.	Applying
CO 3	Build IoT application using Cloud.	Creating
CO 4	Develop IoT based projects.	Creating

Description:

Module	Detailed Contents	Hrs
1	**Module: Introduction to Basic Components** : ☐ Familiarization with Arduino and perform necessary software installation. ☐ Breadboard Basics ☐ Programming the Arduino o Arduino, circuits, and code: Bringing everything together **Self Learning Topics:** Basic electronic components such as LED, resistors, battery etc.	2
2	**Module: Switches, LEDs, and More:** ☐ Programs based on interfacing LED's, Switches/push buttons and Speakers/Buzzer, LCD/ Seven Segment Display with Arduino **Self Learning Topics:** Basics of Switches /push buttons **,** LED, Speakers/Buzzer, LCD/ Seven Segment Display	4
3	**Module: Analog Values** ☐ Programs based on interfacing LED's, Potentiometer, Photoresistor with Arduino ☐ Programs using PWM pins of Arduino ☐ Programs using Serial Monitor of Arduino ☐ Programs based on interfacing DHT11 temperature sensor ☐ Programs based on interfacing Passive infrared sensors (PIR), Ultrasonic	6

	of Arduino **Self Learning Topics:** Basic of Analog values, PWM concepts	
4	**Module: Servo Motors:** ☐ Programs based on interfacing LED's, Servo Motor, Potentiometer with Arduino **Self Learning Topics:** Basics of servo motors, potentiometer	**2**
5	**Module: IoT in Cloud:** ☐ Interfacing IoT device with Cloud **Self Learning Topics:** Computer Network and Cloud Concepts	**4**
6	**Module: Mini Project:** ☐ Mini projects such as Home automation, Robots, Wearable projects, art projects etc. **Self Learning Topics:** Real life problem statement	**8**

Reference Books:

Reference No.	Reference Name
1	Make: Learn electronics with Arduino, Jodi Culkin and Eric Hagan, Maker Media
2	Programming Arduino: Getting started with sketches, Simon Monk , TMH
3	Getting Started with Arduino: A Beginners Guide, Brad Kendal,
4	Make: Getting Started with Arduino, Massimo Banzi, Michael Shiloh, Makermedia
5	Make: Getting Started with Sensors, KimmoKarvinen, TeroKarvinen, Makermedia
6	Learn Electronics wit Arduino, Don Wilcher, Apress
7	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler VlasiosTsiatsis Catherine Mulligan Stefan Aves and StamatisKarnouskos David Boyle
8	VijayMadisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014
9	The Internet of Things in the Cloud:A Middleware Perspectiv,By Honbo Zhou
10	Rethinking the Internet of Things A Scalable Approach to Connecting Everything, Francis daCosta, Apress

Web References:

Reference No	Reference Name
1	http://www.tinkercad.com
2	https://www.arduino.cc/
3	https://www.makerspaces.com/15-simple-arduino-uno-breadboard-projects/
4	https://thingspeak.com/

Suggested list of experiments:

☐ All Programs to be done using Simulation Tool like Tinkercad or any other simulation tool. Interfacing IoT device with cloud using any cloud platform like ThingSpeak, AWS etc.

Practical No	Problem Statement
1	Program to blink Arduino onboard LED and To interface external LED with Arduino and write a program to turn ON LED for 1 sec after every 2 seconds.
2	To interface 5 LED's with Arduino and write a program to blink 6 LEDs, one at a

		time, in a back and forth formation.
	3	To interface Push button with Arduino and write a program to turn ON LED when push button is pressed.
	4	To interface Push button, Speaker/buzzer with Arduino and write a program to turn ON LED and generate a note or tone when push button is pressed.
	5	To interface 2 Push buttons, a Speaker with Arduino and write a program to turn ON LED and generate a 2 different notes on two button keyboard.
	6	To interface Seven Segment Display (SSD) with Arduino and write a program to blink SSD.
	7	To interface Seven Segment Display (SSD) with Arduino and write a program to print numbers from 1 to 4 on SSD.
	8	To interface LCD, push button, potentiometer with Arduino and write a program to display message on LCD when push button is pressed.
	9	To interface LCD, push button, potentiometer with Arduino and write a program to display the no. of times (count) the push button is pressed on LCD.
	10	To interface LED's, potentiometer with Arduino and write a program to turn on or off more of the LEDs by turning the potentiometer knob.
	11	To interface LED, Photo resistor (LDR) with Arduino and write a program to increase and decrease the brightness of the LED based on the amount of light present.
	12	To interface LED's with Arduino and write a program to show the fading effect on LED's.
	13	To interface DHT11 sensor with Arduino and write a program to display temperature and humidity data on serial monitor.
	14	To interface PIR/ Ultrasonic sensor with Arduino and write a program to turn on and off LED depending on motion detection/sound detection.
	15	To interface servo motor/DC motor with Arduino and write a program to sweep a servo back and forth through its full range of motion/ to control a DC motor.
	16	To interface LED with Arduino and write a program to send sensor data to the cloud using ThingSpeak/ AWS and receive notification.
	17	To interface Temperature sensor with Arduino and write a program to send sensor data to the cloud using ThingSpeak/ AWS and receive notification.
	18	To build a mini project based on interfacing any combination of sensors with Arduino and cloud.

