Minutes of Meeting
Board of Study
Master of Computer Application
(Computer Science & Engineering)

[Applicable w.e.f. Academic Session 2025-2026 till Revised]

FACULTY OF ENGINEERING & TECHNOLOGY
RAMA UNIVERSITY, UTTAR PRADESH, KANPUR

Website: www.ramauniversity.ac.in

Ref: RU/FET/CSE/BOS/2025/004

Dated: 19-Aug-2025

Faculty of Engineering & Technology

Department of Computer Science & Engineering

Minutes of Meeting

Boards of Studies

A meeting of Boards of Studies of Master of Computer Application held on 19-Aug-2025 in Dean Office. The following members were present:

1. Dr. Indrajeet Gupta - Chairperson
2. Dr. Abhay Shukla - Member
3. Dr. Somendra Tripathi - Member
4. Dr. Neeraj - Member

The following members agreed to review the minutes online meeting mode.

1. Dr Tapas Badal - External Member
2. Dr. Vandana Dixit Kaushik - External Member
3. Dr. Shubha Jain - External Member
4. Mr. Lokesh Mehra - External Member
5. Mr. Talha Jawed - External Member

Agenda Items

1. **Proposed Change in the Scheme:**
   - ✓ Review and approval of modifications in the academic scheme for upcoming sessions.
2. **Proposed Change in the Credits and Course Nomenclature:**
   - ✓ Discussion on aligning course credits and titles as per updated academic and industry requirements.
3. **Proposed Change in Syllabi and Introduction of New Evaluation Scheme:**
   - ✓ Examination and approval of revisions in existing syllabi to meet emerging technological trends.
   - ✓ Introduction and implementation of a new evaluation scheme for better assessment of student learning.
4. **Internship during MCA:**
   - ✓ Proposal to include structured internship components in the MCA program.
5. **Incorporation of MOOCs in Syllabus**
   - ✓ Integration of Massive Open Online Courses (MOOCs) into the curriculum to enhance learning outcomes.
6. **Incorporation of Flipped Classroom Approach**
   - ✓ Adoption of flipped classroom methodology to improve student engagement and practical learning.
7. **Revision of External Examiner Panel**
   - ✓ Review and update of the panel of external examiners for various courses and programs.

The BOS committee confirmed the minutes of the BOS meeting held on 19-Aug-2025

1. **Action Taken Report (ATR) in Minutes of Previous Meeting**
   The BOS Committee confirmed the minutes of the BoS Meeting Held on 10 May 2024.
   The BOS Committee discussed on Action Taken Report on the basis of result analysis of session 2023-24 (Even) and 2024-25 (Odd Semester).

2. **R-25 Specialization**
   The committee, vide Ref. No. FET/CSE/DO/2025/07-28 dated 28 July 2025, approved the introduction of the following specializations under the R-25 scheme to meet industry requirements and align with NEP 2020 and AICTE 2022 guidelines.
   - i. Artificial Intelligence
   - ii. Data Science
   - iii. Cloud Computing

3. Consider and approve new Evaluation Scheme and Syllabus of 02 Year MCA Program.

S. No.	Item No	Feedback from Faculty and Student	Action Taken / Remarks
1	**RU/FET/CSE/BOS/2025/MCA/001**	**Proposed Change in the Scheme** Students and faculty suggested revising the existing scheme to reduce redundancy, ensure better alignment with industry trends, and incorporate multidisciplinary flexibility as per NEP 2020.	The committee took the decision to revise the scheme under **R-25**, restructuring the curriculum to ensure flexibility, skill-based learning, and alignment with NEP 2020 provisions.
2	**RU/FET/CSE/BOS/2025/MCA/002**	**Proposed Change in the Credits and Course Nomenclature** Faculty emphasized rationalizing credits to balance workload; students requested clarity and uniformity in course titles to match industry standards.	The committee took the decision to rationalize credits as per **AICTE 2022 guidelines** and update course nomenclature to reflect industry relevance.
3	**RU/FET/CSE/BOS/2025/MCA/003**	**Proposed Change in Syllabi and Introduction of New Evaluation Scheme** Feedback from both **faculty and students** highlighted the need to revise the existing syllabi by incorporating modern and industry-relevant subjects such as Artificial Intelligence, Robotics, Cloud Computing, Cybersecurity, and Generative AI. It was also emphasized that the evaluation process should shift towards a more holistic and skill-oriented model, with increased focus on continuous assessment methods including projects, assignments, seminars, certifications, and class participation.	The committee reviewed and approved the R-25 Assessment Components, which are structured as: CA: 30 Marks, MTE: 20 Marks, and ETE: 50 Marks, Total 100 Marks. For Continuous Assessment (CA), the distribution will be: Attendance – 10 Marks, and Assignments/Quiz/Seminar/Term Paper/Certificate/Class Project – 20 Marks. The committee also resolved to update the syllabi by incorporating industry-oriented courses and emerging technologies, along with introducing a revised evaluation scheme that places greater emphasis on projects, assignments, and continuous assessment.
4	**RU/FET/CSE/BOS/2025/MCA/004** (In reference with Circular No: RU/DA/2025/020 Dated: 28 July 2025)	**Incorporation of MOOCs in Syllabus** Faculty and students requested flexibility to pursue online courses (SWAYAM, NPTEL, Coursera) for skill enhancement.	The committee took the decision to incorporate MOOCs in the curriculum, allowing credit transfer (up to 20%) as per **AICTE norms.**
5	**RU/FET/CSE/BOS/2025/MCA/005**	**Incorporation of Flipped Classroom Approach**	The committee took the decision to formally introduce the flipped classroom pedagogy and

		Students preferred interactive and practice-oriented sessions; faculty supported blended learning to increase participation.	circulate guidelines to faculty for effective implementation.
6	**RU/FET/CSE/BOS/2025/MCA/006**	**Course Bucket Structure under R-25** Students and faculty suggested increasing elective choices and introducing structured specialization options.	The committee took the decision to approve the following bucket structure under **R-25**: • **Specialization Core I & II Bucket – 12 Courses** • **Specialization Elective Bucket – 20 Courses** • **Professional Elective Bucket – 15 Courses** • **Open Elective Bucket – 16 Courses**
7	**RU/FET/CSE/BOS/2025/MCA/007**	**Final Year Dissertation / Industrial Training in MCA** Faculty and industry feedback suggested including project-based learning and real-world exposure in the final year.	The committee took the decision to introduce **Final Year Dissertation or Industrial Training** in MCA under **R-25**, ensuring industry relevance and employability enhancement.

4. The experts suggested introducing a **Multiple Entry and Exit** option. In response, it was decided that the matter will be taken up for detailed discussion in the next BoS meeting (December 2025) in line with university norms.
5. **Revision of External Examiner Panel** Faculty recommended updating the panel to include experts from both academia and industry.

   The committee took the decision to revise the external examiner panel, including **industry experts and academicians** from reputed institutions.

6. Question Paper Format: The question paper format, as per NAAC/NBA requirements, includes a dedicated column for CO (Course Outcome) mapping against each question. This ensures clear alignment of assessment items with defined learning outcomes, facilitates transparent evaluation, and supports accreditation compliance through measurable and outcome-based education practices.

7. It was clarified that the **R-25 curriculum and evaluation scheme shall be applicable only from the academic session 2025–26 onwards**. The students admitted in earlier sessions will continue to follow the curriculum and regulations approved under the previous BoS.

Date of the Next Meeting: to be decided and conveyed later

Chairperson

Signature: .....

Name: Dr. Indrajeet Gupta

Date: 28/8/25

Internal Members

Signature: 1.....

Name: Dr. Abhay Shukla

2.....

Name: Dr. Somendra Tripathi

3.....

Name: Dr Neeraj

External Members

Signature: 1.....

Name: Dr. Tapas Badal

Signature: 4.....

Name: Mr. Lokesh Mehra

2.....

Name: Dr. Vandana Dixit Kaushik

5.....

Name: Mr. Talha Jawed

3.....

Name: Dr. Shubha Jain

Date: 28/08/2025

Encl.: Recommended Curriculum attached for consideration and approval.

CC:

1. Dean
2. Registrar Office

Program Educational Objectives

MCA Program of Rama University will prepare its students:

PEO 1: To progress their career productively in software industry, academia, research, entrepreneurial pursuit, government, consulting firms and other Information Technology enabled services.

PEO 2: To achieve peer-recognition; as an individual or in a team; by adopting ethics and professionalism and communicate effectively to excel well in cross culture and inter-disciplinary teams.

PEO 3: To continue a lifelong professional development in computing that contributes in self and societal growth.

Program Specific Outcomes

On completion of the Master of Computer Applications degree, the graduates will be able to

PSO1: understand and apply knowledge on analysis, design and development of software applications.

PSO2: utilize skills and knowledge for computing practice with commitment on social, ethical and legal values.

PSO3: prepare graduates who will perform both as an individual and in a team through good analytical, design and implementation skills.

PSO4: work with latest computing technologies and pursue careers in IT industry/ consultancy/ research and development, teaching and allied areas.

PSO5: design, develop and implement interdisciplinary application software projects to meet the demands of industry requirements using modern tools and technologies.

PSO6: analyze the societal needs to provide novel solutions through technological based research.

Program Outcomes:

PO1 - Computational Knowledge: Apply knowledge of computing fundamentals, computing specialization, mathematics, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

PO2 - Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

PO3 - Design /Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO4 - Conduct investigations of complex Computing problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 - Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

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

PO7 - Life-long Learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

PO8 - Project management and finance: Demonstrate knowledge and understanding of the computing and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO9 - Communication Efficacy: Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PO10 - Societal and Environmental Concern: Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practices.

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

PO12 - Innovation and Entrepreneurship: Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and society at large.

Chairperson

Signature: .....

Name: Dr. Indrajeet Gupta

Date:

Internal Members

Signature: 1.....

Name: Dr. Abhay Shukla

2.....

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Signature: 4.....

Name: Mr. Lokesh Mehra

5.....

Name: Dr. Talha Jawed

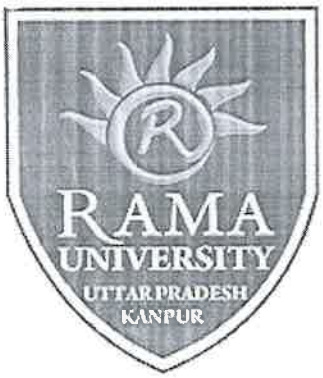
Date:

ORDINANCE
For
Master of Computer Applications

With Specialization in

Cloud Computing (CC)

Program Code:



Faculty of Engineering, Rama University

Preamble

The Master of Computer Applications (MCA) with specialization in Cloud Computing (CC) programme at Rama University is designed to cultivate advanced knowledge, technical expertise, and professional skills in the field of computer science and its applications. This ordinance outlines the academic framework, regulations, and standards governing the MCA with specialization in Cloud Computing (CC) programme to ensure quality education, research orientation, and holistic development of students in alignment with the vision and mission of the University.

1. Program Name & Code

PROGRAM NAME: **MASTER OF COMPUTER APPLICATIONS with specialization in Cloud Computing (CC)**
PROGRAM CODE:
The Master of Computer Applications (MCA) is a Postgraduate (PG) programme. It is offered in Rama University under the Faculty of Engineering, with the following specializations (vide Ref. No. FET/CSE/DO/2025/07-28 dated 28 July 2025):
- Cloud Computing (CC)

2. Eligibility Criteria

Candidates seeking admission to the Master of Computer Applications (MCA) with specialization in Cloud Computing (CC) programme offered by the Faculty of Engineering and Technology at Rama University, Kanpur are required to meet specific eligibility criteria. An applicant must hold either a Bachelor of Science (B.Sc.) degree with Mathematics as one of the subjects or a Bachelor of Computer Applications (BCA) degree from a recognized university. Additionally, the candidate must have secured a minimum of 50% aggregate marks in the qualifying examination to be considered for admission.

3. Admission Procedure

Admission to the programme shall be governed by the provisions of the Acts, Statutes, and Ordinances of Rama University, as in force and as may be amended from time to time. The admission shall be granted strictly on the basis of merit determined through the Entrance Test conducted by Rama University.

Provided further that, while granting admission to the programme, the reservation policy of the Government of Uttar Pradesh, as applicable to admissions in higher educational institutions and as notified from time to time, shall be duly implemented.

4. Duration of the Programme

The Master of Computer Applications (MCA) with specialization in Cloud Computing (CC) programme shall comprise regular study over a minimum period of four semesters

spanning two academic years. The course of study shall be pursued through regular attendance in the prescribed number of lectures, tutorials, and practical training sessions.

Ordinarily, the third semester shall be conducted from 1st July to 31st December, while the first semester shall ordinarily commence from 1st August; the remaining semesters shall be conducted from 1st January to 30th June. These periods shall include the time allocated for examinations and may be modified from time to time as notified by the Vice-Chancellor or other competent authorities. The total duration of the MCA with specialization in Cloud Computing (CC) programme shall be two years, each academic year comprising two semesters, with each semester normally consisting of at least 90 working days or as otherwise prescribed by the UGC/AICTE from time to time.

5. Maximum Duration for Completion

The maximum permissible duration for the completion of the MCA with specialization in Cloud Computing (CC) programme shall be five years, beyond which the candidate shall not be allowed to continue or be awarded the MCA with specialization in Cloud Computing (CC) degree.

6. Medium of Instruction

The medium of instruction, course delivery, examinations, assignments, and laboratory work shall be strictly in English. Students are encouraged to improve communication skills in English through remedial and language enhancement courses offered by the University.

7. Structure of the Programme

The Master of Computer Applications (MCA) with specialization in Cloud Computing (CC) programme is a two-year, four-semester postgraduate programme designed as per NEP-2020, UGC, and AICTE guidelines.

- **Core Courses:** Cover fundamental and advanced subjects in computer science and applications to build strong conceptual foundations.
- **Specialization Core (I and II):** Provide in-depth knowledge and skills in specific emerging domains.
- **Specialization Electives (I, II and III):** Offered in various areas such as Computer Science and Engineering, Artificial Intelligence and Machine Learning, Data Science, Internet of Things, and Cloud Computing.
- **Professional Electives:** Enable students to gain advanced domain-specific expertise within the discipline.
- **Open Electives:** Promote interdisciplinary learning through courses offered by other faculties and departments.

- **Practical and Laboratory Courses:** Provide hands-on training aligned with theoretical subjects to enhance practical skills.
- **Project Work:** Develop research aptitude, problem-solving ability, and application of knowledge to real-world challenges.
- **Internships, lean startup and Industrial Training:** Offer industry, startup setup and exposure, professional experience, and understanding of workplace practices.
- **Seminars, Workshops, and Viva Voce:** Improve communication, presentation, teamwork, and professional competencies.

8. Marks/Credit Distribution

The MCA with specialization in Cloud Computing (CC) programme spans four semesters, progressing from core theory, labs, and skill-based courses in the first two semesters to advanced subjects, electives, and interdisciplinary exposure in the third. The final semester focuses on a major project or internship with seminar and viva, ensuring a balanced blend of theory, practical skills, and professional development aligned with NEP-2020, UGC, and AICTE guidelines.

Semester	Course Type Included	Total Credits
I	Core Theory Courses + Core Labs + Skill Course+ Start of Specialization Core+ Professional Elective	20
II	Core Theory + Labs + + Skill Course+ Specialization Core+ Professional Elective+ Start of Open elective	20
III	Advanced Core + Specialization / Professional Electives + Open Elective + +Capstone project +Lab	15
IV	Dissertation/Project in Research Lab/Industry	15
Total		70

9. Evaluation Procedure

The evaluation scheme is divided into Continuous Evaluation (CE) and End Term Examination (ETE).
Continuous Evaluation (CE) divided into
Continuous Assessment (CA) and Mid Term Examination (MTE)
Assessment Components, are structured as:
CA: 30 Marks,
MTE: 20 Marks,
and ETE: 50 Marks, Total 100 Marks.

Continuous Assessment (CA), the distribution will be:

i) Active participation of students in academic and co-curricular activities, including but not limited to seminars, Student Development Programme (SDP), workshops, and allied engagements, shall be in accordance with the stipulations contained in Circular No. RU/DA/2025/025 dated 25-08-2025. **– 10 Marks**

ii) Assignments/Quiz/Seminar/Term-Paper/Certificate/Class-Project **– 20 Marks.**

Mid Term Examination (MTE) **-20 Marks**

includes written theory papers, viva voce, and practical examinations conducted by internal examiners

End Term Examination (ETE) **– 50 Marks**

includes written theory papers, viva voce, and practical examinations conducted by internal and external examiners.

Seminar/Project: Lean Startups (3rd Semester)

Marks Distribution: CA – 30, MTE – 20, ETE – 50 (Total = 100 Marks)

Assessment:

- Continuous assessment based on presentations, participation, and innovation in startup/project ideas.
- Mid-term evaluation by internal faculty to review project progress.
- End-term evaluation through seminar/viva-voce presentation before an internal board.

Guidelines:

- Each student must prepare and present a seminar/project report on a Lean Startup theme under faculty supervision.
- Emphasis is placed on innovation, feasibility, and practical application.
- Evaluation criteria include originality, clarity of presentation, quality of documentation, and ability to defend ideas.

Capstone Project (3rd Semester)

Marks Distribution: CA – 30, MTE – 20, ETE – 50 (Total = 100 Marks)

Assessment:

- Continuous assessment based on project reports, coding implementation, and periodic presentations.
- Mid-term evaluation conducted by a project review committee.
- End-term evaluation based on project demonstration, report submission, and viva-voce.

Guidelines:

- Students shall undertake the capstone project individually or in small groups under the supervision of a faculty guide.
- The project should integrate knowledge gained across courses and demonstrate problem-solving ability.
- Evaluation will consider technical depth, methodology, quality of implementation, and presentation.

Dissertation/Project in Research Lab/Industry (4th Semester)

Marks Distribution: CA – 100, MTE – 100, ETE – 300 (Total = 500 Marks)

Continuous Assessment (CA): Based on progress reports, project milestones, and interaction with the guide.

Mid-Term Evaluation (MTE): Conducted by a departmental review committee to assess the progress and technical depth of the project.

End-Term Evaluation (ETE): Conducted by a board of internal and external examiners appointed by the Dean, based on report submission, seminar, and viva-voce.
Guidelines:

1. Students shall carry out dissertation/project work in an industry or research laboratory, under a supervisor approved by the Dean.
2. A minimum of four hard copies of the final dissertation report, along with one soft copy, must be submitted at least two weeks before the term-end examination.
3. Evaluation criteria include:
    - Problem identification and objectives.
    - Methodology, technical depth, and use of tools/technologies.
    - Originality, innovation, and contribution to research/industry.
    - Quality of report writing, formatting, and referencing.
    - Seminar/viva-voce presentation and defense.

9.1 Appointment of Examiners

The Head of Department (HoD) shall normally appoint examiners for different courses, ensuring that at least two examiners other than the concerned course instructor are selected at random for theory courses in each semester.

For Laboratory/Project/Viva-Voce examinations, there shall be one internal examiner and one external examiner. A panel of external examiners shall be prepared and approved annually by the Board of Studies (BoS) to facilitate such appointments.

9.2 Moderation of Question Papers

A Moderation Committee constituted by the BoS shall review and, if necessary, revise or improve the question papers. The committee shall consist of:

1. The Dean
2. The Head of the Department
3. Three faculty members nominated by the Dean

9.3 Passing Criteria:

- Minimum 50% marks in aggregate (sessional + end-semester) in each theory subject, with at least 40% marks in the end-semester examination.
- Where no sessional marks are applicable, a minimum of 50% in the end-semester examination is required.
- Minimum 50% marks in project/practical subjects (including sessional marks, if applicable).
- To be promoted, a candidate must secure at least 50% aggregate marks in an academic year (both semesters combined), subject to other conditions prescribed in the University Bye-laws.

9.4 Transcripts:

Transcripts shall be issued by the University for each semester and a consolidated transcript for the entire programme, showing performance in terms of percentage.

9.5 Division and Promotion Rules

Award of Division (Final Year Result) as per below:

Percentage (%)	Division
Below 50%	Fail
50% – 59.99%	Second Division
60% – 74.99%	First Division
75% & above	First Division with Honors'

10. Rules for Backlogs / Supplementary Exams

A student failing in one or more courses shall be eligible to appear in supplementary examinations conducted by the University as per the notified schedule and prevailing rules. The number of permissible backlogs for promotion shall be governed by University promotion regulations. Students failing to clear such backlogs within the maximum duration of the program shall not be awarded the degree. Supplementary examinations may be attempted within the limit of attempts prescribed under University norms. Improvement examinations are permitted only for theory papers already passed, subject to approval of the Examination Cell and applicable University rules.

11. Special Academic Requirements

In addition to the prescribed regular coursework, every student shall be required to complete the courses and activities as specified in the schema/syllabus. Further, the programme mandates participation in co-curricular and professional development components, including a Seminar/Project on *Lean Startups* in the third semester, a minimum of two industrial visits during the programme, a summer internship of 4–6 weeks after the fourth semester, a major internship/industrial training of six months in the final year, a minor project in the sixth semester, and a major project or dissertation during the seventh and eighth semesters. Students must also undertake seminar and viva voce presentations as integral elements of the assessment framework.

12. Other Provisions

12.1 Attendance: Students must maintain a minimum of 75% attendance in every course to be eligible for appearing in examinations. Condonation may be granted in exceptional cases, as per University rules.

12.2 Discipline: Students must adhere to the code of conduct, anti-ragging policies, academic integrity rules, and ethical guidelines laid down by the University.

12.3 Use of Technology: Students are encouraged to complete online certification courses (MOOCs/NPTEL/SWAYAM) to earn credits.

12.4 Plagiarism and Malpractice: Strict action will be taken against students found guilty of unfair practices in examinations, assignments, or project work.

12.5 Change of Program: The change of branch shall be governed strictly in accordance with the prevailing University norms and the provisions contained in the previously applicable ordinances.

12.6 Teaching: Teaching shall be conducted strictly in accordance with the prevailing University norms and in conformity with the provisions of the previously applicable ordinance."

12.7 Examination: Examinations shall be held strictly in accordance with the prevailing University norms and in conformity with the provisions of the previously applicable ordinance.

12.8 Evaluation Feedback: The process of evaluation and feedback shall be regulated in accordance with the established University norms and subject to the stipulations of the earlier ordinance.

12.9 Promotion: Promotion of students shall be determined in pursuance of the University norms and in accordance with the directives contained in the preceding ordinance.

12.10 Carryover: Carryover of courses shall be administered in alignment with the University norms and in consonance with the provisions laid down in the earlier ordinance.

12.11 Ex-Studentship and Re-Admission: Matters pertaining to ex-studentship and re-admission shall be governed in accordance with the University norms and subject to the provisions embodied in the prior ordinance.

13. Exit Options (NEP-2020)

In accordance with NEP-2020 guidelines, the programme provides multiple exit options:

- After 1 year (2 semesters): **PG Certificate in Advance Computer Applications (CC)**
- After 2 years (4 semesters): **Degree in Master in Computer Applications with specialization in Cloud Computing (CC)**

Students opting for exit must fulfill credit requirements and apply formally to the University.

Conclusion

This Ordinance shall come into effect from the academic session 2025-26 and shall be applicable to all new admissions henceforth. The University reserves the right to amend, modify, or update the Ordinance as and when required, subject to approval by statutory bodies. Any interpretation of these regulations shall rest with the Academic Council of Rama University.

Rama University, Uttar Pradesh Kanpur

Faculty of Engineering and Technology

MCA (AI/DS/CC)

I SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	MCA1001	Data structures using Python Programming	2	1	0	3	30	20	50	100
2	MCA1002	Operating System Essentials	2	1	0	3	30	20	50	100
3	MCA1101-1103/MCA1003	Specialization Core I/Computer Network-Layers and Protocols	3	0	0	3	30	20	50	100
4	MCAE201-220/MCAP301-315	Specialization Elective I/Professional Elective I	3	0	0	3	30	20	50	100
5	MCA1004	Software Development Framework	3	0	0	3	30	20	50	100
6	MCA1005	Foundation of Entrepreneurship	2	0	0	2	30	20	50	100
7	MCA1051	Data structures using Python Programming Lab	0	0	2	1	30	20	50	100
8	MCA1151-1153/MCA1053	Specialization Core I/Computer Network-Layers and Protocols Lab	0	0	2	1	30	20	50	100
9	MCA1057	Software Development Framework Lab	0	0	2	1	30	20	50	100
		Total	**15**	**2**	**6**	**20**				**900**

II SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	MCA2001	Algorithms Design for Computer Applications	3	0	0	3	30	20	50	100
2	MCA2002	Information and Database Management Systems	3	0	0	3	30	20	50	100
3	MCA2101-2103/MCA2003	Specialization Core-II/Advanced Programming	3	0	0	3	30	20	50	100
4	MCAE201-220/MCAP301-315	Specialization Elective- II/ Professional Elective II	3	0	0	3	30	20	50	100
5	MCAO401-416	Open Elective I	3	0	0	3	30	20	50	100
6	MCA2004	Ethics, Patents, Copyrights, and IPR	2	0	0	2	30	20	50	100
7	MCA2051	Algorithms Design for Computer Applications Lab	0	0	2	1	30	20	50	100
9	MCA2052	Advanced Information Management Systems Lab	0	0	2	1	30	20	50	100
10	MCA2151-2153/MCA2053	Specialization Core-II Lab/Advanced Programming Lab	0	0	2	1	30	20	50	100
		Total	**17**	**0**	**6**	**20**				**900**

III SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	MCA3001	Seminar/Project: Lean Startups	2	0	0	2	30	20	50	100
2	MCA3002	Capstone Project	0	0	14	7	30	20	50	100
3	MCAE201-220/MCAP301-315	Specialization Elective-III/Professional Elective-III	3	0	0	3	30	20	50	100
4	MCAO401-416	Open Elective-II	3	0	0	3	30	20	50	100

		Total	8	0	14	15				400

IV SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	MCA4001	Dissertation/Project in Research Lab/Industry	0	0	30	15	100	100	300	500
		Total	0	0	15	15				500

Specialization Core I

S No	Course Code	Course Name	L	T	P	C	Specilization
1	MCA1101	Statistical Machine Learning	3	0	2	4	AI Core I
2	MCA1102	Data Analysis using Python	3	0	2	4	DS Core I
3	MCA1103	Cloud Computing	3	0	2	4	CC Core I
4	MCA1151	Statistical Machine Learning	3	0	2	4	AI Core I Lab
5	MCA1152	Data Analysis using Python	3	0	2	4	DS Core I Lab
6	MCA1153	Cloud Computing	3	0	2	4	CC Core I Lab

Specialization Core II

S No	Course Code	Course Name	L	T	P	C	Specilization
1	MCA2101	Intelligent Model Design using AI	3	0	2	4	AI Core II
2	MCA2102	Data Mining and Predictive Modelling	3	0	2	4	DS Core II
3	MCA2103	System and Network Security	3	0	2	4	CC Core II
4	MCA2151	Intelligent Model Design using AI	3	0	2	4	AI Core II Lab
5	MCA2152	Data Mining and Predictive Modelling	3	0	2	4	DS Core II Lab
6	MCA2153	System and Network Security	3	0	2	4	CC Core II Lab

Specialization Elective I

S No	Course Code	Course Name	L	T	P	C
1	MCAE201	Advanced Computer Vision and Video Analytics	3	0	0	3
2	MCAE202	Cognitive Modelling	3	0	0	3
3	MCAE203	Probability and Random Processes	3	0	0	3
4	MCAE204	AI in Healthcare	3	0	0	3
5	MCAE205	Image and Video Processing	3	0	0	3
6	MCAE206	Information Retrieval	3	0	0	3
7	MCAE207	Natural Language Processing	3	0	0	3

Specialization Elective II

S No	Course Code	Course Name	L	T	P	C
1	MCAE208	Social Network Analysis	3	0	0	3
2	MCAE209	Reinforcement Learning	3	0	0	3
3	MCAE210	Digital Marketing and Trend Analysis	3	0	0	3
4	MCAE211	Structural Equation Modelling	3	0	0	3

5	MCAE212	Time Series Analysis	3	0	0	3
6	MCAE213	Data Visualization and Dashboards	3	0	0	3
7	MCAE214	Big Data Analytics and Business Intelligence	3	0	0	3

Specialization Elective III

S No	Course Code	Course Name	L	T	P	C
1	MCAE215	Advanced Database Management System	3	0	0	3
2	MCAE216	Satellite Data Analysis	3	0	0	3
3	MCAE217	Cloud Security and Compliances	3	0	0	3
4	MCAE218	Cloud System Administration and Operations	3	0	0	3
5	MCAE219	Cloud Infrastructure and Services	3	0	0	3
6	MCAE220	Emerging Topics in Cloud Computing	3	0	0	3

Professional Electives I

S No	Course Code	Course Name	L	T	P	C
1	MCAP310	Problem Solving using C	3	0	0	3
2	MCAP301	Secure Coding	3	0	0	3
3	MCAP302	Compiler Construction	3	0	0	3
4	MCAP303	Software Project Management	3	0	0	3
5	MCAP304	Soft Computing	3	0	0	3

Professional Electives II

S No	Course Code	Course Name	L	T	P	C
1	MCAP305	Distributed Computing	3	0	0	3
2	MCAP306	Agile Software Development	3	0	0	3
3	MCAP307	Virtual Reality: Interface, Application and Design	3	0	0	3
4	MCAP308	Combinatorics	3	0	0	3
5	MCAP309	Mobile and Networked Embedded Systems	3	0	0	3

Professional Electives III

S No	Course Code	Course Name	L	T	P	C
1	MCAP311	Game Programming with HTML5	3	0	0	3
2	MCAP312	Software Craftsmanship in DevOps	3	0	0	3
3	MCAP313	Programming using C++	3	0	0	3
4	MCAP314	Device Level IoT Security	3	0	0	3
5	MCAP315	Deep learning	3	0	0	3

Open Electives I

S No	Course Code	Course Name	L	T	P	C
1	MCAO401	Applications of AI	3	0	0	3
2	MCAO402	Web Technologies	3	0	0	3
3	MCAO403	IT Support Technologies	3	0	0	3
4	MCAO404	Software Engineering	3	0	0	3

5	MCA0405	Programming Languages	3	0	0	3
6	MCA0406	Artificial Intelligence for Creative Expression	3	0	0	3
7	MCA0407	AI and Public Policy	3	0	0	3
8	MCA0408	Data Structures and Algorithms	3	0	0	3

Open Electives II

S No	Course Code	Course Name	L	T	P	C
1	MCA0409	Software Testing	3	0	0	3
2	MCA0410	Computing Start-ups	3	0	0	3
3	MCA0411	Career Skills for IT Companies	3	0	0	3
4	MCA0412	Cyber security: Impact on Govts, Policies and Economics	3	0	0	3
5	MCA0413	AI and Society	3	0	0	3
6	MCA0414	Search Engine Optimization	3	0	0	3
7	MCA0415	Growth Hacking	3	0	0	3
8	MCA0416	Digital Marketing	3	0	0	3

Master of Computer Applications (MCA): Syllabus

Computer Science & Engineering

Semester I

Name of Program	Master of Computer Applications				
MCA1001/MCA1051	Data Structures using Python Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	1	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Articulate the design, use and associated algorithms of advanced data structures.
CO2: Examine various advanced searching and sorting techniques based for applicative solutions.
CO3: Demonstrate hands-on experience on implementing different advanced data structures.
CO4: Build optimized solutions for real-word programming problems using efficient data structures.

Course Contents:

UNIT I **08 lecture hours**

Why Data Structures, First Python Program, Execution Cycle of Python Program, OOPs Concepts, Python Inheritance, Multiple inheritance, Friend Function, Run-time Polymorphism, Time Complexity: Asymptotic Analysis, Big-Omega, Big-Theta, Big-Oh Notation, Handling Arrays, Insertion, Deletion, Traversal, Linear Search, Recursion, Binary Search, Tower of Hanoi, Sorting, Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Shell Sort, Counting Sort.

UNIT II **06 lecture hours**

Python Pointers, Structures and Unions, Linked List, Singly Linked List Implementation, Singly Linked List Traversal, Searching, Insertion, Deletion, Polynomial Handling, Circular Linked List, Traversal, Insertion, Deletion, Stacks, Traversal, Insertion, Deletion, Infix to Postfix Conversion, Post-fix Expression Evaluation, Queues, Simple Queue Insertion, Deletion, Traversal, Circular Queue Insertion, Deletion, Traversal.

UNIT III **08 lecture hours**

Tree Data Structures, Height, Complete, Full, Perfect Trees, Binary Search Trees, Pre-Order, In-Order, Post-Order, BST Searching, BST Insertion, BST Deletion, Heaps, Min-Max Heaps, HeapSort, Hashing, Hash Functions, Hash Tables, Hashing Collision Resolution Strategies: Separate Chaining, Open Addressing, Double Hashing, Graphs, Different Types of Graphs, Graphs Representations, Incidence Matrix, Adjacency Matrix, Graphs Traversals: BFS, DFS, Topological Sort.

UNIT IV **06 lecture hours**

Height Balanced Trees: AVL Trees, Balanced Factor, Rotations, Insertion, Deletion, Red-Black Trees, Insertion, Deletion, B Trees, Insertion, Deletion, B+ Trees, Insertion, Deletion, Disjoint Sets, Path Compression, Union Finding Algorithm, van Emde Boas Tree.

Studio Work/ Laboratory Experiments:

The students will be implementing the fundamental design paradigms like dynamic paradigm, greedy algorithms, graphs traversing and several others. The preferred language of the course will be JAVA. Furthermore, the students will be actively participating in open-source projects available at GitHub.

Text Books:

1. Cormen, Thomas H, Charles E Leiserson, Ronald L Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition. MIT Press.
2. Horowitz, Ellis, Sartaj Sahni, and Sanguthevar Rajasekaran. 2008. Computer Algorithms/C++.

Reference Books:

1. Narasimha Karumanchi. 2019. Algorithm Design Techniques: Recursion, Backtracking, Greedy,

Name of Program	Master of Computer Applications				
MCA1002	Operating System Essentials	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Get familiar with the basics of operating systems, concurrency, and various deadlock models
CO2: Comprehend the primitives of distributed operating systems with issues pertaining related to the deadlock detection.
CO3: Explore the diverse protocols available for the resource management and, fault recovery and tolerance in the distributed system.
CO4: Proverbial with the primitives and algorithms available for managing the database operating systems.

Course Contents:

UNIT I **5 lecture hours**

Operating system: Organization, abstraction provided by OS, features and roles, Operating system architecture, OS examples; Process management: Process control block, system calls and interrupts, context switching, schedular and dispatcher, process states and life cycle, multithreading, kernel vs. user level threads, process vs. thread; CPU scheduling algorithms: FCFS, SJF, STRF, priority, round robin, multilevel queue and feedback scheduling, highest response ration next, lottery scheduling.

UNIT II **6 lecture hours**

Inter process communication, shared memory method, message passing method and its types; Process synchronization, critical section problem (CSP), synchronization constructs, hardware solutions to CSP-Lock variables, software solutions to CSP-Peterson solutions, strict alteration; Classical synchronization problem: Producer consumer problem, dining philosopher problem, reader writer problem, monitor; Deadlock, necessary condition for deadlock, deadlock handling mechanism: prevention, avoidance, detection; resource allocation graph, deadlock recovery.

UNIT III **8 lecture hours**

Memory management, techniques, Contiguous: Fixed and variable length partitioning, Non-contiguous: Paging, translation lookaside buffer (TLB), multilevel paging, segmentation, segmented paging; Virtual memory, dynamic loading, demand paging, page fault, thrashing, Page replacement algorithms: First in First Out (FIFO), Least Recently Used (LRU), Optimal Page Replacement; File organization, access mechanism, file allocation methods - Contiguous allocation, linked allocation, indexed allocation, Indexing techniques: Single indirect block, double indirect blocks; Storage management, storage devices — HDD, SSD; disk architecture, disk performance metrics; Disk scheduling algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-Look, NOOP and deadline schedular.

UNIT IV **9 lecture hours**

Distributed systems, network vs. distributed OS, robustness analysis, design issues; Remote procedure call (RPC), structure, parameter passing, handling partial failures, SunRPC and XDR; Distributed file systems, Servers: stateless and stateful, REST; Distributed shared memory, architecture, design principles, consistency model; Security systems calls, authentication & authorization, reliability, availability & privacy, common attacks, crypto systems, Kerberos, access control lists; OS design: MAC, and iOS; Virtualization: Types, models; Cloud computing, architecture, service and deployment models, cloud challenges.

Studio Work/ Laboratory Experiments:

Students will gain practical experience with the implementation and use of operating system functions such

1. Stallings, Willam, Operating Systems Internals and Design Principles (9th e ,a.) , Prentice Hall, 2021. ISBN 978-0134670959.
2. Silberschatz, A., Galvin, P.B. and Gagne, G., Operating System Concepts (10th ed.), John Wiley, 2018. ISBN 978-1- 119-32091-3.

Reference Books:

1. Andrew S Tanenbaum and Herbert Bos, Modern Operating Systems (1st ed.), Pearson, 2021. ISBN 9789332575776.
2. Maurice J. Bach, Design of the Unix Operating Systems (1st ed.), Pearson, 2015. ISBN 978-9332549579.

Name of Program	Master of Computer Applications				
MCA1003	Computer Network-Layers and Protocols	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Examine the functionality of the different layers within network architecture.
CO2: Illustrate TCP/IP model suite protocols.
CO3: Design the networks for organization and select the appropriate networking architecture and technologies, subnetting and routing mechanism.

Course Contents:

UNIT I **6 lecture hours**

Why Computer Networks: Applications of Networks, Transmission Media, Connecting Devices, Local Area Networks: LAN topologies: Bus topology, Ring topology, Star topologies, Mesh topology, Hybrid topology, OSI reference model, TCP/IP Protocol suite, Physical Layer: Services, Line coding scheme, Modulation, Multiplexing, Switching methods, Ethernet, Bluetooth, Wi-Fi, Wi-Fi Direct, WPA/WPA2/WPA3, Data Link layer: Services, Framing, Switches.

UNIT II **6 lecture hours**

Reliable Data Delivery: Error detection, Error Correction, Flow control: Stop and wait, Go Back-N, Flow control: S-R Protocol, Error control (Retransmission techniques, timers), Medium Access sub layer - Channel Allocations, LAN protocols /ALOHA protocols, CSMA, CSMA/CD, Network Layer Protocols: Services (IP, ICMP), IP addressing, sub netting, Super netting (CIDR), IPV4, IPV6.

UNIT III **7 lecture hours**

Routing and Forwarding, Static and dynamic routing, Unicast and Multicast Routing, Distance-Vector Routing, Link-State Routing, Shortest path computation-Dijkstra's algorithm, Address mapping-ARP, RARP, BOOTP, DHCP, Transport Layer: Services, UDP and TCP Principles of Cryptography, Symmetric key, Public key, Authentication protocols, Digital signatures, Firewalls, Security in different layers: segment formats, connection establishment and termination, Expert Lecture from Industry, Congestion control, Congestion control: Open Loop and closed loop, Quality of service, Flow characteristics, Techniques to improve QoS.

UNIT IV **5 lecture hours**

Session Layer: Services, Protocols, Presentation layer: Services, Protocols, Application layer: Services, DNS, SIP, RTP, Telnet/SSH, HTTP, HTTPS, Remote login, Electronic mail, SMTP, FTP Commands and Replies, WWW, SNMP, Addressing Schemes, Uniform Resource Identifiers.

UNIT V **4 lecture hours**

Software-defined networking, Cloud Systems: Services, Data centre, 4G and 5G Networks, Body area sensor Networks, Satellite networks, SWARM networks.

Studio Work/ Laboratory Experiments:

Study of different types of networks cables and practically implement the cross-wired cable and straight through cable using clamping tool. Configure a network topology, connect different networks, static routing and dynamic routing, virtual LAN, RIP and OSPF using packet tracer. Also, Wireshark will be used for network troubleshooting, analysis, software, and communications protocol development.

Text Books:

1. B. A. Forouzan, Data communication and Networking McGraw Hill, 2021. ISBN 10: 1260597822.
2. Andrew S. Tanenbaum and David J. Wetherall, Computer Networks (6th ed.), Pearson, 2021. ISBN 9780137523214.

Reference Books:

Name of Program	Master of Computer Applications				
MCA1004	Software Development Framework	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs):

On completion of this course, the students will be able to:
CO1: To articulate understanding of Software Engineering as an iterative and systematic process.
CO2: To examine the software development process to complement the technical understanding of software products.
CO3: To implement development life cycle through the IDE, UML, and Git.

Course Contents:

UNIT I **8 lecture hours**

Importance of Software Engineering, Phases of software development lifecycle, SDLC case study, Software process model, Waterfall model, V Model, Prototyping model, Incremental model, RAD Model, Spiral model, choosing a model, Lifecycle documents, Agile model, Need of agile, Version Control System, Distributed VC, Git repository, Git online and Desktop, Check-in, and check-out code in repository, Create branch and merging branch, Git + Eclipse/IDE.

UNIT II **7 lecture hours**

Agile manifesto, Agile principles, Agile development methods, Extreme programming (XP), XP principles, Test first development, Refactoring, Pair programming, Scrum, Product backlog, Sprint cycle, Continuous integration, Requirements engineering, Issues in capturing requirements, Requirement elicitation, Requirement analysis, Functional and Non-functional requirements, Requirement specification, Requirement prioritization, User stories, Acceptance criteria, Requirement validation and verification, UML, Use case, Use case Diagram, Include and extend relationship, Generalization in use Case, Top down and bottom-up approach in use case diagram, Guidelines for creating use case diagrams.