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
MCALE233	**Robotic Process Automation**	**02**	**01**	**25**	**30**	**20**	**75**

Pre-requisite: 1. Knowledge of C and C++ Programming.

2. Software Engineering (UML)

Lab Course Objectives:

Sr. No.	Course Objective
1	Identification of Use Cases for creating BOTs
2	Build, Edit and Run BOTs
3	Describe how Automation Anywhere's RPA tool can be used for creating software robots
4	Develop and apply IQ BOTs

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

Sr. No.	Course Outcome	Bloom Level
CO1	Define the key concepts of Robotic Process Automation and evolution.	Remembering
CO2	Demonstrate development of BOT with specific tools	Understanding
CO3	Apply RPA commands to automate atsks	Applying
CO4	Summarize this tool as a summation of Robotic Process Automation, Cognitive Analytics, and Workforce Analytics	Evaluating

Description:

Module	Detailed Contents	Hrs
1	**Module: Introduction to GUI of Tool** Demonstrate good understanding of Recorders, Editor, and various Basic Commands to build simple tasks / Bots for automating simple processes, Develop simple BOT, Control Room Features: Control Room Issues & Login, create Creator & Runner in Control Room, run Bot from Control Room, Schedule Bot from Control Room, working with credential managers, credentials vaults in control room **Self Learning Topics:** Use of Web Control Room of AAE. Control Room, demonstrate client, Audit Log in Control Room	2
2	**Module: Automation anywhere Basic Commands:** MESSAGE BOX, Comment & Variables Type, Clipboard, Delay & Wait, Log To File, Launch Website, - Open Program / File, Read From CSV / Text File, Object Cloning with Insert Keystroke, Variable Operation with Loop,	4

	Window Actions, String operation (Before After - Compare - Find), String operation (Join - Length - Lower Case), String Operation (Replace - Reverse - Split), String Operation (Sub String - Trim - Upper Case), error handling **Self Learning Topics:** Play Sound & System	
3	**Module: Automation anywhere Advanced Commands**: FTP / SFTP, Excel Automation, PDF Integration, Send Email, Email Automation, REST Web Service, SOAP Web Service, Database, PGP (Pretty Good Privacy), Manage Windows Control, OCR (Optical Character Recognition) of Analog values, **Self Learning Topics:** PWM concepts, schedulers and triggers	4
4	**Module: RPA for Excel Commands:** Automation of excel commands for different real-world business use cases using A2019 Excel Commands and Generation of reports for data analysis, decision making, and other business process automation requirements **Self Learning Topics:** Automation of excel commands	4
5	**Module: Working with PDF Documents:** **Self Learning Topics:** Real life problem statement	2
6	**Module: Advanced RPA Techniques:** Manipulating web-based components like textbox, IQBotDahsboard, IQBot Commands, Build resiliency within a bot **Self Learning Topics:** Manipulating web-based component such as drop down	4
7	**Module: Use of UI Path Tool:** **UIPath Orientation, UI Path Structure, Control Flow, Error Handling** **Self Learning Topics: UI Control Flow**	3
8	**Automation of RPA Case study**	3

Reference Books:

Reference No.	Reference Name
1	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems By Tom Taulli
2	Value-Driven Robotic Process Automation Enabling Effective Digital Transformation by Mathias Kirchmer, Peter Franz and Danny Bathmaker
3	Learning Robotic Process Automation- Alok Mani Tripathi, Copyright □ 2018 Packt Publishing

Web References:

Reference No	Reference Name
1	https://www.udemy.com/course/robotic-process-automation/
2	https://www.udemy.com/course/learn-automation-anywhere/
3	https://university.automationanywhere.com/rpa-learning-trails/automation-anywhere-university-essential-level-prep-courses-mba-students/

4	https://www.udemy.com/course/learn-advanced-rpa-automation-anywhere-with-iqbot-and-wlm/
5	https://www.edureka.co/blog/automation-anywhere-examples
6	https://docs.automationanywhere.com/bundle/enterprise-v11.3/page/enterprise/topics/aae-client/bot-creator/commands/commands.html

Suggested list of experiments:

NOTE: All Programs are designed for RPA tool : Automation Anywhere

Interfacing IoT device with cloud using any cloud platform like ThingSpeak, AWS etc.

Practical No	Problem Statement
1	Use of recorder, editors and basic commands to build simple tasks.
2	Run Bot from Control Room and Schedule Bot from Control Room.
3	Automate action of getting the title of active window.
4	Automate action of closing a notepad window.
5	Automate task of replacing few characters from a string
6	Automate task of copying files from a source folder to destination folder.
7	Extract a table from webpage
8	Automate task of extracting a text from a window and display text
9	Automate task of writing text into Notepad file
10	Extract data from JSON file and display output in message box
11	To automate the task of extracting the data from an Excel File according to some condition and storing the extracted data in another File.
12	To automate the task of extracting the data from multiple PDF documents and storing the data into a CSV file.
13	Manipulate web-based components like textbox, drop down
14	Extract data from website and store itin excel or database
15	Demonstrate Scheduler and trigger
16	Design IQ BOT and resilience BOT
17	Apply UIPath tool for some examples.

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
MCALE234	Computer Vision Lab	02	01	25	30	20	75

Pre-requisite: *Fundamental Knowledge of Computer Graphics and Image Processing*

Lab Course Objectives:

Sr.No.	Course Objective
1	Learn basic Image Processing techniques used in Computer Vision
2	Illustrate various components used in Computer Vision
3	Implement Motion Tracking and Face Detection
4	Understand applications of CNN in Computer Vision

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

Sr.No.	Outcome	Bloom Level
CO1	Understand Open CV Framework	Understanding
CO 2	Develop applications using basic image processing techniques used in Computer Vision	Applying
CO 3	Design Applications to Detect Motion and Face in an image	Applying
CO 4	Create a Applications using CNN	Creating

Description:

Unit No	Detailed Contents	Hrs
1	**Module: Open CV and Python** Running Python Programs, Frameworks for CV,UnderstandingOpenCV, Programs using OpenCV	02
2	**Module: Basic Image Handling using python** Reading, Writing and Displaying Images, Plotting images, points and lines, Image contours and histograms, Histogram equalization, Interactive annotation, Gray	06

	level transforms, Image Transformations, Image Derivatives	
	Self Learning Topics: Image Denoising	
3	**Module: Image Transformations**	**06**
	Program based on: Line Detection-Hough Transforms, Harris corner detector, Edge Detection, SIFT - Scale-Invariant Feature Transform, Matching Geotagged Images, Homographies, Warping images, Creating Panoramas :Camera Models and Augmented reality, Light effects	
	Self Learning Topics: Drawing on Images	
4	**Module: Exploring Structure from Motion**	**04**
	Motion Detector Using OpenCV, Motion Detection using Video, Plotting the motion Direction Graph	
	Self Learning Topics: Object Classification	
5	**Module: Face Detection and Tracking**	**04**
	Face detection, Pedestrian detection, Face recognition, Eigenfaces, Viola-Jones Algorithm, Haar-like Features, Integral Image, Training Classifiers	
	Self Learning Topics: Measuring features	
6	**Module: Convolutional Nerual Networks for CV**	**06**
	Object Detection and Identification using CNN, Building a CNN, Project	
	Self LearningTopics:Dogs and cats case study	

Reference Books:

Reference No	Reference Name
1	Solem, Jan Erik. Programming Computer Vision with Python: Tools and algorithms for analyzing images. " O'Reilly Media, Inc.", 2012.ISBN: 144934193
2	Demaagd, Kurt. Practical Computer Vision with SimpleCV: Making Computers See in Python. 2012.ISBN: 9781449337865
3	Jähne, Bernd, Horst Haussecker, and Peter Geissler, eds. Handbook of computer vision and applications. Vol. 2. San Diego: Academic press, 1999.ISBN: 0123797713
4	Baggio, Daniel Lélis. Mastering OpenCV with practical computer vision projects. Packt Publishing Ltd, 2012.ISBN: 1849517827