UNIT III

7 lecture hours

UML behavioural diagrams, Activity diagram, Activity diagram with swimlane, UML structural diagrams, Class diagram, Relationships in class diagram, Sequence diagram, Rules of creating sequence diagram, Description of relationship between use-case, activity, and sequence diagram, Architectural design, Cohesion, Coupling, Early locking of architecture, Architectural pattern, MVC pattern, Layered architecture, Repository architecture, Client server architecture, Software architect, roles, and responsibilities, Pipe and filter architecture.

UNIT IV **6 lecture hours**

Reverse engineering, Horseshoe model, Software cost estimation, Cost estimation factors, COCOMO model, Software quality assurance and testing, Software testing for competitive advantage, Testing strategies, Designing test cases, Black box testing, Equivalence partitioning, Boundary value analysis, White box testing, Black box vs. white box testing, Control flow testing technique, Control flow graph, Cyclometric complexity, Levels of coverage, Integration testing, Top down and bottom-up integration, Continuous Integration testing, Regression testing, Acceptance testing, System testing, Performance testing.

Studio Work/ Laboratory Experiments:

The course will cover labs in the following areas: Getting used to eclipse and GitHub, hands-on session on software design via Visual Paradigm, Designing and inspecting SRS, software testing using Junit approach.

Text Books:

1. Pressman R, Software Engineering 9th edition, A Practitioner's Approach (9th ed.), McGraw Hill 2019. ISBN 9781259872976.
2. Sommerville I., Software Engineering (10th ed.), Person Publications Publishing Company, 2016. ISBN 978-1-292-09613-1.

Name of Program	Master of Computer Applications				
CMCA602	Foundation of Entrepreneurship	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	0	2
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To discuss the basic understanding of the relevant concepts and practices of entrepreneurship.
CO2: To recognize the essential criteria in the decision to become an entrepreneur or opt for entrepreneurship.
CO3: To practice with the basic tools and tactics required to manage and grow an entrepreneurial firm.

Course Contents:

UNIT I

10 lecture hours

DISCOVERING THE ENTREPRENEUR & ENTREPRENEURSHIP:
The Psychology of An Entrepreneur, What is an entrepreneur? The entrepreneurial mindset: looking inside the black box, Entrepreneurial expertise — orientation, Do: Interact with a Start-up Founder, Do: Discover a Problem to solve.

UNIT II

9 lecture hours

OVERVIEW OF ENTREPRENEURSHIP:
Evolving concept of Entrepreneurship & Entrepreneurial Environment, Entrepreneurial Opportunity the Customer, Market, and Competition, how to avoid the pitfalls of entrepreneurship — The Dark Side, Myths & Realities about Entrepreneurship, Do: Know your customer, do: Perform Market Study —Competition Analysis.

UNIT III

9 lecture hours

WHERE DO GOOD IDEAS COME FROM?
Creativity in Entrepreneurship, The Creative Process — Stages/Steps, Creative Thinking — Techniques, Sources for Generation of Ideas, and Role of Imagination, Effectuation, Improvisation, Analogous Thinking, etc, Problem Finding & Solving — Divergent /Convergent, Associative approaches and Do: Generate Viable Ideas, Do: Prototype a Solution.

Studio Work/ Laboratory Experiments:

The students will identify the project problems from their chosen specialization or inter-disciplinary in nature. The lab component of this course is designed to introduce the tools the students used in analysis, design, implementation, testing, and maintenance. Iterative and incremental evaluations will be done till the problem's solution is converted into a workable solution from a quality perspective. The students will choose the tools for each phase on the approval of the course instructor.

Text Books:

1. Oswaldo Lorenzo, Peter Kawalek, Leigh Wharton,, Entrepreneurship, Innovation and Technology (1st ed.), Taylor & Francis, 2018. ISBN 9781351018401

Reference Books:

1. Khanka, S S, Creativity and Innovation in Entrepreneurship (1st ed.), Sultan Chand & Sons, 2021. ISBN 9788195407125

Semester II

Name of Program	Master of Computer Applications				
MCA2001/MCA2051	Algorithms Design for Computer Applications	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Examine and Analyze the asymptotic performance of algorithms.

CO2: Explain various algorithmic techniques for solving problems.

CO3: Experiment to find and develop optimal solutions by applying different algorithmic strategies for polynomial and non-polynomial problems.

Course Contents:

UNIT I **12 lecture hours**

Introduction to algorithm, What is Time Complexity and Space Complexity, Order of Growth; Approximation; Asymptotic Notations : Big Oh, Theta, Omega, Amortized analysis, Analysing control statement, Loop Invariant, Recurrence Relations Introduction, Back Substitution Method, Recursion Tree Method, Master's Theorem, Divide and Conquer Algorithm, Multiplying large Integers Problem, Median of two sorted arrays, Binary search, Quick Sort, Merge Sort, Max-Min problem, Strassen's Matrix Multiplication, Radix Sort, Bucket Sort.

UNIT II **14 lecture hours**

Greedy Algorithm: General Characteristics, Knapsack Problem, Huffman code, Activity selection problem, Minimum Spanning trees, Prim's algorithm, Kruskal's algorithm with Disjoint sets, Shortest paths: Dijkstra's Algorithm, Graphs Algorithms:- Applications of DFS• bi- connectivity, Topology Sort, Articulation point, Connected components, Max-Flow, Min-Cut, Ford-fuelkerson, Dynamic Programming: • Introduction, Principle of Optimality, Calculating Binomial Coefficient, 0-1 Knapsack, Matrix chain multiplication, Longest Common Subsequence, All Points Shortest path Floyd Warshall, Largest Divisible Subset.

UNIT III **8 lecture hours**

Backtracking and Branch and Bound: - State-Space Search Tree, eight queen's problem, Graph Colouring, Hamiltonian Cycle, Travelling Salesman Problem using Branch and Bound Approach, String Matching Algorithms, Naive string-matching algorithm, Knuth Morris-Pratt algorithm.

UNIT IV **8 lecture hours**

Introduction to NP-Completeness: - P and NP, NP Complete and NP-Hard, Approximation algorithms, Travelling Salesman problem, Randomized Algorithms: Randomized Quick Sort, Computational Geometry: Convex hull, Online Algorithms: K Server Problem.

Studio Work/ Laboratory Experiments:

The students will be implementing the fundamental design paradigms like dynamic paradigm, greedy algorithms, graphs traversing and several others. The preferred language of the course will be JAVA. Furthermore, the students will be actively participating in open-source projects available at GitHub.

Text Books:

1. Cormen, Thomas H, Charles E Leiserson, Ronald L Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition. MIT Press.
2. Horowitz, Ellis, Sartaj Sahni, and Sanguthevar Rajasekaran. 2008. Computer Algorithms/C++.

Reference Books:

1. Narasimha Karumanchi. 2019. Algorithm Design Techniques: Recursion, Backtracking, Greedy,

Name of Program	Master of Computer Applications				
MCA2002/MCA2052	Information and Database Management Systems	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Articulate a competent understanding of database systems design and ER Modelling.
CO2: Build database systems and understand new developments and trends in databases.
CO3: Construct databases and make use of efficient SQL queries to retrieve and manipulate data as required.

Course Contents:

UNIT I **10 lecture hours**

Purpose of IMS, Real-life applications of Data-Intensive systems, Typical system challenges, Data independence, Database system architecture levels, Role of several databases, ER diagram: Entity-set, Attributes, Relationships, Cardinality ratio, EER diagram: Specialization, Generalization, Constraints of EER, Aggregation, ER to Relational model, Relational model, Structure of relational databases, Constraints of relational model, Relational algebra: Basic and derived operator, Tuple relational calculus.

UNIT II **10 lecture hours**

Functional dependency — definition, trivial and non-trivial FD, Armstrong's axioms, closure of FD set, Closure of attributes, Irreducible set of FDS, Normalization, 1NF, 2NF, 3NF, BCNF, Decomposition using FD, Dependency preservation, Multivalued Dependency, 4NF, join dependency, 5NF, Query optimization, Measures of query cost: selection operation, sorting, join, Evaluation of expressions, Transformation of relational expressions, Estimating statistics of expression results.

UNIT III **10 lecture hours**

Properties of transactions, Serializability of transactions, testing for serializability, System recovery, Two-Phase Commit protocol, Recovery and Atomicity, Log-based recovery, concurrent executions of transactions, Locking mechanism, Solution to concurrency related. problems, Deadlocks, Two-phase locking protocol, Isolation, Intent locking, Discretionary Access Control, Mandatory Access Control, Authentication, Authorization and access control, DAC, MAC and RBAC models.

UNIT IV **12 lecture hours**

Pipelining, Streaming algorithms framework, Turnstile model, Cash register models, sliding window model, Data warehouse, Operational data store, Star schema, Snowflake schema, Data cube concept, OLAP, Cube and Roll-up, NoSQL database systems framework, Column stores, RDF stores, HBase, Big Data, Hadoop MapReduce architecture, Distributed Database Systems framework (DDS), Need for Data Privacy, Privacy law, Anonymity models, Privacy in Cloud and Big Data.

Studio Work/ Laboratory Experiments:

Entity-Relationship model: Design process, constraints, Keys, Design issues, E-R diagrams, weak entity sets, extended E-R features — generalization, specialization, aggregation, reduction to E-R database schema. Basics of SQL, DDL, DML, DCL, structure — creation, alteration, defining constraints — Primary key, foreign key, unique, not null, check, IN operator Functions - aggregate functions, Built-in functions — numeric, date, string functions, set operations, subqueries, correlated sub-queries, use of group by, having, order by, join and its types, Exist, Any, All, view and its types. Transaction control commands — Commit, Rollback, save point.PL/SQL Concepts: - Cursors, Stored Procedures, Stored Function, Database Triggers,

2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts (7th e ia.) , McGraw-Hill, 2019. ISBN 9780078022159.

Reference Books:

1. Date C.J, An Introduction to Database (8th ed.), Addison- Wesley Pub Co, 2003. ISBN 9780321197849.

Name of Program	Master of Computer Applications				
MCA2003/MCA2053	Advanced Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure					

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Understand the build system: IDE, tools for testing, debugging, profiling, and source code management.
CO2: Demonstrate proficiency in object-oriented programming.
CO3: Identify and abstract the programming task involved for a given programming problem.
CO4: Learning and using language libraries for building large programs.
CO5: Apply defensive programming techniques (e.g., assertions, exceptions).

Course Contents:

UNIT I **08 lecture hours**

Understanding the build system, IDE, debugging, profiling (Eclipse TPTP / gprof / VTune etc.), and source code management, Familiarity with terminal/command prompt, using git commands and github to pull/commit/push/merge code, writing, compiling and running simple programs, debugging by setting breakpoints

UNIT II **12 lecture hours**

Introduction to Object-Oriented Paradigm: Data encapsulation, modularity, code reuse, identifying classes, attributes, methods and objects, class relationships, Importing pre-written classes using this keyword, calling and defining methods, instantiating classes, setter/getter methods, instance variables, returning values, debugging using print function

UNIT III **12 lecture hours**

Interfaces, inheritance, polymorphism, abstract classes, immutability, copying and cloning objects. Exception handling using try/catch block, nesting try/catch blocks, throw and throws keywords, rethrowing exceptions, handling checked exception, user defined exceptions, assertions, Language supported libraries for handling advanced data structures

UNIT IV **10 lecture hours**

JUnit/Boost.test testing framework, assertion methods, testcase timeout, testing for exceptions, test suite Basic modeling techniques – e.g. Class diagram, sequence diagram, use case diagrams, etc. Introduction to design patterns: iterator, singleton, flyweight, adapter, strategy, template, prototype, factory, façade, decorator, composite, proxy, chain of responsibility, observer, state)

Studio Work/ Laboratory Experiments:

Students will gain familiarity with essential programming concepts and tools, including using the terminal/command prompt, Git commands, and GitHub for version control (pull/commit/push/merge). They will learn to write, compile, run, and debug simple programs using breakpoints and print functions, while mastering object-oriented programming techniques like defining and instantiating classes, using the this keyword, and implementing setter/getter methods, instance variables, and method calls. Advanced topics include containment, association, scope, parameter passing, parameter polymorphism, method resolution, and overriding methods, as well as calling superclass constructors and using protected fields. Students will also explore abstract classes versus interfaces with default and abstract methods, object equality, comparison (Comparable/Comparator), and the Cloneable interface/copy constructor. Finally, they will develop testing skills using JUnit/Boost.test frameworks, including assertion methods, test case timeouts, exception testing, and test suites.

Text Books:

1. Taming Python by Programming, Jeeva Jose, Khanna Book Publishing Company, New Delhi.
2. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kelli A.

1. Jeeva Jose, Introduction to Computing and Problem Solving with Python, Khanna Book Publishing Company, New Delhi.
2. R. Sebesta. Concepts of Programming Languages. 10th edition
3. J. Rumbaugh et al. The Unified Modeling Language Reference Manual.

Name of Program	Master of Computer Applications				
MCA2004	Professionals Ethics, Patent, Copyrights and IPR	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	0	2
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Explain and Practice the professional ethics for engineers.
CO2: Examine and understand the patent law, and how patents are prosecuted and enforced.
CO3: Articulate the importance of intellectual property laws in modern engineering.

UNIT I **14 lecture hours**

Why Ethics, Patents, Copyrights, and IPR, Moral issues, Types of inquiry, Moral dilemmas, Moral autonomy, Theories about right action, Kohlberg's theory, Gilligan's theory, Models of Professional Roles, Self-interest, customs, and religion, uses of ethical theories, Patents, Patentable Subject Matter, Novelty, Non-Obviousness, Patenting Process, Infringement and Searching, Patent Applications, Claim Drafting, Patent Prosecution, Design Patents, Business Method Patents, Foreign Patent Protection, Computer-Related Inventions, Patent Enforcement, Technical Design-Around.

UNIT II **14 lecture hours**

Copyrights Subject matter of Copyright, Rights of the owners of the copyright, Authorship, ownership, licensing, assignment of Copyright, Registration of Copyright & Authorities, Copyrights for Technology Protection, Intellectual Property Rights, IP Law Overview, Mask Works, Trade Secrets, Trademarks, Engineers as Expert Witnesses.

Text Books:

1. H B Rockman, H B Rockman (2'1 ed.), Wiley-IEEE Press, 2020. ISBN 978-1119381976.

Reference Books:

1. William Stallings, William Stallings (1st ed.), CRC Press, 2018. ISBN 978-1498788472.

Semester III

Name of Program	Master of Computer Applications				
MCA3001	Seminar/Project: Lean Startups	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	0	2
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate speech preparation and presentation techniques, audience awareness and self-awareness along with the cultivation of self-confidence.
CO2: To examine the ability to present scientific material in visual, written and oral form including the formulation of an effective presentation on a topic in the Computer Science domain.
CO3: To explain an ability to listen to a scientific presentation with the discussion of the strengths and weaknesses of a speaker's presentation.

Course Contents:

UNIT I **28 lecture hours**

Importance of seminars/presentations in undergraduate studies. Introduction presentation with extemporaneous delivery approach (include information on likes/dislikes, hobbies, family, career goals, etc.) Experiencing the problems of talking in front of people, Understanding body language. Considerations when preparing an oral presentation - audience, purpose, organization, flow, style. Presentation delivery approaches, Importance of visual aids, Designing effective presentations. Demonstration/How-To Speech - valuable information to the audience by demonstrating a process via visual aid. Informative speech/Speech of Explanation - original concept, policy, idea, or person, location, or event to inform the audience about it via visual aids. Persuasive Speech - establish a problem with references and offering a solution via visual aids. Language of presentations: Explaining the title, outline, and summary, Explaining the background, problem, materials, methods, and processes, Explaining and discussing data in the form of figures and tables, Understanding and answering questions from the audience and Final presentations.

Text Books:

1. Philip Small, Lean Project Management (20th ed.), Arkham Publishing Ltd, 2021. ISBN 9781801928618.

Assessment Scheme:

Components	Internal Assessment	Mid Term Exam	End Exam	Total
Weightage (%)	30%	35%	35%	100%

Name of Program	Master of Computer Applications				
MCA3002	Capstone Project	L	T	P	C
Owning School/Department	Computer Science and Engineering	0	0	14	7
Pre-requisites/Exposure					

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Finalize the Capstone Project problem which is of the level of representative of the Undergraduate work.
CO2: Evaluate the proposal keeping in view the different stakeholders including potential customers and market analysis.
CO3: Assess the idea from feasibility, scope, timeline, and delivery point of view.

Course Contents:

UNIT I **196 lecture hours**

Initial Milestones of the Capstone Project should be completed in this course. Capstone is a two-semester activity. In this semester students
should have a full understanding of the problem he is working upon and should be able to do all the preliminary analysis and documentation required for Capstone. Students should be able to discuss with potential stakeholders about the viability, risks, and opportunities associated with the project. He should also assess it from the point of view of scope and limitations so that it can be completed in time with desired functionalities. Students will be discussing the proposed project with the instructors and iterate to make it more optimistic and workable for the issuing facing the society.

Studio Work/ Laboratory Experiments:

The students will identify the project problems from their chosen specialization or inter-disciplinary in nature. The lab component of this course is designed to introduce the tools the students used in analysis, design, implementation, testing, and maintenance. Iterative and incremental evaluations will be done till the problem's solution is converted into a workable solution from a quality perspective. The students will choose the tools for each phase on the approval of the course instructor.

Semester IV

Specialization Core I and II

Name of Program	Master of Computer Applications				
MCA1101/MCA1151	Statistical Machine Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate key features and methods of Statistical Machine Learning (SML).
CO2: To formulate and design the given application as a statistical machine learning problem.
CO3: To implement and evaluate common statistical machine learning techniques.

Course Contents:

UNIT I **7 lecture hours**
Statistical Theory, Supervised Learning, Unsupervised Learning, Data and Types, Feature variable, Machine Learning, Statistics terms, Supervised learning, Concentration inequalities, Generalization bounds, Plugin classifiers, Least-squares methods, Bias vs Variance, Theory of generalization, Understand Underfitting, Overfitting, Parametric methods, Maximum likelihood, Bayes algorithm, Minimax algorithm, Expectation-Maximization, Advantages and Disadvantages, Applications of EM Algorithm, Use case of EM Algorithm.

UNIT II **10 lecture hours**
Bayesian versus Non-Bayesian approaches, Density estimation, Gaussian Distributions, Gaussian Mixture Models, Gaussian Discriminant Analysis, Independent Component Analysis, Convexity and Optimization: Convexity, Conjugate functions, Nonparametric classifications methods, Unconstrained optimization, Constrained optimization, Nonparametric methods, KKT conditions, Lagrangian minimization, Primal feasibility, Dual feasibility, Complementary slackness.

UNIT III **13 lecture hours**
Basis pursuit, Polynomial Expansion, Feature maps, The "kernel trick", Vapnik-Chervonenkis (VC) dimension, VC generalization bounds, Sparsity: High dimensional data, The role of sparsity, Sparsistency, Consistency, Persistency, Sparsity in nonparametric regression, Sparsity in graphical models, Greedy algorithms, Sparse linear regression, Compressed sensing, Nonparametric Methods: Nonparametric regression, Density estimation, Factor Analysis, Matrix Factorization, The bootstrap, Subsampling, Nonparametric Bayes.

UNIT IV **12 lecture hours**
Probability Distributions for modelling, Markov Networks, Hidden Markov Model, Advanced Theory: Concentration of measure, Covering numbers, Learning theory, Exact learning (Dana Angluin), Probably approximately correct learning (PAC learning), VC theory (Vladimir Vapnik and Alexey Chervonenkis), Risk minimization and its approaches, Bundle Methods, Graph Analytics, Graph-based machine learning algorithms, Simulation methods, Variational methods, Tsybakov noise conditions, Surrogate loss functions, Minimax rates for classification, Minimax rates for regression, Manifold methods, Spectral methods.

Studio Work/ Laboratory Experiments:

Students will gain practical experience with the implementation of different statistical methods by using different statistical machine learning tools. Eventually, the lab works formulate the problem as a statistical machine learning problem followed by its implementation.

Text Books:

1. Masashi Sugiyama, Introduction to Statistical Machine Learning (1st ed.), Morgan Kaufmann, 2017. ISBN 978- 0128021217
2. T. M. Mitchell, Machine Learning (1st ed.), McGraw Hill, 2017. ISBN 978-1259096952.

Reference Books:

Name of Program	Master of Computer Applications				
MCA1102/MCA1152	Data Analysis using Python	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure					

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the structured and unstructured data for extracting useful information.
CO2: To work with data through visualization and distributions.
CO3: To make use of real-world datasets utilizing various numerical libraries.

Course Contents:

UNIT I **10 lecture hours**
Purpose of data analysis, Structured and Unstructured data, Steps of data analysis, Python Packages for Data Analysis: Numpy, Scipy, Matplotlib, Plotyly, NLTK. Data Frames, Usage of frames analytical roles, File handling and reading data for processing,

UNIT II **8 lecture hours**
Pre-processing data using multiple python frameworks, Data Formatting, Data Manipulation, Data normalization, Data Merging, Data reshaping, Data Wrangling, Missing value handling, Aggregation function, Data reporting, Data Scrapping using beautifulsoup

UNIT III **12 lecture hours**
String Manipulations, Demonstrating string functions, A regular expression for data, manipulation, Data Visualization, Using Histograms, Using Boxplots, Plotting data, Venn Diagram, Bar Chart, Pie Chart, Line Chart, Scatter Plots and R2, Grouped charts, Area Charts, Descriptive Statistics, Central tendencies, Analyzing variability, Data Distributions, Random Variables, Bernoulli Distribution, Binomial Distribution, Normal Distribution, Z score, Statistical Properties, Standard Normal Distribution, Correlation: Pearson correlation method

UNIT IV **12 lecture hours**
Exponential distribution, Statistical test, Hypothesis testing, Z-test, Right-tailed test, Two-tailed test, T-Test, Significance of p-value in t-test, Two-sample Z-test, Paired t-test, Introduction to machine learning system, overview of prediction methods, models for classification problems, Sample implementation of machine learning methods on standard datasets, recent start ups based on data analysis, social impact of data analysis.

Studio Work/ Laboratory Experiments:

Studio work focuses on Different Data Analysis Methods, Techniques, Algorithms using Python Data manipulation using numpy and scipy. Make use of numpy arrays, matrices, indexing and slicing options with the demonstration of numerical packages for data analysis.

Text Books:

1. Bharti Motwani, Data Analytics using Python, Wiley, 2020, ISBN 978-8126502950.
2. Klosterman and Stephen, Data Science Projects with Python: A Case Study Approach to Successful Data Science Projects Using Python (1st ed.),) Packt Publishing Limited, 2019. ISBN 978-1838551025.

Reference Books:

1. Suresh Kumar Mukhiya and Usman Ahmed, Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data (1st ed.), Packt

Name of Program	Master of Computer Applications				
MCA1103/MCA1153	Cloud Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate cloud computing principle and its business need.
CO2: To identify the design principles of virtualization techniques in cloud resource management.
CO3: To design and development of cloud architectural solution with its detailed monitoring.

Course Contents:

UNIT I — 11 lecture hours

Cloud Computing and the Integration of cloud-based IT resources, Service Models encompassing Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), and various Deployment models such as Public Cloud, Private Cloud, Hybrid Cloud, and Community Cloud. Detailed exploration of Cloud Computing Characteristics, the Adoption Challenges, and the Virtualization concept, including various Types of virtualizations. Practical demonstration of virtualization through a Demo, discussion of Virtualization Merits, the Role of virtualization in the cloud computing landscape, and an examination of Virtualization Demerits. Insights into VM Placement, VM Migration, VM Migration Demo, and VM clustering, along with a focus on Design Issues in VM Clustering. Addressing the significance of Dockers and Containers, delving into the Docker Eco-System, and presenting a Comparative Analysis between Hypervisor and Docker.

UNIT II — 12 lecture hours

Need of Dockers and Containers, Docker Eco-System, Hypervisor vs Docker, kubernetes, Microservices, Service-Oriented Architecture, REST API, IP Addressing, Subnetting, Supernetting, Designing of Virtual Private Cloud, Demo of VPC, VPC Peering, VPC Case Study, Cloud Storage, Serverless Computing, Cloud API Gateway, Cloud Databases, Resource Provisioning, Time shared and space shared, Efficient VM Consolidation on cloud server, Task/DAG Scheduling Algorithms, Min-Min, Max-Min, MET, B-level Demo, T-level Demo, Task-VM Mapping, Auto Scaling, Load Balancing.

UNIT III — 10 lecture hours

Case Study: Cloud Market analysis, Security and Compliances, Shared security model in IAAS/PAAS/SAAS, Shared technology issues, Implementation of cloud security, Security Groups, Network Access Control Lists, Cloud databases, Parallel Query Execution with NoSQL Database, Big Data, Handling Big Data on Cloud Platform, Map- Reduce framework for large clusters using Hadoop, Design of data applications based on Map Reduce in Apache Hadoop.

UNIT IV — 9 lecture hours

Analysis and comparison of public cloud services, exploration of Edge Computing and Fog Computing, strategies for Data Offloading, examination of Cloud-Based DevOps Tools, approaches to Task Partitioning, Data Partitioning, and Data Synchronization. Study of Distributed File Systems, insights into Data Centers, exploration of Ongoing Research Topics, and engagement in a practical Hands-on project involving the deployment of an application on a cloud platform.

Text Books:

1. Lizhe Wang, Rajiv Ranjan, Jinjun Chen and Boualem Benatallah, Cloud Computing (1st ed.), CRC Press, 2017. ISBN 978-1351833097.
2. Judith S. Hurwitz and Daniel Kirsch, Cloud Computing For Dummies (1st ed.), Hoboken: John Wiley & Sons, 2020. ISBN 978- 1119546658.

Reference Books:

1. Prerna Sharma, Moolchand Sharma and Mohamed Elhoseny, Applications of Cloud Computing (1st ed.), missing, 2020. ISBN 9780367904128.

Name of Program	Master of Computer Applications				
MCA2101/MCA2151	Intelligent Model Design using AI	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs):

On completion of this course, the students will be able to:
CO1: To articulate key features of various Machine learning and Deep Learning tools for Intelligent Modelling.
CO2: To examine and implement intelligent applications using Machine Learning and Deep Learning tools.
CO3: To implement Machine Learning and Deep Learning models for design thinking and evaluate them using relevant metrics.

Course Contents:

UNIT I **8 lecture hours**
Introduction to intelligent model design, Core principles and components of AI models, AI paradigms, Data Preparation and Feature Engineering, Importance of Data Quality, Feature selection and engineering strategies, Dimensionality reduction techniques (PCA, t-SNE), Data Driven Marketing and Commerce, Biases in AI Models, Handling Gender, Race, Religion, Cultural Biases, Unintended Biases.

UNIT II **12 lecture hours**
User privacy, Data Privacy aware AI, Data Sharing Regulations, AI Model Security, Attacks on AI models, Adversarial Attack, Responsible AI practices , Adaptive Learning, Online learning, Model fine-tuning, Transfer Learning, Domain Adaption, Importance of explainability in AI models, Techniques for interpreting complex models, SHAP (SHapley Additive exPlanations), Lime, Shapash, Dalex, Accountability and Fairness, Model Interpretation, Class imbalance in Modelling, Handling Data Drift, Human-Machine Co-learning.

UNIT III **10 lecture hours**
Aligning Mental and Machine Learning Models, Coding Automation, Rapid Prototyping in AI, Market Demand Analysis, Automated Requirement Analysis, Customer opinion analysis, Attribute based opinion mining, Geospatial Analytics, Spatial analysis, Spatial-temporal analysis, Geo-clustering, Market Segmentation, Demographic, Cultural, Behavioural and Psychographic Segmentation, Dynamic Pricing, Price Optimization, Personalization, Recommender Systems, Feature Attribution.

UNIT IV **12 lecture hours**
Speed vs Accuracy Trade-off, optimizing models for resource constrained devices, Deep Learning Model compression, Pruning, Low-rank factorization, Automatic Machine Learning, Neural Architecture Search, Deploying Machine Learning Models, Staging Automation, Cognitive Modelling, Reinforcement Learning, Markov Decision Processes (MDPs) Monte Carlo Methods, Function Approximation in RL ,Policy Gradient Methods, Applications of Reinforcement Learning.

Studio Work/ Laboratory Experiments:

Students will gain practical experience with the implementation of different intelligent methods. The lab work consists of exploratory data analysis using tools, libraries and python programming language by using Machine Learning and Deep Learning models.

Text Books:

1. Charu C. Aggarwal, Neural Networks and Deep Learning (1st ed.), Springer International, 2018. ISBN 978- 3030068561.

Name of Program	Master of Computer Applications				
MCA2102/ MCA2152	Data Mining and Predictive Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate data preparation for data mining and analysing based on pre-processing techniques.
CO2: To examine predictive analysis in various use cases.
CO3: To make use of exploratory data analysis to gain insights and prepare data for predictive modelling.

Course Contents:

UNIT I **11 lecture hours**

Introduction to Data Mining, Concepts of Data mining, Data Mining Processes, Knowledge data discovery Process Model, Challenges of Data Mining, Applications of Data Mining, Social Impacts of data mining, Data Understanding and Preparation Parameters, Data and attribute type, Properties of data, Discrete and continuous attribute, Dataset types, Data quality measurement, Noise Analysis and its importance, Reading data from various sources, Data visualization, Distributions and summary statistics, Relationships among variables, Missing Values Segmentation, Outlier detection.

UNIT II **7 lecture hours**

Aggregation, Sampling, Curse of dimensionality, Dimensionality reduction, Feature selection and generation, Association rule mining, Apriori algorithm, Rule generation, Term Frequency and Inverse Document Frequency, Measuring data similarity, Similarity Metrics: Distance based measure, Information based measures, Set similarity measure, Jaccard Index, Sorenson Dice Coefficient, Model Selection Problem, Error Analysis, Case study, Startups in Data Analysis.

UNIT III **10 lecture hours**

Model selection, Model Development Techniques, Probabilistic models for clustering, Clustering high dimensional data: Subspace clustering, Projection Based clustering, Exploratory data analysis, Data summarization and visualization, Dataset exploration, Data Exploration Tools, Interactive Data Exploration, Predictive models, Design Principles, Parametric Models, Non-Parametric Models, ANOVA, Regression Analysis, Frequent Pattern Mining, Mining Closed and Max Patterns.

UNIT IV **14 lecture hours**

Model Validation and Deployment, Linear discriminant analysis, Fisher discriminant analysis, Time series Model: ARMA, ARIMA, ARFIMA, Factor Analysis, Uncertainty quantification, Forward uncertainty propagation, Inverse uncertainty quantification, Non-Negative Matrix Factorization, Sequential Matrix Factorization. Exact Matrix Factorization, Expert Lecture from Industry, Recommendation System and Collaborative Filtering, Multidimensional Scaling, Mining Textual Data, Temporal mining, Spatial mining, Visual and audio data mining, Ubiquitous and invisible data mining- Privacy, Security, Social Impacts of data mining, Streaming Data Analytics: Real-time Data Processing, Online Learning Algorithms, Challenges in Streaming Data Analysis, Case Studies and Practical Applications: Real-world Applications of Advanced Data Analysis Techniques, Hands-on Projects and Implementations.

Studio Work / Laboratory Experiments:

Data pre-processing and vectorization. Quality analysis of data. Feature selection and Ranking. Association rule mining and implementation of the Apriori algorithm. Data Similarity and set similarity. Error analysis and model selection. Frequent pattern mining and regression. Discriminant Analysis. Factor Analysis. Matrix Factorization. Recommendation System.

Text Books :

Name of Program	Master of Computer Applications				
MCA2103/ MCA2153	System and Network Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs):

On completion of this course, the students will be able to:
CO1: To articulate the system vulnerabilities, exploitation, and defense mechanisms.
CO2: To examine the spyware, security issues and different types of attacks.
CO3: To do programming for system and mobile security.

Course Contents:

UNIT I **12 lecture hours**

Threats and Vulnerabilities: Assessment of threats and vulnerabilities specific to Windows and Linux environments. Controls and Risk Management: Understanding security controls and effective risk management strategies. Confidentiality, Integrity, and Availability (CIA): Basics of ensuring confidentiality, integrity, and availability of information. Generic Security Policies: Formulation and application of generic security policies. Security Mechanisms: Exploration of security mechanisms for safeguarding systems. Assurance, Prevention, and Detection: Strategies for assurance, prevention, and detection of security threats. Security Issues in Windows OS: In-depth analysis of security challenges in Windows XP, Vista, 7, and 10. Linux Kernel TCP/IP Vulnerabilities: Identification and mitigation of TCP/IP vulnerabilities in the Linux kernel. TCP SACKs and SACK Panic: Understanding vulnerabilities related to TCP Selective Acknowledgments (SACKs) and mitigating SACK Panic. Mitigation Schemes and Patches: Development and application of mitigation schemes and patches for each identified security issue. Boot Loader Security Issues: Assessment of security challenges related to boot loaders. Grub Security Flaw: Investigation and mitigation of security flaws in the GRUB boot loader.

UNIT II **9 lecture hours**

Security in Broadcast Networks, Security in Centralised Networks, DDOS Attacks, Volume-based DDoS attacks, Protocol attacks, Application-layer DDoS attacks, Introduction to Malicious Softwares- Botnet, Logical Bombs, Grayware, Spyware, Adware, File Binders, Antivirus, Honeypot, Trapdoor, Latest Malwares Definitions and Their Defence Mechanisms. Android-based Malwares and their Security Patches.

UNIT III **9 lecture hours**

Introduction to Network Security, Network-based Attacks, Active and Passive Attacks, Phishing and Its Types, Tailgating, Impersonation, Dumpster Diving, Shoulder Surfing, Hoax, Waterhole Attacks, Denial of Service Attacks and its Types, Man in the Middle Attack, Overflow Attack, Cross-Site Scripting, SQL Injection Attack, Privilege Escalation, Man in the Browser, Zero-Day Attack, SQL Injection Attack, Privilege Escalation, Man in the Browser.

UNIT IV **12 lecture hours**

Generic Security Software: Overview and applications of generic security software. Windows and Linux Firewalls: Functions and configurations of firewalls in Windows and Linux environments. Access Control Lists (ACLs) of Firewalls: Understanding and implementation of access control lists in firewalls. Types and Examples of Firewalls: Exploration of various firewall types with practical examples. Network-based Honeypots and Trapdoors: Implementation and significance of network-based honeypots. Virtual Private Network (VPN) Implementation: Principles and practical implementation of Virtual Private Networks. Network Intrusion Detection System (NIDS): Understanding and deployment of network intrusion detection systems. Network Intrusion Prevention System (NIPS): Functions and implementation of network intrusion prevention systems, Router and Switch Security: Best practices for securing routers and switches in a network,

The lab component is meant to analyse various network security-related concepts and deals with launching different types of attacks and creating a network blueprint of an organization.

Text Books:

1. R. Bragg et al, Network Security: The Complete Reference (1st ed.), TMH Publications, 2017. ISBN 978-0070586710.
2. W. Stallings, Network Security Essentials: Applications and Standards (1st ed.), Pearson, 2018. ISBN 978-0132380331.

Reference Books:

1. Joseph Migga Kizza, Guide to Computer Network Security 2022. ISBN 9783030381412
2. Jaydip Sen, Computer and Network Security (1st ed.), 2020. ISBN 978183880854X.

Specialization Electives

Name of Program	Master of Computer Applications				
MCAE201	Advanced Computer Vision and Video Analytics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the key features of Computer Vision to analyze and interpret the visible world around us.
CO2: To build the applications of Deep Learning in Computer vision and video processing.
CO3: Implement the state-of-the-art computer vision and video analytics concepts to different applications.

Course Contents:

UNIT I **12 lecture hours**

Introduction to Computer Vision, The Four Rs of Computer Vision, Challenges in Computer Vision, Low-level vs High-level processing, Two View Geometry, Binocular Stereopsis: Camera and Epipolar Geometry, Planar Scenes and Homography, Depth estimation and multi• camera views, Robust Correspondence Estimation, 3-D reconstruction, Auto-calibration, DLT and RANSAC, Structure from Motion, Hough Transform, Fourier Transform, Interest Point Detection, Edge Detection, Local Binary Pattern, Convolution and Filtering, Gaussian derivative filters, Gabor Filters, DWT, Pyramids, Visual Matching: Bag-of-words, Pyramid Matching, Part based recognition models, Recognition: Detectors and Descriptors, Optical Flow & Tracking.

UNIT II **10 lecture hours**

Shape from Texture, Color, motion and edges, Face Detection, Feature Tracking & Motion Layers, SIFT & Single Object Recognition, Dense Neural Networks, Backpropagation, Convolutional Neural Networks (CNNs), AlexNet, VGG16, Image Quality Enhancement, Image Restoration, Super resolution, Residual Learning, Visual Saliency detection.

UNIT III **12 lecture hours**

Evolution of CNN Architectures: AlexNet, MobileNet, InceptionNets, ResNets, DenseNets, 3D CNN for images and videos, Unsupervised image segmentation, Watershed, Level set, Active Contour, GraphCut, Supervised image segmentation, Agglomerative clustering, Segmentation as pixel classification, UNets, FCN, Deep Generative Models, GANs, VAEs, PixelRNNs, NADE, Normalizing Flows, Zero• shot, One-shot, Few-shot Learning, Self-supervised Learning, Reinforcement Leaming in Vision, Video Analytics, Spatial Domain Processing, Frequency Domain Processing, Background Modelling, Crowd Analysis, Video Surveillance, Traffic Monitoring, Intelligent Transport System.

UNIT IV **08 lecture hours**

Optical Character Recognition, Online Character Recognition, Visual Anomaly Detection, Anomalous action recognition, Post Estimation, Action Recognition, Graph CNN, Shape Recognition, Shape Retrieval, Content based Image retrieval, Visual Instance Recognition, Emotion Recognition from videos, Video Generation.

Text Books:

1. Rajalingappaa Shanmugamani, Deep Leamingfor Computer Vision (1st ed.), Packt Publishing, 2018. ISBN 9781788295628
2. J.Nedumaan, Prof Thomas Binford, J. Lepika, J. Tisa, J. Ruby and P. S. Jagadeesh Kumar, Modem Deep Leaming andadvanced Computer Vision (1sted.), missing, 2019. ISBN 9781708798641.

Reference Books:

1. Krishnendu Kar, Mastering Computer Vision with TensorFlow (1st ed.), Packt Publishing Limited,

Name of Program	Master of Computer Applications				
MCAE202	Cognitive Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the thought, learning, and mental organization.
CO2: To examine the extraction of brain signals into digital form and develop critical skills to evaluate and assess problems including psychology, philosophy, neuroscience, and computer modelling.
CO3: To implement the models that reflects human cognition and apply to different real-life scenarios.

Course Contents:

UNIT I **08 lecture hours**

Why Cognitive Science, Structure and processes of human cognition, Computational simulation or modelling, Theory and Research in Human Cognition, Object Perception, Object Recognition, Attentional Processes, Concept formation, Visual perception, Acquisition and processing of natural language, Human reasoning and problem-solving

UNIT III **12 lecture hours**

Memory Introduction, Long Term Memory encoding, Retrieval from Long Term Memory, Memory of general knowledge, Semantic memory basics, Models of semantic memory, Human language skills, Midlevel Vision and Attention, Motion, disparity, depth, and orientation representation, Convolution, Mechanisms underlying attention, Attention at the cognitive/algorithm level

UNIT III **12 lecture hours**

Brain Signals and Feature extraction, Types of Brain signals, case study, Feature extraction methods and their analysis, Models of Understanding Cognition or Mind: Neuroscientific Model, Psychological Model, Representational Model, Computational Model, Isomorphic Model, Multiple realizable Model, Multiple Draft Model, Sub personal Model

UNIT IV 10 **lecture hours**

Thought process and Problem Solving, Applications of cognitive computing in the field of psychology, Applications of cognitive computing in linguistics, Decision Making models, Commercial Applications of Cognitive science/computing, Advanced Topics in Cognitive computing, Applications of cognitive computing in philosophy, Applications of cognitive computing in computer modelling, Machine Learning models for cognitive computing, Neural Networks for cognitive computing

Text Books:

1. Jose Luis Bermudez, Cognitive Science: An Introduction to the Science of the Mind (3rd ed.), Cambridge University Press, 2020. ISBN 978-1108440349.

Reference Books:

1. Rob High and Tanmay Bakshi, Cognitive Computing with IBM Watson: Build Smart Applications Using Artificial Intelligence as a Service (1st ed.), missing, 2019. ISBN missing. 414

Name of Program	Master of Computer Applications				
MCAE203	Probability and Random Processes	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the probability and random processes.
CO2: To formulate the problems and tackle with probability and random processes.
CO3: To implement the applications of probabilities for a real-world scenario.

Course Contents:

UNIT I **10 lecture hours**

Events, sample spaces, and probability, Limitation of classical and relative-frequency-based definitions, Independent events, Conditional probability, Sets and fields, Sample space and events, Axiomatic definition of probability, Joint probability, Conditional probability, Independence probability, Total probability, Stationarity: strict-sense stationary (SSS), wide-sense stationary (WSS) processes, Ergodicity and its importance, Bayes theorem, Combinatorics: Probability on fmite sample spaces.

UNIT II **12 lecture hours**

Random variables, Discrete and continuous random variables, Probability mass functions, Moment generating functions - Binomial, Poisson, Geometric, Uniform distribution, Exponential, and Gamma distributions, Normal distributions: definitions, applications, Joint distributions-Marginal and conditional distributions, Covariance: defmition, type, applications, Correlation regression, Linear regression, Transformation of random variables, Classification -Stationary process.