Web References:

Reference No	Reference Name
1	http://groups.csail.mit.edu/vision/
2	https://medium.com/readers-writers-digest/beginners-guide-to-computer-vision-23606224b720

3	https://vision.in.tum.de/research
4	Deeplearning.ai
5	http://www.cs.cmu.edu/afs/cs/project/cil/ftp/html/vision.html
6	http://groups.csail.mit.edu/vision/

Suggested list of experiments

Practical No	Problem Statement
1	Program for Reading, Writing and Displaying Images
2	Program for Changing Color Spaces
3	Program to resize Images
4	Program to Rotate Images
5	Programs using Histogram Equalization
6	Programs for Edge detection
7	Programs for Line Detection
8	Programs using Scale Invariant Feature Transform (SIFT)
9	Programs for Motion Detection
10	Programs for Face Detection
11	Programs to differentiate objects

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
MCALE235	**Embedded Systems Lab**	**02**	**01**	**25**	**30**	**20**	**75**

Pre-requisite: Basic understanding of C / C++ and Python Programming.

Lab Course Objectives

Sr.No.	Course Objective
1	Understand basics of Embedded Systems and methods for programming.
2	Understand tools that can be used to write and execute programs for 8051 microcontrollers.
3	Implement some basic programs in Embedded C for 8051 microcontroller.
4	Execute some basic interfacing methods.

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

Sr.No.	Outcome	Bloom Level
CO1	Understand the programming environment of the 8051microcontroller	Understanding
CO 2	Explain how microcontrollers can be programmed using embedded C programming	Understanding
CO 3	Learn execution of Embedded C programming using simulators	Applying
CO 4	Implement some basic hardware interfacing programs for 8051 / ARM / Raspberry Pi / Arduino	Analyse

Description:

Module	Detailed Contents	Hrs
1	**Introduction to Kiel or any other Simulator:** Introduction to Keil or any other simulator for executing Embedded C programs	2
2	**Embedded C Programming:** Introduction to Basics of Embedded C Programming, Program Structure and execution Methodology, Basic programs in Embedded C : Variable and Constant Declaration and	4

	Basic Input Output, Arrays		
3	**Embedded C Programming : Operators and Control Structures:** Basic programs on Operators and Control Structures	5
4	**Embedded C Programming : Functions** : Basic Programs to demonstrate the use of Functions.	5
5	**8051 Interfacing:** Basic Programs for interfacing various I/O ports and other devices with 8051 microcontroller.	6
6	**Raspberry Pi / Arduino platforms:** Introduction to basic interfacing methods on Raspberry Pi / Arduino or similar platforms using C / C++ / Java / Python	4

Reference Books:

Reference No	Reference Name
1	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill
2	Raj Kamal, "Embedded Systems : Architecture, Programming and Design", 2e, Tata McGraw Hill
3	K Uma Rao, AndhePallavi, "The 8051 and MSP430 Microcontrollers : Architecture, Programming and Applications, Wiley
4	Bahadure, Chandrakar, " Microcontrollers and Embedded System Design", Wiley
5	Raj Kamal, "Embedded Systems : Architecture, Programming and Design", Tata McGraw Hill.
6	Michael J. Pont, "Embedded C", Pearson Education, 2nd Edition

Web References:

Reference No.	Reference Name
1	www.nptel.ac.in
2	www.keil.com
2	www.arduino.cc
3	www.raspberrypi.org

Suggested list of experiments

Practical No	Problem Statement
1	Program for basic Input/output.
2	Program to declare, initialize and use basic data types.
3	Program to implement control structures : If-Else
4	Program to implement control structures : While Loop
5	Program to implement control structures : for Loop
6	Program to implement Functions
7	Program to read and write a byte to a Pin of 8051

8	Program to continuously toggle an LED connected to an output pin of 8051
9	Program to display numbers on a Seven Segment Display connected to 8051
10	Program to generate time delay
11	Introduction to Raspberry Pi / Arduino processor kits and its interfaces
12	Program for interfacing LED / LCD Panel using Python / C++ / Java on Raspberry Pi / Arduino
13	Program for interfacing a DC Motor / Switches using Python / C++ / Java on Raspberry Pi / Arduino

Experiment No. 1 to 10 can be performed using simulators / emulators like Keil / Proteus / Mbed Studio. Experiment No. 11 to 13 can be performed using any of the kits available.