UNIT III **10 lecture hours**

Markov process, Poisson process, Random telegraph process, Bernoulli and Binomial random variables, Geometric random variables, Negative Binomial random variables, Random process realizations, Random process sample paths, Discrete time processes, Continuous time processes, Probabilistic structure of a random process.

UNIT IV **10 lecture hours**

Mean functions, Autocorrelation functions, Autocovariance functions, Poisson random variables, Hypergeometric random variables, Discrete uniform random variables and counting, Independent continuous random variables, Normal distribution and CLT, Approximate models of continuous uniform distribution, Probability in Spam filtering, Random processes in gambling app design, Probability and random processes in market prediction and risk prediction.

Text Books:

1. Peebles. P.Z, Probability, Random Variables and Random Signal Principles (4th ed.), Tata Mc Graw Hill, 2017. ISBN 978-0070474284.

Reference Books:

1. Fundamentals of Applied Probability and Random Processes (2nd ed.), Elsevier, 2014. ISBN 978-0128008522

Name of Program	Master of Computer Applications				
MCAE204	AI in Healthcare	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the factors involved in decision support that can improve business performance across the provider/payer ecosystem.
CO2: To build methods and techniques in order to appropriately apply to pain points using case studies.
CO3: To make use of opportunities to leverage decision support in adapting to trends in the industry.

Course Contents:

UNIT I **08 lecture hours**

History of AI in Medicine, AI for Decision Support, Capabilities and limitations of AI in Healthcare, Automated healthcare system: challenges and opportunities, Biostatistics, Research ethics in AI, Common healthcare data types, Medical data: quality vs quantity, Clinical Data, Clinical decision support systems, Electronic Health Records (EHR).

UNIT II **10 lecture hours**

Time series and non-time series data, Data Sourcing, Data Enrichment, Handling missing values, Advantages and challenges in observational data, Geographic and demographic variation in medical Data, Classification, regression, clustering for healthcare, Evaluation measures for healthcare applications, Bias and Error in medical data, Analysis of data from IOT body sensors, Automated diagnosis processes, Treatment protocol development.

UNIT III **12 lecture hours**

Predictive modeling, Disease prediction, Early detection, Cancer detection using tabular data, Risk estimation in medical insurance, Medical Imaging, MRI, CT scan, X-Ray, 3D CNN, Biomedical signals, Large scale medical image retrieval, Handling hyper-dimensional medical images, Electronic phenotyping, Rule based phenotyping, Probabilistic phenotyping, DNA phenotyping, Multimodal data analysis, Regression analysis for Patient Monitoring and Preventive Screening.

UNIT IV **12 lecture hours**

Clinical text, Medical Word Corpus, Text representation, BERT for medical data, PubMed BERT, Question answering systems, Finding similar patients through clustering, Medicine or treatment recommender systems, Q&A systems for Telemedicine, Personalized medicine recommendation system, Drug development analysis, Drug discovery, Modeling drug-drug interactions, Pandemic spread prediction, Infection pattern identification, Computer Vision systems for physiotherapy, Pose estimation, Gait Analysis.

Text Books :

1. Adam Bohr and Kaveh Memarzadeh, Artificial Intelligence in Healthcare (1st ed.), Elsevier Science, 2020. ISBN 978- 0128184387.

Reference Books :

1.Arjun Panesar, Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes (1sted.), Apress, 2019. ISBN 978-1484237984.

Name of Program	Master of Computer Applications				
MCAE205	Image and Video Processing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate images using Histograms and spatial and image representation using textures.
CO2: To examine motion using optic flow, morphological operations, and compress images using lossless and lossy compression techniques.
CO3: To implement different low-level and high-level image and video processing techniques to a wide variety of applications.

Course Contents:

UNIT I **10 lecture hours**

Applications of Digital Image Processing, Elements of Digital image processing systems, Sampling and quantization, Neighbours of a pixel, adjacency, connectivity, Regions and Boundaries, Distance measures, Gray scale to Binary image using thresholding, Image Enhancement in the Spatial domain, Gray level transforms, Histogram Processing, Histogram Equalization, Enhancement using Spatial filters, Concept of convolution, Smoothing, Mean, median and Gaussian filters, Edge detection using Prewitt, Sobel, Laplace Filters, Laplace of Gaussian Filter

UNIT II **12 lecture hours**

Canny Edge Detector, Harris Comer Detector, Color models, RGB, HSV, YCbCr models, Pseudocolor Image Processing, Color Transforms, Color to grayscale conversion, Handling Binary Images, Line detection using Hough transform, Polar form, Circle Detection, Morphological Operations, Dilation, Erosion, Opening, Closing, Boundary detection, Hole filling, connected components, Hit and Miss transform, Shape representation using moments, Texture analysis, Texture from the histogram, Texture from GLCM matrices, Motion Detection, Concept of Optical Flow, Optical flow equation, Lucas Kanade method.

UNIT III **10 lecture hours**

Image Enhancement in the Frequency domain, 1-D and 2-D Fourier Transform and their Inverse, Low pass and Hi pass Filtering, Ideal and Butterworth and Gaussian Filters, Homomorphic Filtering, hnage Compression Fundamentals, Lossless Compression Models, Run-length Encoding, Ruffin.an Coding, Lossy Compression, Discrete Cosine Transform, Quantization, Zigzag coding, Color image compression, Text recognition, Feature detection, Integral Image Formation.

UNIT IV **10 lecture hours**

Face Detection - Viola-Jones method, Face Recognition, Principal Component Analysis (PCA), Concept of Eigenface, Feature detection for Machine learning applications, SIFT and HOG parameters, Video Processing, Video formation, Video sampling, Motion estimation, Motion- compensated (MC) filtering, Frame-rate conversion, Video Coding, Video Compression, Frame-based compression (MPEG), Salient object detection, Human action recognition from videos, Depth cameras -Kinect camera data capture, RGBD data.

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications (2nd ed.), missing, 2022. ISBN 978-3030343712.
2. Manas Kamal Bhuyan, Computer Vision and Image Processing Fundamentals and Applications (18ted.), 2021. ISBN 9781351248383.

Reference Books:

Name of Program	Master of Computer Applications				
MCAE206	Information Retrieval	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the comprehend types of text analysis, Information retrieval, IR system architecture, query processing models and probabilistic models.
CO2: To build information retrieval systems by performing indexing, compression, information categorization sentiment analysis, network management, search engine optimization, records compliance and risk management.
CO3: Implement different information retrieval approaches for applications in text domain.

Course Contents:

UNIT I **14 lecture hours**

Text analysis and types, Information retrieval, Text processing, Indexes and query matching, Semi-structured text data, Tokenization, Stemming, Lemmatization, Language modelling, Examples of open source IR Systems, Query processing models, Probabilistic models, Binary independence model, Robertson/Spark Jones weighting formula, Two-Poisson model, Relevance feedback, Term selection, Pseudo relevance feedback, Language models, Unigram, Bigram language models, Generating queries from documents, Language models and smoothing, Ranking with language models, Retrieval evaluation measures Normalized Discounted Cumulative Gain (NDCG), Kullback Leibler divergence, Divergence from randomness, Passage retrieval and ranking, Management of Information Retrieval Systems, Knowledge management, Information management, Digital asset management, Network management.

UNIT II **14 lecture hours**

Search engine optimization, Records compliance and risk management, Version control, Data and data quality, Information system failure, Web retrieval and mining, Semantic web, XML information retrieval, Recommender systems and expert locators, Knowledge management systems, Decision support systems, Geographic information system (GIS), Indexing, Inverted indices, Index components and Index life cycle, Interleaving Dictionary and Postings lists, Index construction, Query processing for ranked retrieval, Compression, General-purpose data compression, Symbol-wise data compression, Compressing posting lists, Compressing the dictionary.

UNIT III **14 lecture hours**

Information categorization and filtering, Classification, Probabilistic classifiers, Linear classifiers, Similarity-based classifiers, Multi category ranking and classification, Learning to rank, Text Clustering, Partitioning methods, Clustering versus classificatio n, Reduced dimensionality/spectral methods, Lexicons, Corpora, Sentiment Analysis, Document-level, Sentence-level and Aspect-based sentiment analysis, Web crawling, Near duplicate pages, Distributed word representations, Link Analysis, PageRank algorithm, Search engine bias, Personalized searching, Question Answering, Cross lingual retrieval, Adversarial Information Retrieval

Text Books:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze, Introduction to Information Retrieval (1st ed.), 2019. ISBN 9781107666392.
2. Bhaskar Mitra and Nick Craswell, An Introduction to Neural Information Retrieval (1st ed.), 2019. ISBN 9781680835327.

Reference Books:

1. Muhammad Sarfraz, Critical Approaches to Information Retrieval Research (1st ed.), 2019. ISBN 9781799810232.

Name of Program	Master of Computer Applications				
MCAE207	Natural Language Processing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate natural language processing and importance of word representation.
CO2: To build deep learning model for solving natural language problems such as language modelling, machine translation, POS tagging, Seq2Seqgeneration.
CO3: To implement state-of-the-art Machine Learning and Deep Learning solutions to NLP problems in Global& Indian context.

Course Contents:

UNIT I **08 lecture hours**

Natural Language Processing: Need, applications, industry demand, Challenges in NLP: Ambiguity in language, Contextual words and phrases and homonyms, Coreference, Domain-specific language, Low-resource languages, Segmentation, Stemming, Lemmatization, Spelling correction, Synsets, Hypernyms, Tokenization, N-grams, Stops Words, WordNet, WordNet Similarity, Language Corpus, N-gram Language Models, Hidden Markov Models.

UNIT II **12 lecture hours**

iNLTK (Natural Language Toolkit for Indic Languages), Text normalisation, script normalisation, Parallel Corpus, Handling Code-mix text, Cross Lingual Information Retrieval, Word representation, Sentence representation, Word embedding, Vector space model, Term Frequency, TF-IDF Representation, Distributional representation, Word2vec: CBOW(20), Word embedding for regional language, Word2Vec, GloVe, Document to Vector.

UNIT III **12 lecture hours**

Neural Networks for text, Recurrent Neural Networks, Vanishing Gradients, Exploding gradient, LSTM (Long sort term memory), GRU (Gated recurrent Unit), Seq2Seq Modelling, Bidirectional Model, Contextual Representations, Transformers, BERT, Multilingual Embedding, Transfer Learning in Word Embeddings, MUSE, POS tagging, Named Entity Recognition, Sentiment Analysis, Text Clustering

UNIT IV **10 lecture hours**

Topic Modeling, Latent Semantic Analysis, Statistical Machine Translation, Neural Machine Translation, Self-Attention for Generative Models, Natural Language Generation, Attention, Question Answering Bot, ID-CNN for NLP, Sub-word Models, OpenAI's GPT, Google's ALBERT, ULMFiT, Facebook's RoBERTa, Text Summarization, Extractive, Abstractive Text summarization, Transformer models for Text Summarization

Text Books:

1. Delip Rao and Brian McMahan, Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning (1st ed.), O'Reilly Media, 2019. ISBN 978- 1491978238.

Reference Books:

1. Jacob Eisenstein, Introduction to Natural Language Processing (1st ed.), missing, 2019. ISBN 9780262042843.
2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta and Harshit Surana, Practical Natural Language Processing (Ist ed.), missing, 2020. ISBN 978149205402X.

Name of Program	Master of Computer Applications				
MCAE208	Social Network Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To understand human behavior in social networks and related communities.
CO2: To build and apply networking models for understanding social interactions.
CO3: To implement network media graph virtualization and network relationships.

Course Contents:

UNIT I **12 lecture hours**

Social network analysis purposes, Phenomenology of social media, Social network monitoring tools, Entity resolution, Types of social networks, Networks Representation, Adjacency Matrix, Weighted and Directed Networks, Hypergraphs, Bipartite Networks, Graph Laplacian, Random Walks, One mode and two mode networks, Heterogeneous Information Networks, Closeness centrality, Betweenness centrality, Eigenvector centrality, Clustering coefficient, Density of graphs, Isomorphic graphs, Reachability, Cliques, Graph colouring problem, Valued graphs, Multi graphs.

UNIT II **10 lecture hours**

Large Scale Structure of Networks, Small World Effect, Degree Distributions, Power Law, Scale Free Networks, Assortative Mixing, Time series analysis in graph, Temporal graph algorithms, Parallel dynamic graph algorithm, Matching theory, Bipartite matching, Konig's theorem, Hall's Matching Theorem, Network flow, Max flow min cut theorem, Menger's theorem, Ford Fulkerson method.

UNIT III **10 lecture hours**

Ties, Structural holes, Structural balance, Equivalence, Motifs, Random Graphs, Giant Component, Small Components, Configurat ion Model, Excess Degree Distribution, Vertex Copying network models, Erdos-Renyi model, Barabasi-Albert model, Exponential Random Graphs, Percolation.

UNIT IV **10 lecture hours**

Communities in network, Community detection from network, Louvain Method, Overlapping communities, Non-overlapping communities, Information diffusion in social networks, Cascading Behavior in Networks, Link Prediction, Preferential Attachment, Geospatial social networks, Crowdsourcing, Rumours and Deception in social network, Fake News, Spamming, Identify theft.

Text Books:

1. *Gerardus Blokdyk, Social Network Analysis A Complete Guide (3rd ed.), starcooks, 2020. ISBN 978-1867330097.*
2. *Lowell W. Beineke, Martin Charles Golumbic and Robin J. Wilson, Topics in Algorithmic Graph Theory (1st ed.), Cambridge University Press, 2021. ISBN 9781108492607.*

Reference Books:

1. *David Knoke and Song Yang, Social Network Analysis (3rd ed.), SAGE Publications, 2019. ISBN 9781506389295.*

Name of Program	Master of Computer Applications				
MCAE209	Reinforcement Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the key features of Reinforcement Learning (RL).
CO2: To examine the formulation, design, and implementation of the given application as RL problem.
CO3: To implement common RL algorithms and evaluate the musing relevant metrics.

Course Contents:

UNIT I **10 lecture hours**

Reinforcement Learning (RL), RL vs ML, RL applications, Ethics in RL, Sequential Decision Making, Modelling the World, RL simulators, State, Action, Reward, Environment, Taxonomy of reinforcement learning agents, Fully vs partially observed environment, Markov Processes, Markov property, Markov chains, Markov Decision Processes (MDP), Markov Reward Process (MRP).

UNIT II **10 lecture hours**

Polices, Value Functions, Value based RL, Policy based RL, Bellman Equations, Exploration vs exploitation, Q Learning, Deep Q Networks (DQN), DDQN, Dueling DQN, Experience Replay, Bandit Algorithms, Online Learning, Optimality Proofs, Contextual Bandits, Dynamic Programming, Asynchronous Dynamic Programming.

UNIT III **12 lecture hours**

Policy-based Reinforcement Learning, Policy Gradients, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, REINFORCE algorithm, Stochastic policy search, Actor-critic methods (A2C, A3C), Hierarchical Reinforcement Learning, Generalized Policy Iteration, Hierarchical RL: MAXQ, Monte Carlo Policy Gradients, Generalized Advantage Estimation (GAE), Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control.

UNIT IV **10 lecture hours**

On-Policy Learning, Off-Policy Learning, Temporal Difference Prediction, Full RL, Reinforcement Learning in Continuous Spaces, State-action-reward-state-action (SARSA), Incremental Implementation, Policy optimization methods, Trust Region Policy Optimization (TRPO), Proximal Policy Optimization (PPO), Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process.

Text Books:

1. *Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction (2nd ed.), MIT Press, 2018. ISBN 978-0262039246.*

Reference Books:

1. *Mohit Sewak, Deep Reinforcement learning: Frontiers of Artificial Intelligence (1st ed.), Springer, 2019. ISBN 978-9811382840.*

Name of Program	Master of Computer Applications				
MCAE209	Digital Marketing and Trend Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate online applications based on recent digital marketing trends.
CO2: To examine digital marketing and its applications.
CO3: To make use of state-of-the-art tools for digital marketing and trend analysis.

Course Contents:

UNIT I **12 lecture hours**

Digital Marketing, CRM, Affiliate Marketing, P-0-E-M Framework, Online vs offiine retail, Customer profile analysis, Factors influencing consumer behavior, Traffic source analysis, Multi-channel analysis, On-site merchandising analysis, Digital Advertising Market, Growth of e- commerce, Social media monitoring vs listening, Competitor and Website Analysis, Structure of online conversations, Methods of gathering data, Unlocking actionable insights from e-commerce, Adwords, Link Tagging, Exit rate and bound rate, Online advertising optimization, Measuring Performance and Quality Control, Crisis management.

UNIT II **10 lecture hours**

Online content, Content Creation, Types of Content, Content optimization, Content Management & Distribution, Recommendation system for e-commerce, User-User and User Item, Study of popular recommendation platforms, Market basket analysis, Predicting product adoption.

UNIT III **10 lecture hours**

Conversation modeling, Campaign optimization, Clickstream Analytics, Traffic Analytics, Customer segmentation, Search Engine Optimization techniques, Expertise Authority and Trustworthiness, Featured Snippets, Site architecture optimization, Long -Tail Keyword Phrases, Keyword Planner, Google rankings, Link Building, Steps to optimize the website.

UNIT IV **10 lecture hours**

Mobile Advertising, Mobile Marketing tool Kit, Mobile Marketing Features, Brand Health Management, Surrogate advertising, Fake news propagation models, Fake news identification, Social Media Monitoring, Digital data treasure, Digital rights.

Text Books:

1. *Gary P Schneider, Electronic commerce (13th ed.), Cengage Learning, Inc, 2019. ISBN 9781285425436.*
2. *Simon Kingsnorth, Digital Marketing Strategy: An Integrated Approach to Online Marketing (4th ed.), Pearson, 2019. ISBN 0749484225.*

Reference Books:

1. *Adam Clarke, SEO 2020 (2nd ed.), Amazon Digital Services LLC - KDP Print, 2019. ISBN 9781712354889.*

Name of Program	Master of Computer Applications				
MCAE211	Structural Equation Modeling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs):

On completion of this course, the students will be able to:
CO1: To explain the statistical and numerical models used in SEM Framework.
CO2: To build factor analysis to find multiple hidden variables.
CO3: To implement parameter estimation and regression analysis of practical frameworks.

Course Contents:

UNIT I **10 lecture hours**

Structural Equation Modelling, Representation of Structural Equation Models using Path Diagrams, Multiple Regression, Estimation Parameters, Least Squares estimation, Latent Variable Estimation, Estimation with Non-normal Distributions, Computing Power, Equivalent Models, Causal Foundations of SEM, Representing Interventions, Causal effects, Model Specification, Identification and Estimation, Power Analysis, Categorical Data in SEM Framework.

UNIT II **10 lecture hours**

Model Fitting, Model Selection, Path Modelling, Covariance Structure Analysis, Parameter Estimation, Maximum Likelihood, EM Algorithm, Bootstrapping Standard Errors, Bayesian bootstrap, Smooth bootstrap.

UNIT III **10 lecture hours**

Factor Analysis, Factor quantification and selection, Exploratory factor analysis, Factor selection and rotation, Velicer's Minimum Average Partial test, Convergence of Tests, Confirmatory Factor Analysis, Investigating Measurement Invariance, Indirect Effects in SEM, Bootstrapping Methods, Monte Carlo Method, Likelihood Ratio Test, Single-Group and Multi-Group Approaches.

UNIT IV **12 lecture hours**

Latent Interaction Modelling, Quasi-maximum-likelihood (QML), Multilevel Modelling of Networks, Linear and non-linear Multilevel Networks, Growth Mixture Modelling, Multiple-group Growth Curve Modelling, Latent Curve Modelling of Longitudinal Growth Data, Adding Covariates and Multiple Causes Model, Estimating Group Effects, Moderation, Mediation Effect, Indirect effect.

Text Books:

1. *Jitesh J. Thakkar, Structural Equation Modelling: Application for Research and Practice (1st ed.), Springer, 2020. ISBN 978-981-15-3793-6.*

Reference Books:

1. *Mustafa Emre Civelek, Essentials of Structural equation modelling (1st ed.), Zea Books, 2019. ISBN 978-1-60962- 129-2.*

Name of Program	Master of Computer Applications				
MCAE212	Time Series Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the working of different components of a time series.
CO2: To build autoregressive models for time series forecasting.
CO3: To implement multiple time series methods on real-world datasets.

Course Contents:

UNIT I **12 lecture hours**

Objective of Time Series Analysis, Descriptive Techniques, Time Series Plots including Line Charts, Visualization of Multidimensional Time Series Data, Displaying Multiple Time Series, Histograms for Data Distribution, Identifying Seasonal Effects and Trends, Transformation Methods, Sample Autocorrelation Analysis, Correlogram, Time series filtering, Probability models, Stochastic processes, Bernoulli Process, Weiner process, Brownian Motion, Omstein- Uhlenbeck Process, Stationarity, Second-order stationarity, Autocorrelation.

UNIT II **10 lecture hours**

White noise model, Random walks, moving average, Invertibility, ARIMA Models, Autoregressive processes, Utilizing an autoregressive (AR) model, Yule-Walker equations, general linear processes, Wold decomposition theorem, time series forecasting, exponential smoothing, Holt-Winters method, Box-Jenkins forecasting, optimality models for exponential smoothing, and model selection for time series forecasting.

UNIT III **10 lecture hours**

Spectral analysis, Sinusoidal model, Wiener-K.hintchine theory, Cramer representation, Periodogram analysis, Statistical properties of periodogram, Consistent estimators of spectral density, Bivariate processes, Cross-covariance, Cross-correlation, ARCH, GARCH.

UNIT IV **10 lecture hours**

Gaussian Process, Gaussian Regression, Vector autoregression models VAR, Structural Form, Reduced Form, Parameter Estimation, Kernel Methods for forecasting, Adaptive filtering mechanism for forecasting, Statistical Testing for stationarity, Augmented Dickey, Fuller, Kwiatkowski-Phillips-Schmidt-Shin Test, Goodness of estimation.

Text Books:

1. *Aileen Nielsen, Practical Time Series Analysis: Prediction with Statistics and Machine Learning (1st ed.), O'Reilly, 2019. ISBN 1492041653.*
2. *Terence C. Mills, Applied Time Series Analysis: A Practical Guide to Modelling and Forecasting (1st ed.), Academic Press, 2019. ISBN 978-0-12-813117-6.*

REFERENCE BOOKS:

1. *Aileen Nielsen, Practical Time Series Analysis (1st ed.), O'Reilly, 2019. ISBN 9781492041629.*

Name of Program	Master of Computer Applications				
MCAE213	Data Visualization and Dashboards	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Elucidate optimal practices in data visualization for crafting charts, maps, tables, and other visual depictions of data.
CO2: Construct an interactive dashboard to achieve a unified and smooth data visualization experience.
CO3: Apply diverse visualization techniques to real-world datasets for practical implementation and analysis.

Course Contents

UNIT I **12 lecture hours**

Data Aggregation and Operational Process Modeling, Corporate Framework Blueprinting, Operational Harmony through Business Process Integration, Modeling Workflows for Efficiency, Strategic Business Process Governance, Workflow Visualization Strategies, Layered graph drawing, Layout Algorithm, Information visualization, Graph Drawing Theory, Layout Methods, Forced Layout, Spectral Arrangement Method, Hierarchical Structure Visualization, Interactive Visual Discovery, Data Exploration through Visualization, Cognitive Visualization Techniques.

UNIT II **10 lecture hours**

Visual Analytics, Visualization from Heterogenous data sources, Reasoning and data representation, Optimal visualization types, Binning, Dashboard development, Design principles, Interactivity, Connected drill-down dashboards, Drill Down and Drill Up Charts, Bidirectional Relationship, Working with stakeholders, Stakeholder categories, Creating analytical products, Receiving feedback, Dashboard retune, Design iterations.

UNIT III **10 lecture hours**

Performance management, Balanced scorecard, Showing Rank and Magnitude, Bump Chart, Measuring Claims across Multiple Dimensions, KPI wheel, Quantitative KPI, Qualitative KPI, Lagging KPI, Leading KPI, KPI Reporting.

UNIT IV **10 lecture hours**

Current vs. Potential Usage Analysis, Utilization Rollup Overview, Tailored Dashboards for Individuals, Demographic Insight Dashboard, Dimensional Trend Visualization, Comparing growth rates, Assessing the quality of dashboards, Measuring success, Dashboard Administration, Creating Inclusive Visual Representations for Color Vision Impairments.

Text Books:

1. *Steve Wexler, Jeffrey Shaffer and Andy Cotgreave, The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios (1st ed.), John Wiley & Sons, 2017. ISBN 978- 1119282716.*

Name of Program	Master of Computer Applications				
MCAE214	Big Data Analytics and Business Intelligence	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate key technologies in data science and business analytics.
CO2: To build Big Data framework: Hadoop (HDFS and MapReduce), Hadoop Ecosystem & spark.
CO3: To make use of cutting-edge tools and technologies to analyze Big Data.

CO – PO /PSO Mapping

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

1=weakly related 2= moderately related 3=strongly related

Course Contents:

UNIT I **8 lecture hours**

Big Data Analytics: Data and Relations, Business Intelligence, Business intelligence vs business analytics, Big Data Predictive Analysis, Why what and how BI?, OLTP VS OLAP, Project life cycle, Methodology, hnpact Analysis, Testing and release management, Ethics in Business Intelligence, Big Data Technology Component, Real Time Analysis of Big Data, Big Data Architecture, Cost Conscious Design, Storage Conscious Design.

UNIT II **6 lecture hours**

Big Data Warehouse, Functional vs Procedural programming models, Data placement strategies, CAP Theorem, Streaming, Stream Data Types, Stream Computing, Filtering Stream, Estimating Moments, NoSQL, Aggregate Data Models, Document Data Model, Schema Less Databases.

UNIT III **6 lecture hours**

Hadoop Ecosystem, Hadoop Overview, HDFS, Map-Reduce, Pig Overview, Pig Grunt Shell, Hive, HBase, Architecture of Hive and HBase.

UNIT IV **8 lecture hours**

HQL, Associations and Joins, Aggregate function, Polymorphic queries, Clauses, Subqueries, Spark, Core, Spark SQL, Spark RDD, Deployment and Integration, Spark GraphX and Graph Analytics, Research Topics in Big Data Analytics.

TEXT BOOKS:

1. *Peter Ghavami, Big Data Analytics Methods (2nd ed.), De Gruyter, 2020. ISBN 9781547417951.*
2. *Acharya and Seema, Data Analytics using R (1st ed.), New York: McGraw-Hill Education, 2018. ISBN 9352605241.*

Reference Books/Learning Resources:

Name of Program	Master of Computer Applications				
MCAE215	Advanced Database Management System	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Articulate the concepts of transaction processing, concurrency control techniques, database recovery techniques.
CO2: To build distributed and object-oriented databases and learn to apply concurrency control and recovery algorithms.
CO3: To implement distributed and Object-Oriented DBMS to speed up information processing and storage.

Course Contents:

UNIT I **12 lecture hours**

ER Model, Indexing Dependencies, Transaction processing, Transaction management, Scheduling in Databases, Serial Scheduler, Non• Serial Schedulers, Concurrency Control, Time stamp ordering Protocol, Multi version concurrency control, Validation concurrency control, Recovery Techniques in Databases, Undoing, Deferred Update, Immediate Update, Buffering and Caching :in Databases, Design Elements, Cache SQL ResultSet, Cache selected fields and values, Caching serialized applications, Shadow Paging, Data Backup Architecture, Transaction logging, Paging Architecture in Databases, Full Backup, Differential Backup.

UNIT II **10 lecture hours**

Distributed DBMS, Architecture of a DDBMS, Distributed Design of Relational Database, Variant of the 2 Tier Model, Fragmentation and Replication, Update in DDBMS, Update Strategies, Eager update, Distributed Reliability, Phase commit protocol, Asynchronous Update, Distributed transaction management, Distributed concurrency control, Distributed deadlock management.

UNIT III **10 lecture hours**

Object-Oriented DBMS Architecture, Capturing Semantics, Message Passing, OODB persistence, Object relational database model, Object relational features, Object tables, Nested tables, Varying arrays, Support for large objects, Database Migration, Migration Architecture, Heterogeneous migration versus homogeneous migration, Migration consistency, Database Transformation, Differential Querying, Migration Consistency Verification, Order violation, Consistency violation, Local Transactions.

UNIT IV **10 lecture hours**

Flex Cluster Architecture, Policy-Based Cluster, Grid Infrastructure, Kernel Requirements, Data Redaction, Database Auditing, Database Diagnostic Monitor, Global User Authentication, Label Security, Data Masking, Privilege Analysis, Virtual Private Databases.

Text Books:

1. *Saudamini Patil, Narendra Joshi, Vrushali R. Sonar, Umesh M Patil, Yogesh B. Patil and Rohit A. Kautkar, Advanced Database Management Systems (1st ed.), Technical Publications, 2020. ISBN 9789389180336.*

Reference Books:

1. *Pankaj B. Brahmankar, Advanced Database Management Systems (1st ed.), Tech Neo Publications, 2019. ISBN 9788194154600.*

Name of Program	Master of Computer Applications				
MCAE216	Satellite Data Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the mechanisms of GIS and spatial data towards the preparation of thematic maps.
CO2: To examine and interpret various land features over satellite images.
CO3: To design and implement techniques for land feature recognition and image mosaicking.

Course Contents:

UNIT I **10 lecture hours**

GIS Data Representation, Geospatial data for GIS applications, Digital representation of geospatial data, Mapping, Paper based maps vs digital maps, Map scale, Cartography, Electromagnetic spectrum, Pre-processing of Satellite Images, Georeferencing, Image enhancement, Ground Control Points collection, Satellite Image Interpretation, Raster Based GIS, Raster representation of data grid size and resolution, Data capture/preparation, Raster to vector conversion, Vector based GIS, Vector representation of data, Spatial data Collection, Sampling, Scaling.

UNIT II **10 lecture hours**

Type of Spatial Data, Geospatial Analysis, Mobile Geospatial Computing, Spatial Database Management, Standard Data Formats, Modelling Features, Spatial Data Analysis and Modelling, Proximity Analysis, Overlay Analysis, Buffer Analysis Network Analysis, Interaction mechanisms of EM radiation with ground, Spectral response curves, Multi-spectral scanning, Salient characteristics of Satellites.

UNIT III **10 lecture hours**

Different types of resolutions in Remote Sensing, Image interpretation of different geological landforms, rock types and structures, Remote Sensing integration with GIS and GPS, SAR Technique and its applications, Hyperspectral Remote Sensing, Integrated RS and GIS, Limitations of Remote Sensing Techniques, 3-dimensional viewing of land features, Spatial maps and Geoservers, Image mosaicking, Keypoint Detection, Projective Layouts, Image interpretation.

UNIT IV **12 lecture hours**

Onboard data handling in LandSat 8 and 9, Handling reflective bands, Handling thermal infrared bands, Liner adaptive contrasting, Non• linear adaptive contrasting (25), Hubble telescope images, Data Calibration and Pipeline reduction, Chandra X-ray Observatory, Processing False Color Images, 3-Color Composite Image Reduction, Google Earth Engine for large scale and multi-temporal data analysis (25) Limitations and future of satellite Image analysis.

Text Books:

1. *Chang, K. T., Introduction to geographic information systems(9th ed.), McGraw-Hill Higher Education, 2019. ISBN 978-1260136371.*
2. *D. Jude Hemanth, Artificial Intelligence Techniques For Satellite Image Analysis (1st ed.), Springer, 2020. ISBN 9783030241803.*

Reference Books:

1. *Timothy Prat, Satellite Communications (3rd ed.), Wiley, 2021. ISBN 9354243037.*
2. *Qihao Weng and Yuhong He, High Spatial Resolution Remote Sensing (1st ed.), CRC Press, 2018. ISBN 9780429892993.*

Name of Program	Master of Computer Applications				
MCAE217	Cloud Security & Compliances	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To learn and examine the security breaches of IaaS, PaaS, and SaaS.
CO2: To apply various data encryption methods and security mechanisms to get the administrative control using IAM service.
CO3: To create a secure production environment using cloud security features and services.

Course Contents:

UNIT I: **14 lecture hours**

Security Patterns for Cloud Computing – Network Security, Identity & Access Management & Trust, Secure On-Premises Internet Access, Secure External Cloud Connection, Cloud Denial-of- Service Protection, Cloud Traffic Hijacking Protection, Automatically Defined Perimeter, Cloud Authentication Gateway, Federated Cloud Authentication, Cloud Key Management, Trust Attestation Service, Collaborative Monitoring and Logging, Independent Cloud Auditing

UNIT II: **14 lecture hours**

End-to-end security, Shared responsibility in the cloud, Backup and restore, Detect and mitigate threats, Plan for ransomware, recovering from systemic identity compromise, Threat protection, Securing Workloads, Security technical capabilities, Physical security, Components and boundaries, Operations and Monitoring, Platform integrity and security, Secure Data Protection Law: national and International, Firmware security, Code integrity, Secure Boot, Secure Isolation of Physical & Logical Infrastructure, Compute, Network, Storage, Common attack vectors and threats, Secure Isolation Strategies, Multitenancy, Virtualization strategies.

UNIT III: **14 lectures hours**

Data Protection for Cloud Infrastructure and Services. Understand the Cloud based Information Life, Cycle, Data protection for Confidentiality and Integrity, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key, Management, Assuring data deletion, Data retention, deletion and archiving procedures for tenant data, Data Protection Strategies.

Text Books :

1. *Chen, Lei, Hassan Takabi, and Nhien-An Le-Khac, Security, privacy, and digital forensics in the cloud (1 ed.), John Wiley & Sons, 2019. ISBN 13: 9781119053286.*

2. *Russell, Brian, and Drew Van Duren, Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem (2 ed.), Packt Publishing Ltd, 2018. ISBN 13: 9781788625821.*

Reference Books :

1. *Anthony, Mastering AWS Security: Create and maintain a secure cloud ecosystem (1 ed.), Packt Publishing Ltd, 2017. ISBN 13: 9781788293723.*

2. *Tevault, Donald A, Mastering Linux Security and Hardening: Secure your Linux server and protect it from intruders, malware attacks, and other external threats (1 ed.), Packt Publishing Ltd, 2018. ISBN 1788620305.*

Name of Program	Master of Computer Applications				
MCAE218	Cloud System Administration & Operations	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To get fundamentals of support and maintain cloud workloads as per the cloud architecture.
CO2: To perform operations by using the cloud management console, CLI and SDK.
CO3: To implement architectural requirements with monitoring, logging, and troubleshooting.

Course Contents:

UNIT I: **14 lecture hours**

Need of cloud administration and operations, Roles and responsibilities of cloud Admin, Inter-cloud Resource Management, Resource Deployment and Provisioning, Identifying the steps to provision cloud resources, Identify, and remediate deployment issues, Storage and Data Management Connectivity services of public/private cloud Automation and Optimization, Manage and assess resource utilization, Employ cost optimization strategies, Automate manual or repeatable process, Minimize management overhead, Monitoring and Reporting, Maintain metrics and alarms utilizing, Recognize and differentiate performance metrics, Availability metrics, Manage security policies on cloud, Access controls when using cloud, Shared responsibility model.

UNIT II: **12 lecture hours**

Data Centre Management Tools Integration, Service and Resource Management, implement scalability and elasticity, highly available and resilient environments on cloud, automate snapshots, Data Lifecycle Manager, Data Retention policy, Restore databases versioning, Lifecycle rules, Disaster recovery procedures, Cost optimization strategies, Networking and Content Delivery, Performance optimization strategies.

UNIT III: **16 lectures hours**

OS boot process (Win/Linux) and Troubleshooting: Memory management, Memory pages, Buffer and Caches, System date/time management, Network time protocol, Network Logs Auditing, Managing Users and groups, File permissions, Assessment/Buffer Lecture, managing software, Managing system services, Background processes, Windows start-up tasks Integrated Internet-aware network troubleshooting, Network tools to report the problem, Network address translation, troubleshooting in common VPC, Troubleshooting in On-premises to VPC, System performance – DISK, System performance – Memory, System performance – Network System Login issues, System booting issues System logs, Network connectivity issues

Studio Work/Laboratory Experiments:

Studio work focuses on seven cloud sub domains that are as; 1. Monitoring and Reporting, 2. High 3. Availability, 4. Deployment and Provisioning, 5. Storage and Data Management 6. Security and Compliance, 7. Networking and Automation and Optimization.

Text Books :

1. *S., Digby, G., Fitch, C., Friedberg, S., Qualheim, S., Rhoads, J and Sundrud, B, AWS Certified SysOps Administrator Official Study Guide: Associate Exam (1 ed.), John Wiley & Sons, 2017. ISBN 9781119377429.*
2. *Chandra Rajasekharaiah, Cloud-Based Microservices: Techniques, Challenges, and Solutions (1*

Name of Program	Master of Computer Applications				
MCAE219	Cloud Infrastructure and Services	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the building blocks of cloud infrastructure in the current industry scenario.
CO2: To design the cloud infrastructure using infrastructure as code.
CO3: To develop and deploy cloud services as per the cloud architectural use case.

Course Contents

UNIT I **14 lecture hours**

Cloud Deployment Models, Strategies for Cloud Migration On-premises IT vs On-Cloud IT, Vrrtualization, Virtual Cluster Formation, Classic Data Centre (CDC), Virtualized Data Centre (VDC) Configurations Virtual Network devices, Compute Resource, Storage resource, Network clusters, Edge Location, Distinguishing Between Cloud Infrastructure and Cloud Architecture, Defining Cloud Infrastructure, Design issues of cloud-based development and deployment, Addressing Design Challenges in Cloud-Based Development and Deployment, Software Development Life Cycle, Agile Methodology, DevOps Culture, Cl/CD implementation of Infrastructure as a code, Cloud-Infrastructure cost estimation, Specifying the service level agreements, Publishing Cloud Resource Templates, Defining licensing models, Categories of Cloud Infrastructure, Datacenter Rack Management, Green Cloud computing, Embracing Ubiquitous Cloud Solutions, Utility Computing, Cluster Computing, Grid Computing, Case Study: Applications of Edge Computing in Cloud Environments.

UNIT II **12 lecture hours**

Integrating Tools for Data Centre Management, Effective Service and Resource Management in the Cloud, Infrastructure Security and compliances Case and Study, Designing Cloud Infrastructure template/code, Inter-cloud Resource Management & Demo, Interfaces for Users, Admins, and Developers, Exploring Service-Oriented Architecture (SOA), Services life cycle management, Understanding Cloud APIs and Their Applications Message-oriented Middleware, Workflow in SOA.

UNIT III **16 lecture hours**

Case Study: Analyzing the Cloud Infrastructure Market: A Comprehensive Case Study, Understanding Active Directory Concept, Demo of Active Directory, Microservices and its detailed programming model, Diving into Serverless Computing: A Practical Demonstration, Exploring Parallel and Distributed Programming Paradigms, Balancing Coupling and Decoupling in Well-Defined Architectures, Criteria for cloud service selection, Parameters affecting to performances of service implementation, Popular open sources DevOps tools, Case Study of DevOps Tools, Working with Container and Docker, Working with Kubernetes, Application Development and Deployment on Kubernetes, Continuous Integration and Continuous Development (CI-CD), Demo Cl/CD pipeline, Everything is as a service: Case Studies.

Text Books:

1. Judith S. Hurwitz and Daniel Kirsch, Cloud Computing for Dummies (1st ed.), Hoboken: John Wiley & Sons, 2020. ISBN 978-1119546658.
2. Chandra Rajasekharaiah, Cloud-Based Microservices: Techniques, Challenges, and Solutions (1st ed.), Apress, 2020. ISBN 9781484265642.

Reference Books:

1. Silvano Gai, Building a Future-Proo/ Cloud Infrastructure (1st ed.), Addison- Wesley, 2020. ISBN

Name of Program	Master of Computer Applications				
MCAE210	Emerging Topics in Cloud Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To familiarize and learn about the latest trends and research in the field.
CO2: To equip themselves with the conceptual and practical experience of few latest methods, tools, technologies or algorithms in Cloud Computing.

Course Contents:

UNIT I **42 lecture hours**

This course covers the latest advancements and emerging trends in Cloud Computing, with UNITs selected by the instructor based on current industry demands and technological relevance. The topics will align with the needs of enterprises, cloud service providers, and start-ups, incorporating real-world case studies, use cases, and deployment scenarios. Students will explore areas such as cloud architecture, virtualization, containerization, serverless computing, and cloud-native application development. Emphasis will be placed on hands-on lab work, enabling learners to work with leading platforms like AWS, Azure, and Google Cloud. The course will also address cloud security, compliance, and cost optimization strategies. Practical assignments will guide students through the process of designing, deploying, and managing scalable cloud solutions. Projects will simulate real industry challenges to foster problem-solving and innovation. The dynamic nature of the curriculum ensures exposure to the most relevant tools and technologies in the cloud ecosystem.

Professional Electives

Name of Program	Master of Computer Applications				
MCAP301	Secure Coding	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain secure programming philosophy, design principles, and its methods.
CO2: To examine typical mistakes done during programming and the methods of their handling.
CO3: To implement the typical threats in programming and understand concepts of implementing the secure codes.

Course Contents:

UNIT I **14 lecture hours**

Secure Programming, Robust vs. Secure Programming, Security Policies and Procedures, Checking Design and Implementation, Where to Look for Vulnerabilities, Classification of Security Flaws, Landwehr's Taxonomy, Fortify Taxonomy, Protection methods at different layers, PreDeCo matrix of software security. Input Validation in Programming, Improper Error and Exception Handling, Code Injection and Mitigation, Broken Authentication.