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 term work will be evaluated by the subject teacher and documented accordingly.

End Semester Practical Examination:

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

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL24	Advanced Web Technologies	04	02	50	30	20	100

Pre-requisite:

1) Understanding of Object Oriented Programming concepts
2) Basic knowledge of web technologies

Lab Course Objectives:

Sr.No.	Course Objective
1	Understand advanced windows and web development techniques using dot NET
2	Use Microsoft ADO.NET to access data in web Application
3	Impart understanding of Web Techniques and Design Web Services
4	Learn advanced web framework MVC with razor

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Develop Web applications using various controls and programming techniques.	Applying
CO 2	Implement Data Binding applications using ADO.NET	Analyzing
CO 3	Solve identity management problems in web Applications application using session management and AJAX concepts.	Evaluating
CO 4	Create modern web applications using Web Services and MVC5	Creating

Description:

Module No	Detailed Contents	Hrs
1	**Module: Basics of C#** Windows Forms Application, Classes and Objects, UI Controls, Inheritance, Interfaces, Abstract Classes **Self-Learning Topics**: Indexers and Strings Manipulations	4
2	**Module: Introduction to ASP.NET** Design Simple web pages(Data types, variables, operators,ASP.net Objects), Basic Server side controls, Working with CrossPage, Postback And Autopostback ,Advanced Web server controls (validation, Calendar, AdRotator, Navigation, File upload),Build an	12

		Applications using Angular JS,JQuery and NodeJS, Websites using Master Pages (creating master and content pages) **Self-Learning Topics**: Themes and skins	
3		**Module: Database Programming in ASP.NET** Connected and disconnected Architecture of ADO.NET , Commands, Datasets, Data Readers, Data Adapters, Working with Stored Procedures, Data bound controls (DataList, DetailsView, FormView, GridView, ListView, Repeater), LINQ with ASP.NET,LINQ Introduction, Mapping data model to an Object model, Introducing query syntax, Entity Framework **Self-Learning Topics**: Charts and Data Pagers	10
4		**Module: Session Management and AJAX** Client Side State Management - View State, Query String, Cookie, Hidden Fields ,Server Side State Management Various State Management Techniques - Profiles, Session State, Application State, cache ,ASP.NET Applications with AJAX , AJAX Controls, Testing an ASP.NET Ajax application, Global.asax and Web Config,Caching **Self-Learning Topics**: Web Parts	8
5		**Module: Web Services and WCF** Creating and Consuming a XML Web Service-Simple and Database ,Creating and Consuming a WCF service – Simple and Database **Self-Learning Topics**: Caching Web service responses	6
6		**Module: ASP.NET MVC** Designing MVC application, Creating a Simple Data-Entry Application with validations, Using Automatically Implemented Properties, Using Object and Collection Initializers, Using Extension Methods, Using Lambda Expressions, Programs based on MVC Pattern, FORMS AND HTML HELPERS, Define and access the model type , Reduce duplication in views, Specify a default layout, Pass data values to the view from the controller , Generate different content based on data values, Add a namespace to a view **Self-Learning Topics**: Xamarin application	12

Reference Books:

Reference No	Reference Name
1	Spaanjaars, Imar. Beginning ASP. NET 4.5. 1: in C# and VB. John Wiley & Sons, 2014. ISBN: 1861009038
2	Evjen, Bill, Scott Hanselman, and Devin Rader. Professional ASP. NET 3.5 SP1 Edition: In C# and VB. John Wiley & Sons, 2011. ISBN: 0470187573
3	Freeman, Adam. "Pro asp. netmvc 5 platform." Pro ASP. NET MVC 5 Platform. Apress, Berkeley, CA, 2014. ISBN: 1430265418
4	Allen, K. Scott, et al. Professional ASP. NET MVC 5. Wrox Press, 2014. ISBN: 1118794753
5	Walther, Stephen. ASP. Net 4.5 Unleashed. Pearson Education India, 2012. ISBN: 067233688X
6	Nagel, Christian, Jay Glynn, and Morgan Skinner. Professional C# 2008 John Wiley & Sons, 2014. ISBN: 0470191376
7	MacDonald, Matthew. ASP. NET: The Complete Reference. McGraw-Hill, Inc., 2002. ISBN: 0072125764
8	Schildt, Herbert. C# 4.0: the complete reference. Tata McGraw-Hill Education, 2010.