UNIT II **14 lecture hours**

Secure Programming Design Principles, Principle of Least Privilege, Fail-Safe Defaults, Principle of Economy of Mechanism, Principle of Complete Mediation, Separation of Privilege Principle, Principle of Open Design, Principle of Least Common Mechanism, Principle of Least Astonishment, Control Hijacking Attacks and Defences, Attacks Using Virtual Machines, Static and Dynamic Analysis, Language• based Security Models, Isolation Techniques.

UNIT III **14 lecture hours**

XML External Entity (XXE), Cross-Site Scripting (XSS), Insecure Deserialization, LFI (Local File Inclusion) and RFI (Remote File Inclusion) vulnerabilities, Unvalidated File Upload vulnerability, Buffer Overflow vulnerabilities, Client Side Security, JavaScript Security, Click Jacking, Ajax Security, HTML5 Security, Java Secure Socket Extension (JSSE), Common Coding Errors and Vulnerability, Automation and Testing for secure coding, Research Issues in Secure Coding.

Text Books:

1. *Richardson T. and Thies C. N., Secure Software Design, Jones & Bartlett Leaming (1st ed.), Jones & Bartlett, 2012. ISBN 978-1449626327.*

Reference Books:

1. *Zach Codings, Computer Programming and Cyber Security for Beginner (1st ed.), Independently published, 2019. ISBN 978-1671532908*
2. *Seacord Robert C., Secure Coding in C and C++ (2nd ed.), Pearson Education, 2013. ISBN 978-0321822130.*

Name of Program	Master of Computer Applications				
MCAP302	Compiler Construction	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate major phases of compilation.
CO2: To examine various parameters passing scheme, explain memory management of a programming languages and perform code optimization.
CO3: To Implement lexical analyzers, parsers, and small compilers by using general purpose programming languages.

Course Contents:

UNIT I **14 lecture hours**

Compiler, Code Analysis, Interpreter, Single Pass, Two pass, Multi Passcompiler, Preprocessor, Macros, Phasesofcompiler,Symboltable manager, Operations on symbol table, Error handling, Bootstrapping and cross compiler, Lexical Analysis, Tokens, Regular expr ession, Generation oflexicalanalysisfrom DFA,SyntaxAnalysis, Parser, Context Free Grammar, Conversion RuleforAmbigous ToUnambigous Grammar, Non-Deterministic & Deterministic Grammar, Left Recursive And Right Recursive Grammar, Parsing: Top down and Bottom up, Backtracking andtheirautomatic generation, LL(1)Parser, LRParser, LR(0) items, SLR(1), LALR (1),Canonical Parsing.

UNIT II **16 lecture hours**

Error Analysis, Error Classification, Error detection, Error Detection in LL and LR parsers, Error recovery, Panic mode error recovery, Static semantic, Intermediate code generation, static semantic analyses in declaration processing, name, and scope analysis, S-attribute, Semantic analysis through S-attribute grammar, L-attribute, Type checking, Language features influencing run time memory management. Parameter passing mechanism, Division of memory into code, stack, heap and static, Activation record, Garbage collection, Code generation for expressions, issues in efficient code generation.

UNIT III **12 lecture hours**

Sethi IDlman algorithm, optimal code generation, Retargetable code generation, Code generation for control structures, Code Optimization, Local and global optimization, Control flow analysis, Data flow analysis, Global optimizations, Graph colouring in optimization, Live ranges of run time values.

Text Books:

1. *Sunitha, K. V. N., Compiler construction (1st ed.), Pearson Education India, 2013. ISBN 978-9332500297.*
2. *Douglas Thain, Introduction to Compilers and Language Design (2nd ed.), Lulu.com, 2019. ISBN 978-0359142835.*

Reference Books:

1. *Mogensen T.JE.,Introduction to Compiler Design (2nd ed.), Springer, 2017. ISBN 978-3319669656.*
2. *Joh I.Moore, Introduction to Compiler Design: An Object-Oriented Approach Using Java (1st ed.), Softmoore Consulting, 2019. ISBN 978-1734139105.*

Name of Program	Master of Computer Applications				
MCAP303	Software Project Management	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate and determine the purpose and importance of basic processes involved in project management from the perspectives of planning, tracking and completion of project.
CO2: To exam in different organization structure sand project structures.
CO3: To implement programs to manage project management, project schedule, expenses and resources with the applications of project management tools.

Course Contents:

UNIT I **16 lecture hours**

Project Management: Characteristics of software projects, Objectives, Stakeholders, Feasibility Study, Cost-benefit Analysis, Planning, Project Execution, Project and Product Life Cycles, Role of project manager, Knowledge areas, Tools & Techniques, System view of project management, Agile software, Iterative steps for planning, Project Plan documentation methods, Software Requirement Specification, Measurement and Control, Reviews, feedback and reporting mechanisms, revisiting the plan, Scope Planning & Scope management plans, Function point calculation, Scope definitions & project scope statement, Project time management, Activities sequencing, Network diagrams, Activity recourse estimation, Activity duration estimation, Schedule development, Gantt Charts, Critical path method, Program evaluation & review technique (PERT) and CPM, Principles of cost management, Cost estimating, Type of cost estimate, Cost estimate tools & techniques, COCOMO.

UNIT II **14 lecture hours**

Putnam/SLIM model Estimating by Analogy, Cost budgeting, Cost control, Earned value management, Project portfolio management, Project Quality Planning, Quality Assurance, Quality control, Tool & techniques for quality control, Pareto Analysis, Six Sigma, CMM, ISO Standards, Juran Methodology, Project Hwnan resource planning, Project organisational charts, Responsibility assignment metrics, Acquiring project team, Resource assignment, resource loading, Resource levelling, Team structures, Project Communication Planning, Performance reporting, Managing stakeholders.

UNIT III **12 lecture hours**

Project Risk Management planning, Common sources of risk, Risk identification techniques, Qualitative risk analysis, Expert judgement, Decision trees, Expected monetary value, Simulation, sensitivity analysis, Risk response planning, Risk monitoring & control, Project Procurement management plans, Contract statement of work. Planning contracts, Requesting seller responses, Selecting sellers, Administrating the contract, Closing the contract, Software Configuration Management, Retaining versions, Software Configuration elements (SCl's), Change Control and Management.

Text Books:

1. *Roger Pressman and Bruce Maxim, Software Engineering : A practitioners approach (9th ed.), TataMcGraw Hill, 2020. ISBN 978-1259872976.*

Reference Books:

1. *Manuj Aggarwal and Tetra Tutorials Team, The Art of Project Management for Software and IT Engineers (l8t ed.), Packt Publishing, 2018.ISBN 978-1789804768.*

Name of Program	Master of Computer Applications				
MCAP304	Soft Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To comprehend the fuzzy logic and the concept of fuzzy set theory in soft computing.
CO2: To examine Neuro-Fuzzy and Genetic Algorithm expert system.
CO3: To implement applications on different soft computing techniques like Fuzzy, Multi Objective optimization and Genetic Algorithm (GA).

Course Contents:

UNIT I **14 lecture hours**

Soft Computing, Key characteristics and applications of soft computing, Soft vs. Hard computing, Fuzzy logic, Fuzzy set, Crispvs.Fuzzy Set, Fuzzy Set Properties, Operations on Fuzzy set: Union, Intersection, Complement, Sumand Difference, Equality and Power, C artesian Product, Fuzzy If-Then Rules - Fuzzy Reasoning, Fuzzy membership functions, Gaussian membership function, Sigmoid membership function, Triangular membership function, Trapezoidal membership function, Fuzzy proposition, Fuzzy interferences, Fuzzy rela tions• Max- Min Approach, Fuzzification -Defuzzification, Fuzzy Logic Controller, Neuro-Fuzzy modelling.

UNIT II **14 lecture hours**

Multi Objective Optimization, Multi-Objective Evolutionary Algorithm, Pareto based Approach, Non-Pareto based approaches, Genetic Algorithm (GA), GA working architecture, Genetic representations, GA Encoding and Selection Techniques, Survival of the Fittest, Fitness Computations, GA Crossover Techniques, GA Mutation, Reproduction, Rank method, Rank space method, GA Case Studies: Optimization of traveling salesman problem using Genetic Algorithm, Genetic algorithm-based Internet Search Techniques.

UNIT III **14 lecture hours**

Evolutionary Algorithm, Ant system, Ant Colony Optimization, Max-Min Ant System, Ant Miner, Snake-Ant Algorithm, Particle Swarm Optimization, Artificial Bee Colony, Cuckoo Search Algorithm, Working architecture, Co-evolution, Plasticity and life-time learning, Lamarckian learning, "No free lunch" theorem, Hybrid fuzzy controller, Fuzzy Logic Controlled Genetic Algorithms. UNIT IV (6 lecture hours Genetic Algorithms-Neural Networks, Neural Networks Fuzzy Logic, Extreme Leaming Machine, Training SLFN using ELM, Extreme Leaming Machine, Variants of ELM, Applications of ELM, Extended ELM.

Text Books:

1. *Saroj Kaushik and Sunita Tiwari, Soft Computing, Fundamentals, Techniques and Applications (1st ed.), McGraw- Hill Education, 2018. ISBN 978-9353160678.*
2. *Sivanandam, S. N., and Deepa, S.N, Principles ofsoft computing (18t ed.), John Wiley & Sons, 2011. ISBN 978-8126527410.*

Reference Books:

1. *Buontemp F., Genetic Algorithms and Machine Learningfor Programmer (1st ed.), Pragmatic Bookshelf, 2019. ISBN 978-1680506204.*
2. *Gridin I., Learning Genetic Algorithms with Python (1st ed.), BPB Publications, 2021. ISBN 978-8194837756.*

Name of Program	Master of Computer Applications				
MCAP305	Distributed Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0		3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the models, architectures, and the concept of virtual clock and clock synchronization.
CO2: To examine the algorithms for mutual exclusion, deadlock detections, and termination detection.
CO3: To implementing the concepts of distributed computing on Google File System , Hadoop Distributed File System(HDFS), and sensor networks.

Course Contents:

UNIT I **12 lecture hours**

Introduction, process communication, Message Passing, Leader Election, Leader election algorithm, Distributed Models, Causality and Logical Time, Size of Vector Clock, Matrix Clocks, Vrrtual Time and Physical Clock Synchronization, Global State and Snapshot Recording Algorithms, Distributed Mutual Exclusion and Non-Token based Approaches, Quorum Based Distributed Mutual Exclusion Approaches: Maekawa's Algorithm.

UNIT II **10 lecture hours**

Distributed Mutual Exclusion-Token based approaches, Consensus & Agreement, Checkpointing & Rollback Recovery, Deadlock Detection in Distributed Systems, Approaches, Algorithms for deadlock detection:Path-Pushing, Edge Chasing, Diffusion Compution, and Global state detection Distributed Shared Memory, Features and advantage, Distributed Minimum Spanning Tree.

UNIT III **10 lecture hours**

Termination Detection, Huang's algorithm, Message Ordering & Group Communication, Fault Tolerance and Self-Stabilization, Distributed Randomized Algorithms, Distributed Hash Tables and Peer to Peer Computing.

UNIT IV **10 lecture hours**

Case Studies: Google File System and HDFS, Distributed Execution using Map Reduce, Introduction to Spark, Introduction to Sensor Networks, Distributed Algorithms for Sensor Networks: Coverage and Connectivity, Topology Discovery, LEACH -Cluster based Low Power Algorithm ,Authentication in Distributed Systems, Security in Distributed Systems and Block Chain.

Text Books:

1. *Van Steen Maarten and Tanenbaum Andrew S., Distributed Systems (3rd ed.), Amazon Digital Services, 2017. ISBN 978- 1543057386.*

Reference Books:

1. James Aspnes, Notes on Theory of Distributed Systems

Name of Program	Master of Computer Applications				
MCAP306	Agile Software Development	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate existing problem with the team, development process, and wider organization.
C02: To specify the most appropriate way to improve the results for a specific need using agile techniques.
CO3: To apply understanding of agile principles and specific practices.

Course Contents:

UNIT I **14 lecture hours**

Agile mindset, Agile manifesto, Predictive model, adaptive model, Agile principles, Organizational impact of adopting agile, Agile case study, Agile requirements, User stories and acceptance criteria, 3 C's in user stories.

UNIT II **14 lecture hours**

Epics and tasks, Product backlog and refinement, Scrum framework, Roles in scrum, Phases in scrum, Sprints, Sprint backlog, Daily scrum, Scrum rules, Agile estimation and planning, Effectively using story points, Need of velocity and duration, Planning poker technique for PBI sizing, Fixed estimation based on velocity, Velocity range, Release planning, Fixed scope release, Fixed date release, Agile and DevOps.

UNIT III **14 lecture hours**

Sprint planning, Capacity determination, Sprint Execution, Flow management, Swarming in flow management, Task board and task table, Sprint charts, Sprint review, Pre-work, process, and activities, Sprint retrospective, Participants, pre-work, process, and activities, Sprint retrospective steps, Extreme Programming (XP) in agile, XP values, XP practices, XP process model, Scrum vs XP.

Text Books:

1. *Craig Lannan and Bas Vodde, Large-Scale Scrum: More with LeSS (1st ed.), Addison-Wesley Professional, 2016. ISBN 978- 0321985712.*

Reference Books:

1. *Alex Cambell, Agile: All You Need to Know about Agile SoftwareDevelopment. Team and Project Management using Scru (1st ed.), Independently Published, 2020. ISBN 979-8672282909.*

Name of Program	Master of Computer Applications				
MCAP307	Vu1ual Reality: Interface, Application and Design	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To demonstrate an understanding of fundamental techniques, processes, technologies, and equipment used in immersive virtual reality.
CO2: To explore the materials and processes used in immersive virtual reality.
CO3: To show a basic awareness and understanding of historical and theoretical contexts relevant to immersive virtual reality and demonstrate an understanding of the importance of critical and self-reflective practice.

Course Contents:

UNIT1 **12 lecture hours**

VR Goals and definitions, Historical perspective, Birds-eye view, Geometry of Virtual Worlds, Geometric modelling, transforming models, Matrix algebra and 2D rotations, 3D rotations and yaw, pitch, and roll, Axis-angle representations, Quaternions, Converting and multiplying rotations, Homogeneous transforms, the chain of viewing transforms, Eye transforms, Canonical view transform, Viewport transform. Hardware Technologies for 3D user Interfaces: Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.JD user Interface Input hardware: Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces.

UNIT II **10 lecture hours**

Light and Optics: Three interpretations of light, Refraction, Simple lenses, Dioptres, Imaging properties of lenses, Imaging properties of lenses, Lens aberrations, Optical system of eyes. Visual Physiology: Photoreceptors, Enough resolution for VR, Light intensity, Eye movements, Eye movement issues for VR, Neuroscience of vision. Visual Perception: Depth perception, Motion perception, Frame rates and displays.

UNIT III **10 lecture hours**

Tracking Systems: Orientation tracking, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Filtering, Lighthouse approach. Visual Rendering: Visual Rendering-overview, Shading models, Rasterization, Pixel shading, VR-speci:fic problems, Distortion shading, Post-rendering image warp.

UNIT IV **10lecture hours**

Physics and physiology, Auditory perception, Auditory localization, Rendering, Spatialization and display, Combining other senses. Interfaces: Interfaces -overview, Locomotion, Manipulation, System control, Social interaction, Evaluation of VR Systems.

Text Books:

1. *William R. Sherman and Alan Craig, Understanding Virtual Reality, Interface, Application and Design (2nd ed.), Morgan Kaufmann, 2018. ISBN 978-0128183991.*
2. *Josh Gregory, Minecraft Virtual Reality (1st ed.), Cherry Lake Publishing, 2018. ISBN 978-1534133112.*

Reference Books:

Name of Program	Master of Computer Applications				
MCAP308	Combinatorics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain knowledge of combinatorics, numbers, and probability theory.
CO2: To articulate combinatorial problems, extract and interpret descriptive statistics from social networks, search engine and hypergraphs.
CO3: To implement and design various quantitative properties of large combinatorial structure.

Course Contents:

UNIT I **10 lecture hours**

Combinatorics, Counting and product principle, Counting over counting and sum principle, Function and bijection principle, Relations and equivalence principle, Pigeonhole principle, Subsets, Partitions, Subsets of fixed size, Subset of multiset, Subset of combination, Binomial theorem and Pascal's triangle, Binomial Coefficients, Congruences, Congruence of binomial coefficients, Permutations, One-line notation, Two-line notation, Canonical cycle notation, Estimates for factorials, Stirling's Approximation, Ramanujan's factorial approximation, Selections, Equivalence and order, Finite topologies, 0 or 1points, 2 points.

UNIT II **12 lecture hours**

Compactness and countability, Connectivity, Separation axioms, Cayley's Theorem on trees, Algebraic topology, Generating Combinatorial Objects, Generating Subsets, Variable Size Decrease Algorithms, PageRank (PgRk) algorithm for searching engine, Kernel Networks for pattern analysis, Partially ordered sets or Posets, Graded poset, Lattices, Metroid, Linear extensions of posets, Distributive lattices, Propositional logic, Chains and antichains, Products and dimensions.

UNIT III **10 lecture hours**

Mobius function of poset, Famous Number Families, Multinomial Coefficients, Fibonacci Numbers, Lucas Numbers, Stirling Numbers, Integer Partition Numbers, Bell numbers, Recurrence Relation and Generating Functions, First order recurrence relation, Second order recurrence relation, Non-homogeneous recurrence relation.

UNIT IV **10 lecture hours**

Combinatorics on graphs, Infinite Combinatorics and Graphs, Counting trees, Minimal spanning Trees, Chromatic polynomial, Manifold method for non-linear dimensionality reduction, Spectral methods to solve differential equations, Turan Problem, Littlewood-Offord Problem, Catalans Numbers, Isoperimetric Problems.

Text Books:

1. M Miklos Bona, A Walk-Through Combinatorics: An Introduction to Enumeration and Graph Theory4th ed.), WSPC, 2016. ISBN 978- 9813148840.

Reference Books:

1. Pavle Mladenovic, Combinatorics: AProblem-Based Approach (1st ed.), Springer, 2019. ISBN 978-3030008307.

Name of Program	Master of Computer Applications				
MCAP309	Mobile and Networked Embedded Systems	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the concepts of mobile and networked embedded systems.
CO2: To explain the architecture of networked embedded systems.
CO3: To design and develop networking systems for automated applications for smart cities, building, parking.

Course Contents:

UNIT1 **14 lecture hours**

Smart Environments, Paradigms for pervasive networking, Networked Embedded Systems, Wireless Embedded Networking, Applications, Network Topology, Real-time embedded systems, Components of networked embedded systems, Centralized and distributed embedded systems, Physical sensor, Passive sensor, Semi-passive, Active sensors, Soft sensors, Sensor nodes, Hardware architecture. Operating systems for sensor nodes, Mobile sensor network, Sensor networks with mobile nodes.

UNIT II **14 lecture hours**

Power management and mobile node discovery, Data transfer to mobile nodes, Routing to mobile nodes, Sensor networks with all mobile nodes, Participatory sensing, Vehicular Networked Embedded Systems, Embedded Networks for Car Domains, Intra -vehicular Network Embedded Systems, Event Triggered Systems, Time Triggered Systems, Inter-Vehicular Network Embedded Systems.

UNIT III **14 lecture hours**

Applications for smart cities (pollution monitoring), Applications for smart cities (smart lighting, context-aware applications), Smart mobility (parking area management), Smart mobility (intelligent transportation systems), Smart buildings (home/building automation, energy efficiency), Social sensing applications.

Text Books:

1. Chattopadhyay S., Embedded System and Design. (2nd ed.), Prentice Hall India Learning Private Limited, 2013. ISBN 978-8120347304.

Reference Books:

1. Lyla B. Das, Embedded Systems: An Integrated Approach (1st ed.), Pearson Education India, 2012. ISBN 978- 8131787663.
2. Peckol, Embedded Systems (2nd ed.), Wiley, 2019. ISBN 978-1119457503.

Name of Program	Master of Computer Applications				
MCAP310	Problem Solving using C	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain various concepts in C programming language and understand the problem-solving aspect.
CO2: To Implement concept of pointer and perform I/O operations in files and make use of concepts in finding solutions to real-life problems.

Course Contents:

UNIT I **14 lecture hours**

Program structure, Communications with the Operating System, Library Functions, Pre-processor Directives, Debugging and Efficiency, Memory Models, Data Types-Simple C data types, Integer Data types, Floating Point types, Derived Data types, The ASCII Character Set, Compilation and Linking, Types of compilers, Decision making, Loops, Switch statement, Goto statement, Null statement, Comma operator, setjmp functions, longjmp functions, Storage classes: automatic variable, external, static, register, Arrays, Array Indexing, Using Array Names as Pointers, Character Arrays.