Web References:

Reference No	Reference Name
1	https://docs.microsoft.com/en-us/aspnet/core/?view=aspnetcore-3.1
2	ttps://docs.microsoft.com/en-us/aspnet/mvc/overview/getting-started/introduction/getting-started
3	https://docs.microsoft.com/en-us/dotnet/csharp/programming-guide/
4	https://www.w3schools.com/asp/default.ASP
5	en.wikipedia.org › wiki › Web_service
6	https://docs.microsoft.com/en-us/aspnet/core/mvc/views/razor?view=aspnetcore-3.1

Suggested list of experiments

Practical No	Problem Statement
1	Design UI based applications using basic Windows forms Controls
2	Design Applications using Classes and Objects
3	Design Applications using Inheritance and Abstract Classes
4	Design a Web Application for an Organization with Regisration forms and advanced controls
5	Create website using master page concept.
6	Build an angular web application.
7	Design a webpage to demonstrate a connection oriented architecture.
8	Design a webpage to demonstrate a disconnected architecture.
9	Create a webpage that demonstrates the use of data bound controls of ASP.NET.
10	Design a webpage to demonstrate the working of a simple stored procedure.
11	Design a webpage to demonstrate the working of parameterized stored procedure.
12	Design a webpage to display the use of LINQ.
13	Build websites to demonstrate the working of entity framework in dot net.
14	Design Web Applications using Client Side Session Management
15	Design Web Applications using Server Side Session Management Techniques
16	Design Web Application to produce and Consume a web Service
17	Design Web Application to produce and Consume a WCF Service
18	Design MVC based Web applications.

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 the suggested practical list and entire syllabus.

Course Code	Course Name	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
MCAL25	User Interface Lab	02	01	25	30	20	75

Pre-requisite: Basic knowledge of Web Technologies and Software Engineering.

Lab Course Objectives

Sr.No.	Course Objective
1	Understand the importance of User Interface Design (UI) Process.
2	Analyze how to design Effective and Efficient User Interfaces for intended users.
3	Learn techniques for Prototyping and Evaluating User Experience.
4	Apply the concept of Good UI and User Experience (UX).

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Interpret user needs and context of User Interface design Specification	Analyzing
CO2	Demonstrate the tools and techniques for designing informing models	Applying
CO3	Develop high fidelity prototype for end to end solution.	Applying
CO4	Apply best practices for evaluating user experience.	Applying

Description:

Module	Detailed Contents	Hrs
1	**The UI life cycle:** Introduction to UI life cycle and UI tools. **Self Learning Topics:** phases and importance of UI life cycle	4
2	**Requirement gathering:** Include the business purpose and user needs. **Self Learning Topics:** Understand the user, types of users, requirement gathering techniques, contextual enquiry.	2
3	**Analysis:** User analysis,Task analysis,Domain analysis **Self Learning Topics:** Identifying the types of tasks, design objects model, contextual analysis.	4
4	**Design:** Scenario, Storyboard designs. **Self Learning Topics: Principles of good design, Mental model**	4
5	**Build and test the low fidelity prototype:** Build a prototype. Paper prototype, Wireframe Prepare a briefing for test users.(test the prototype) **Self Learning Topics: Types of prototypes**	4

6	**Implementation:** Working implementation of the chosen project. Light weight page loading, optimal design. **Self Learning Topics:** Implementation tool, user friendly design.	6
7	**Testing:** Evaluate the interface with a small user test and write a final reflection **Self Learning Topics : Testing Techniques**	2

Reference Books:

Reference No	Reference Name
1	Norman, Donald , *The Design of Everyday Things,* Basic Books*,* ISBN 978-0-465-06710-7
2	Steve Krug, Don't Make Me Think, Revisited: A Common Sense, New Riders, ISBN ,Third edition, 978-0-321-96551-6
3	Golden Krishna,The Best Interface Is No Interface, New Riders, First Edition, ISBN*978-0-133-89041-9.*
4	Theo Mandel, The Elements of User Interface Design, Wiley, First Edition, 978-0471162674
5	Wilbert O. Galitz, The Essential Guide to User Interface Design : An Introduction to GUI Design Principles and Techniques, Wiley , Second Edition, 978-8126502806
6	Rex Hartson and Pardha S Pyla, The UX Book, Morgan Kaufmann, 9780123852410

Web References:

Reference No	Reference Name
1	http://jjg.net/ia/elements.pdf
2	http://www.boxesandarrows.com
3	https://www.nngroup.com/articles/

List of Experiments:

1	**Introduction to UI life cycle and UI tools.**
2	**Project Proposal and Requirement Gathering (Choose the project)** The project should be a web, desktop, or mobile interface. If the chosen project is a mobile application, note that it must at least be possible to simulate the project, since one of the prototypes will be such a simulation that can be evaluated.
3	**Analysis** **Problem statement:** Briefly state the problem(s) that the project will seek to solve. Take the user's point of view. Consider what the user's goals are, and what obstacles lie in the way. **Output :** ☐ Write up a user analysis, task analysis (identify three tasks of the chosen problem), and domain analysis clearly, concisely, and completely. ☐ Design a persona. ☐ A problem object model or entity-relationship diagram.

4	**Design**
	Creation of Scenario
	Write a scenario that involves all three of the tasks identified for the chosen project.
	Output:
	    ☐ Explain the Scenario
	    ☐ Sketch the scenario (use any tool or hand sketches)
	    ☐ Draw a mental model.

5	**Prototype**
	Creating a Paper Prototype and High Fidelity prototype (Wire Frame)usingFigma tool.
	Output
	    ☐ Paper prototype
	    ☐ Wireframe.

6	**Implementation** The code should be optimal and user friendly.
7	**Usability Evaluation of the Design** Testing of User Interface from Third Party(**Test scripts**) **Output** ☐ Test Script

Assessment:

Term Work: Will be based on Continuous Assessment

1. Laboratory work will be based on any two case studies or mini projects based on the above syllabus.

    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
MCAL26	**Networking with Linux**	**02**	**01**	**25**	**30**	**20**	**75**

Pre-requisite: Linux, Computer Networks

Lab Course Objectives

Sr.No.	Course Objective
1	Train to install Network Simulation tool on Linux
2	Familiarize to a Network Simulation Tool
3	Design various network topologies using Network Simulation tool
4	Analyze network traffic using network sniffing software

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate installation and configuration of Network simulator	Understanding
CO 2	Construct network topologies using Network Simulator	Applying
CO 3	Analyze network traffic using network sniffing software	Analyzing
CO 4	Design and develop solutions to complex network problems using Network Simulator and Network Software	Creating

Description:

Module No.	Detailed Contents	Hrs
1	**Introduction to Network Simulation and sniffing software** ☐ Installation of NS3 on Linux ☐ Installation of NetAnim ☐ Installation of Wireshark **Self learning:** Linux Operating System Commands for installation	6
2	**Client Server Network topology using NS-3** ☐ Program to Create simple topology ☐ Programs to different types of topologies ☐ Program for complex topologies ☐ Program for client server networks **Self learning:Network** Programming in Java	10
3	**Animating the Network** ☐ Introduction to NetAnim ☐ Animation a network using NetAnim **Self learning: Other Animation tools available with NS3**	4
4	**Analyzing Network traffic** ☐ Monitoring the Network using WireShark **Self learning: Parameters used for analyzing Network Traffic**	2
5	**Real time problem Solving** ☐ Mini Project of Creating Complex Networks using NS3, NetAnim and WireShark **Self learning: Integrating NS3,NetAdmin and Wireshark**	4

Reference Books:

Reference No	Reference Name
1	Learning Network Programming with Java by Richard M. ...
2	Java Network Programming, Third Edition, by Elliotte Rusty Harold.Oreily Pub
3	TCP/IP Sockets in Java, Second Edition: Practical Guide for Programmers (The Practical Guides)2nd Edition by Kenneth L. Calvert , Michael J. ...

Web References:

Reference No	Reference Name
1	https://www.nsnam.org/docs/release/3.9/manual.pdf
2	https://www.nsnam.org/tutorials/NS-3-LABMEETING-1.pdf
3	https://www.nsnam.org/wiki/Installation
4	https://www.nsnam.org/releases/ns-3-30/download/
5	https://www.nsnam.com/2014/08/installing-netanim-software-for-ns3-in.html
6	https://www.wireshark.org/download.html
7	https://www.wireshark.org/docs/wsug_html_chunked/ChBuildInstallWinInstall.html
8	https://www.howtogeek.com/104278/how-to-use-wireshark-to-capture-filter-and-inspect-packets/

Suggested list of experiments

Practical No	Problem Statement
1	Installation of NS-3 in Linux
2	Installation of NetAnim
3	Installation of WireShark
4	Program to simulate traffic between two nodes
5	Program to simulate star topology
6	Program to simulate bus topology
7	Program to simulate mesh topology
8	Program to simulate hybrid topology
9	Program to simulate UDP server client
10	Program to simulate DHCP server and n clients
11	Program to simulate FTP using TCP protocol
12	Animate a simple network using NetAnim in Network Simulator
13	Animate Three way handshake for TCP connection using NetAnim
14	Program to assign IPv4 Addresses in NS3
15	Analyze the network traffic using WireShark
16	Analyze the performance parameters of network using Wire Shark

Assessment:

Term Work: Will be based on Continuous Assessment

1. Laboratory work will be based on the syllabus with minimum 10 experiments, mini project has to be assessed internally.

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	Pract.	Oral	Total
MCAP21	Mini Project – 1 B	02	01	50	-	--	50

Pre-requisite: NIL

Lab Course Objectives: The course is aimed to

Sr. No.	Course Objective
1	Conceptualize knowledge with emphasis on team work, effective communication, critical thinking and problem solving skills.
2	Adapt to a rapidly changing environment by having learned and applied new skills and new technologies.
3	Acquaint with the process of applying basic computer applications and provide solutions to the problems in various application domains.

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	Apply software project management skills during project work.	Applying
CO3	Build small groups to work effectively in team on medium scale computing projects.	Creating
CO4	Design and evaluate solutions for complex problems.	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 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		
		Contact Hours				
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
MCA31	Big Data Analytics and Visualization	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:

Referenc e 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**
		3	**--**	**3**	**--**	**3**
MCAE332	**Deep Learning**	**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

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 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**	**7**
	Difference between unity and C# scripting, Scripting basics, Variables, Operators, Conditionals, Iterations, Methods, Input,Classes	
	Self LearningTopics: Exception Handling	
4	**Module: Managing State and Transitions**	**7**
	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	
5	**Module: Physics and Special Effects**	**7**
	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	
6	**Module:Inventory Logic**	**6**
	Using Layers,Creating the Inventory Screen,Adding Inventory Icons,Organizing the Inventory Objects, InventoryLayout,Inventory overflow	
	Self LearningTopics: Dialog Trees	

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

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

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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.

Cou rse Code	Course Name	Teaching Scheme		Credits Assigned		
		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
MCAE335	Quantum Computing	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 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

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		
		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
MCAE343	**Management Information System**	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: 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		
		Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
MCAE34 4	Cyber Security and Digital Forensics	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** 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
5	**Module: Data Recovery and Evidence Collection** 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	8
6	**Module: Network Forensic and Steganography** 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	10

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		
MCAE345	**Entrepreneurship Management**	**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: 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 CRUD Document: Insert, Query, Update and Delete Document. **Self-Learning Topics:** HBASE Commands	4
4	Hive: Introduction Creation of Database and Table, Hive Partition, Hive Built in Function and Operators, Hive View and Index. **Self-Learning Topics**: Configure Hive Metastore to MySQL	4
5	Pig: Pig Latin Basic Pig Shell, Pig Data Types, Creating a Pig Data Model, Reading and Storing Data, Pig Operations **Self-Learning Topics:**	4
6	Spark: RDD, Actions and Transformation on RDD , Ways to Create -file, data in memory, other RDD. Lazy Execution, Persisting RDD **Self-Learning Topics:** Machine Learning Algorithms like K-Means using Spark.	2
7	Visualization: Connect to data, Build Charts and Analyze Data, Create Dashboard, Create Stories using Tableau **Self-Learning Topics:** Tableau using web.	6

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 Matei**Z**aharia,"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.

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

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**

8	**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	**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

		Use port scanning. network scanning tools, IDS tool, sniffing tool and generate reports.	
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

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) Presentation	Credits Assigned	
				Presentation	Total
			01	01	01

			Examination Scheme		
MCAR42	Research Paper	Institute	Internal Assessment		Total
			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			
		Contact Hours			Theory	Practical	Tut.	Total
		Theory	Pract	Tut				
MCABR2	**Data Structures**	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

Module	Detailed Contents	Hrs
05	Non-linearData Structures: • 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	Pract	Tut	Theory	Practical	Tut.	Total	
		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

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

Module	Detailed Contents	Hrs
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