UNIT II **14 lecture hours**

Advanced data types: #define statement, Variable length array, Flexible array members, Complex number type, Type Qualifiers: Const, Volatile, Restrict, Functions, Pass by value, Pass by reference, Command Line Arguments, Structures, Arrays of Structures, Structures of Arrays, Structures of Structures, Bit Fields in Structures, offsetom, Macro, unions, Typedef, Typecasting, Implicit type cast ing, Explicit typecasting, Pointers- Declaration, NULL pointers, Indirection, Pointer to array, Pointer to function, Pointer to structure, Arrays of Pointers, Passing pointers to functions.

UNIT III **14 lecture hours**

File handling, Recursive functions, Memory allocation in a recursive method, Dynamic memory allocation, Global Memory versus Local Memory, Error handling in C, Global Variable Ermo, perrorO and strerror(), Exit status, Divide by zero errors, Interfacing C with Python code: Calling C functions from Python, Calling python functions from C, Threads: Creating a thread, Passing arguments and returning values, Common thread functions, Thread synchronization concepts, Mutexes, condition variables.

Text Books:

1. Byron Gottfried, Outline of Programming with C (4th ed.), McGraw Hill Education, 2018. ISBN 978-0070145900.

Reference Books:.

1. E. Balaguruswamy, Programming inANSI (8th ed.), McGraw Hill Education, 2018. ISBN 978-9351343202

Name of Program	Master of Computer Applications				
MCAP311	Game Programming with HTML	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the fundamentals of Game Programming in HTML5 and understanding the elements of programming in two-dimensional environment for the creation of Games.
CO2: To create the games for the desktop machine and Internet using the different tools available in a major programming language like HTML5.

Course Contents:

UNIT I **14 lecture hours**

HTML5 Multimedia, Game framework, FrameRate class, Creating custom rendering thre Creating an active rendered th.re Changing the display mode, Active rendering in full-screen display mode, Handling keyboard input, Keyboard improvements, Handling mouse Input, Relative mouse movement, Points and vectors, Transformations, Transformation using the vector 2f class, Transformation using polar coordinates, Matrix transformations, Row-major vs column-major matrices, Matrix.3x3f class, Affine transformation in time and space, Calculating time delta, Screen mapping, Viewport ratio, Cannon physics.

UNIT II **16 lecture hours**

Intersection testing, Point in polygon testing, Testing using AABB, Testing using circles for intersections, Testing using the separating axis method, Testing using the line-line overlap method, Testing using the rectangle-rectangle overlap method, Optimizing the tests, Game development setup, Exploring the Game Library, XML, Deploying an Applet, Executable JAR, Deployment of game on multiple applications, Swing animation, Component animator, RepaintCollector, LoopGovemer, Animated component, Animation library, ComponentPainter, ComponentUpdater, ComponentAnimator. Advanced Graphics, Hardware-Accelerated Images, Multi-Buffering and Multi-Threading, Full-Screen Exclusive Mode, Persistent Data, Persistent data formats, Persistence mechanisms, Data Integrity, Game architecture, Interfaces and inheritance, Model-View-controller, Component View MVC, A• Algorithm, GridCartographer and GradientCartographer.

UNIT III **12 lecture hours**

HTTP Tunneling, Reusable Client and server-side code, Game specific client and server side code, HTTP Polling, HTTP Pulling, HTML5 file upload and downlo File API and Ajax I XHR2, Drag and drop files, IndexedDB, HTML5 Multimedia, Web Components, Web Workers, The Orientation and Device Motion APis.

Text Books:

1. *Aditya Ravi Shankar, Pro HTML5 Games, Learn to Build Your Own Games Using HTML5 and JavaScript (2nd ed.), Apress, 2017. ISBN 978-1484229095.*

Reference Books:

1. *Gabor Szauer, GamePhysics Cookbook (1st ed.),Packt Publishing Limited, 2017. ISBN 978-1787123663.*

Name of Program	Master of Computer Applications				
MCAP312	Software Craftmanship in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : To articulate the concept of Software Craftsmanship
CO2 : To examine the concept of software documentation, structure, testing and validation.
CO3 : To implement the rules and principles of software craftsmanship.

Course Contents:

UNIT I: **10 lecture hours**

Software Craftsmanship, Four Dimensions of Quality, Software Ethics, Clean code, Craftsmanship Vs Engineering, Frameworks and Tools, Design, Structure, Formatting, and Documentation of Code, Types of Designs/Models, Design Structure Matrix (DSM), Product-Service System using DSM.

UNIT II: **12 lecture hours**

Process Documentation, Product Documentation, Different Phases of Design, Requirement of Documentation, Advantages of Documentation, Technical and Non-Technical Challenges in Code Documentation, Content Authoring, Formatting, Styling, Issue Tracking, Testing, Publishing, Documentation: Testing, Debugging, Refactoring Improving Structure.

UNIT III: **10 lectures hours**

Testing and Validation, Different Types of Testing, Properties of Testing, Customizable, Extendable, Link Validity, Component Checking, Semantic, and Syntax Parsing.

UNIT IV: **10 lectures hours**

Frameworks, Tools, and the Programming Process, DevOps Frame Definition, Agile Framework, Scaled Agile Framework, Adoption Framework, Industry Practices.

Text Books :

1. *Fowler Martin, Refactoring: Improving the Design of Existing Code (2nd ed.), Addison- Wesley, 2019. ISBN 978-0134757599.*

2. *Martin Series Robert C., Software Craftsman, The: Professionalism, Pragmatism, Pride 1st Edition (1st ed.), Addison Wesley, 2020. ISBN 978-0134052502.*

Name of Program	Master of Computer Applications				
MCAP313	Programming using C++	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the fundamental programming concepts and methodologies to building C++ programs.
CO2: To implement various OOPs concepts including memory allocation/deallocation procedures and Member functions.

Course Contents:

UNIT I **12 lecture hours**

Principles of Object-Oriented Programming, data types, Symbolic constants, Reference by variables, Operators, Operator precedence, Control structures, If-else, Nested If, Switch, break, continue, Functions, main function, Function prototyping, Call by reference, Return by reference, Inline function, Default arguments, Function overloading, Defining a class and member functions, Private member functions, Nesting of member functions.

UNIT II **16 lecture hours**

Arrays within a class, Arrays of objects, Memory allocation, Static data members, Static member functions, Friendly functions, Objects as function arguments, Returning Objects, Constructors, Default constructor, Parameterized constructor, Copy constructor, Multiple constructors, Constructors with default arguments, Dynamic constructor, Destructors, Rules for overloading, Operator overloading, Unary and binary operator overloading, Overloading using friends, Type conversion, Inheritance, Defining derived classes, Visibility modes, Single inheritance, Multilevel inheritance, Multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Runtime Polymorphism.

UNIT III **14 lecture hours**

Virtual base classes, Abstract classes, File Handling, lbrowing Mechanism, Caching Mechanism, Rethrowing an Exception, Constructors in derived classes, Nesting of classes, Exception Handling, Opening and closing a file, Detecting End-of-file, Sequential input and output operations, Generic Programming using template, Class template, Function template, Class member function template, Function overloading, Standard Template Library: Containers, Stack, List, Queue, Algorithms, Iterators.

Text Books:

1. Bjarne Stroustrup, The C++Programming Language.(4th ed.), Addison-Wesley Professional, 2013. ISBN 978- 0321563842.
2. E. Balagurusamy, Object Oriented Programming with C++ (1st ed.), Tata McGraw Education Hill, 2013. ISBN 978-1259029936.

Reference Books:

1. D Ravichandran, Programming with C++ (3rd ed.), McGraw Hill Education, 2017. ISBN 978-

Name of Program	Master of Computer Applications				
MCAP314	Device Level IoT Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the security issues in IoT.
CO2: To apply the cryptographic techniques in IoT.
CO3: To implement various types of access control mechanism for IoT devices in network environment.

CO – PO /PSO Mapping

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

1=weakly related 2= moderately related 3=strongly related

Course Contents:

UNIT I **6 lecture hours**

Brief review of the Internet of Things IoT, IoT in business world, Benefits Applications of IoT, Security Issues with IoT, Basic Architecture of IoT, IoT Attack Surface, OWASP Top 10 for IoT. Concept of Vulnerability management, Quarantine and Prevention.

UNIT II **8 lecture hours**

Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things- Security Requirements in IoT - Insufficient Authentication/ Authorization - Insecure Access Control
- Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities - Secrecy and Secret-Key Capacity• Authentication/ Authorization for Smart Devices - Transport Encryption - Attack Fault trees.

UNIT III **14 lecture hours**

Cryptographic primitives and its role in IoT, Encryption and Decryption, Hashes, Digital Signatures, Random number generation, Cipher suites, key management fundamentals cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication, Identity lifecycle, authentication credentials, IoT IAM infrastructure, Authorization with Publish I Subscribe schemes, access control. Concerns in data dissemination, Lightweight and robust schemes for Privacy protection, Trust and Trust models for IoT, self-organizing Things, Preventing unauthorized access, Cloud security for IoT, Cloud services and IoT, offerings related to IoT from cloud service providers, Cloud IoT security controls.

Studio Work/Laboratory Experiments:

Consists of using network monitoring tools, implementing different types of attacks and some protection schemes of various IoT devices.

Text Books:

1. *Vijayalakshmi Saravanan, Securing IoT and Big Data: Next Generation Intelligence (Internet of Everything (IoE) (1sted.), CRC Press, 2020. ISBN 0367432889.*

Reference Books:

Name of Program	Master of Computer Applications				
MCAP315	Deep Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the fundamentals of deep learning, Convolution neural network.
CO2: To articulate different problem of classification, detection, segmentation, generation and understand existing solutions/ deep learning architectures.
CO3: To implement a solution for the given problem and improve it using various methods transfer learning, hyperparameter optimization.

Course Contents:

UNIT I **14 lecture hours**

Why Deep Learning?, Machine Learning: features, weights, Artificial Neural Network, loss function, cost function, ANN: forward propagation; Back:propagation, Stochastic Gradient Descent, Batch gradient descent, mini batch gradient descent, Optimizers: Momentum, RMSProp, Adam, Deep Learning Experiments: Datasets, training-validation testing set, evaluation measures: accuracy, precision, recall, f• measure, Model Improvement: Overfitting vs underfitting, Bias vs Variance, Regularization: LI, L2 regularization, Dropout, Early stopping, Data normalization, Batch normalization, Hyper parameter Tuning: random, coarse to fine, Network architecture search.

UNIT II **14 lecture hours**

Data Augmentation in image: Cropping, Flipping, Rotation, Brightness, Contrast, Color Augmentation, Saturation, Convolutional Neural Networks: convolution, striding, padding, pooling, Alexnet Architecture, Image classification (ImageNet Challenge), Well known CNN architectures VGG16&19, Residual Block, Resnet50, lxl convolution, XceptionNet, EfficientNet, Transfer learning, Object Detection: setup problem and cost function, well known datasets, Evaluation measure: Average precision, Mean average precession, Two stage detector, single stage detector, RCNN, Fast RCNN, Faster RCNN, SSD, YOLOl-4, RetinaNet, EfficientDet, Image Segmentation: setup problem and cost function, various dataset, Semantic segmentation, Instance segmentation, Evaluation measure: IoU/Jacard Index, Dice score, Mean pixel accuracy, Segnet, Unet, Mask R-CNN.

UNIT III **14 lecture hours**

Generative Learning, Variational Auto-encoders, Generative Adversarial Neural Networks, GL Applications: Image generation, font generation, video generation, anime face/celebrity face generation, Deep Reinforcement Learning, Markov decision Processing, Deep Q Learning, Exploration vs Exploitation, Value Iteration vs Policy Iteration, RL Applications: Robotics, gaming, Ad Targeting, recommendation system, decision making, Model optimization for Deployment, Pruning, Quantization and binarization, Transferred or Compact Convolutional Filters, Knowledge distillation.

Text Books:

1. Ian Good fellow, Yoshua Bengio, Aaron Courville and Yoshua Bengio, Deep learning. Vol. 1. C (1st ed.), ambridge: MIT press, 2016. ISBN 978-0262035613.

Reference Books:

1. Aston Zhang, Zack C. Lipton, Mu Li and Alex J. Smola, Dive into Deep Learning (1st ed.), Corwin, 2019. ISBN 9 1544361376.

Open Electives

Name of Program	Master of Computer Applications				
MCAO401	Applications of AI	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the broader picture of cyber security at the world stage.
CO2: To articulate the arguments for Cybersecurity related policy frameworks.
CO3: To examine the cybersecurity related challenges facing the world

Course Contents

UNIT I **10 lecture hours**

Definition of Cybersecurity; Key Concepts in Cybersecurity; Threats to Cybersecurity; Compromises to IP, Deviations in QoS, & Espionage or Trespass; Forces of Nature, Human Error or Failure & Information Extortion; Sabotage or Vandalism, Software Attacks & Technical Hardware Failures; Technical Software Failure, Technological Obsolescence, and Theft. Security Technologies; Access Control; Firewalls; Intrusion Detection and Prevention Systems; Virtual Private Networks, Vulnerabilities in Information Assets, Understanding Vulnerabilities and Vulnerability Assessment, Vulnerability Assessment: Tools and Techniques, Vulnerability Remediation Strategies, Configuration and Change Management in Vulnerability Assessment.

UNIT II **10 lecture hours**

Governance, Risk Management, and Compliance (GRC) approach to Managing Cybersecurity; Management of Cybersecurity; Cybersecurity Personnel: Roles and Responsibilities; Cybersecurity & Personnel Issues; Cybersecurity Governance and Planning; Cybersecurity Strategic Planning; Cybersecurity Planning for Contingencies; Cybersecurity Risk Management; Risk Management: Models and Methodologies; Preparation for Risk Management; Risk Assessment; Risk Treatment; Cybersecurity Policy; Enterprise Cybersecurity Policy; Issue Specific Cybersecurity Policies; System Specific Security Policies; Developing and Implementing Effective Cybersecurity Policy; Enterprise Cybersecurity Policy; Performance Measures in Cybersecurity; Specifying Cybersecurity Measurements; Law and Regulation in Cybersecurity; Key Security Laws; Privacy Laws.

UNIT III **10 lecture hours**

The Role of Intelligence and Information Sharing; Design and Operation of the Internet; Internet Naming and Routing Protocols; Cyber Exploits; Major Cyber Attacks; Secure Communications and Authorization; Cyber Conflict; Cyber Economics; Contingency Planning; Contingency Planning Methodology; Business Impact Analysis; CP Strategies - Data Backup and Recovery; Incident Response; Incident Response Planning; Incident Response: Detection, Containment and
Recovery, Disaster Recovery; Disaster Recovery Planning; Disaster Classifications; Planning for Disasters; Disaster Preparation.

UNIT IV 12 lecture hours

History and Role of United nations in setting the norms and guidelines for cybersecurity challenges across the borders; Application in International laws to Cyberspace; Case studies of few countries exploiting the internet space to their advantage; Cybersecurity issues with the increase in Global data centres; Cloud Computing and exponential increase in data storage systems; Cyber control systems; Cyber command systems; Cyber warfare; Cyber Soldiers.
and battalions; Cyber resilience; Use of Cyberspace as part of defence strategy; State surveillance; Cyber freedom; trade-off between privacy and security; Case studies to new dimensions of cybersecurity for public, Govts and Economies.

Text Books:

1. Why Hackers Win, Power and Disruption in the Network Society, By Patrick Burkart, Tom McCourt (1st ed.), University of California Press, 2019, ISBN 9780520300132

Name of Program	Master of Computer Applications				
MCAO402	Web Technologies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Know various AI Agents and AI search algorithms (uninformed, informed, heuristic, constraint satisfaction, genetic algorithms).
CO2: Demonstrate working knowledge of reasoning in the presence of incomplete and/or uncertain information.
CO3: Apply knowledge representation, reasoning, and machine learning techniques to real- world problems.

Course Contents

UNIT I **12 lecture hours**

Introduction: Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Introduction to Search: Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning, Applications of Artificial Intelligence. Markov decision processes, Intro to neural nets.

UNIT II **12 lecture hours**

Reasoning with uncertainty, Probabilistic reasoning over time Learning Gaming: Movement, Decision Making, Strategy, Infrastructure, Agent-Based AI.

UNIT III **6 lecture hours**

Hacks and Heuristics. Vision Systems: fundamentals of image formation, camera imaging geometry, feature detection and matching, Multiview geometry.

UNIT IV **9 lecture hours**

Motion estimation and tracking, and classification, Action recognition Color spaces and Segmentation.

Text Books:

1. Stuard Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3 ed.), Prentice Hall, 2010. ISBN 978-0136042594.

Reference Books:

1. Forsynth and Ponce, Computer Vision: A Modern Approach (2 ed.), Prentice Hall, 2011. ISBN 978-9332550117.
2. IAN Millington and John Funge, Artificial Intelligence for games (2 ed.), CRC Press, 2009. ISBN 978-0123747310.

Assessment Scheme:

Components	Internal Assessment	Mid Term Exam	End Exam	Total
Weightage (%)	45%	20%	35%	100%

Name of Program	Master of Computer Applications				
MCAO403	IT Support Technologies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Demonstrate the understanding of the approach to modelling information and knowledge.
CO2: Produce the data that encodes semantics using well-known technologies such as RDF and OWL.

Course Contents

UNIT I **12 lecture hours**

Information Architecture and Interoperability, Semantics and Knowledge Modeling, RDF Modeling Language, RDFS Extended Modeling Language.

UNIT II **12 lecture hours**

Logic and Rule, OWL Modeling Language, OWL and Reasoning, Projects Discussion.

UNIT III **18 lecture hours**

Projects Discussion, Ontology Mapping, SPARQL Overview. SPARQL Extended Features, Projects Presentation, Projects Presentation.

Text Books:

1. Pascal Hitzler, Markus Krotzsch and Sebastian Rudolph, Foundations of Semantic Web Technologies(1st ed.), CRC Press, 2009. ISBN 978-1420090505.

Name of Program	Master of Computer Applications				
MCAO404	Software Engineering	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Understand the need for IT Support Technologies in the current era.
CO2: Gain an in-depth knowledge of firewall security and other network security components.

Course Contents

UNIT I **12 lecture hours**

Introduction to the different types of IT Support Technologies. Infrastructure, Hardware Support, Security. Need for IT Support, traditional IT Support demands vs modern IT Support demands. Evolving support technologies.

UNIT II **14 lecture hours**

Introduction to LANs, WANs, MANs, Internet. Types of cables, switches, routers, repeaters. LAN topologies: Bus topology, Ring topology, Token passing rings. Cloud service and Deployment models, Server virtualization.

UNIT III **16 lecture hours**

Security concerns in modern IT, Challenges of cloud computing in terms of application security, server security, and network security. Security in computer networks: principles of cryptography, symmetric key, public key, digital signatures, firewalls, Security in different layers: secure E-mail, SSL, IP security. Firewall planning and design, developing a security policy, firewall configuration strategies. Recent trends and challenges in the field of IT Support Technologies.

Text Books:

1. Deal Richard, Cisco ASA configuration (1st ed.), Tata McGraw-Hill Education, 2009. ISBN 978-0070677241.
2. William Stallings, Data and Computer Communications (9th ed.), Pearson Education, 2010. ISBN 978-0131392052.

Reference Books:

1. Raj Kumar Buyya, James Broberg and Andrezei M. Goscinski, Cloud Computing: Principles and paradigms (1st ed.), MIT Press, 2011. ISBN 978-0470887998.
2. B. A. Forouzan, Data communication and Networking (5th ed.), McGraw Hill, 2007. ISBN 978-1259064753.
3. S. Tanenbaum, Computer Networks (5th ed.), Prentice Hall, 2010. ISBN 978-0133485936.

Name of Program	Master of Computer Applications				
MCAO405	Programming Languages	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Demonstrate understanding of Software Engineering as an iterative and systematic process. CO2: Apply development life cycle through version control system, IDE, UML, etc.
CO3: To develop programs and debug.

Course Contents

UNIT I **12 lecture hours**

Importance of Software Engineering, Discipline of Software Engineering Lifecycle, Engineering standards in building, testing, operation and maintenance of the computer and software systems. Software Process Model Introduction, Waterfall Process, Spiral Process, Evolutionary Prototyping Process, Agile Process, Choosing a Model, Lifecycle Documents, Version Control System: Introduction to Git, Git Demo: Git + Eclipse, Git.

UNIT II **12 lecture hours**

Requirements Engineering: General RE Definition, Functional and Non-functional Requirements, User and System Requirements, Modelling Requirements, Analysing Requirements,Requirements Prioritization, Requirements Engineering Process and steps, Creating SRS, Requirements Inspections. OO Software and UML: Object Orientation Introduction, UML Structural Diagrams: Class Diagrams, Component Diagram, UML Structural Diagram:Deployment Diagram., UML Behavioural Diagram: Use Case, Use Case Diagram: Creation Tips,UML Behavioural Diagrams: Sequence, UML Behavioural Diagrams: State Transition Diagram.

UNIT III **9 lecture hours**

Agile Development Methods: Cost of Change, Agile Software Development, Extreme Programming (XP), XP's Values and Principles, Test First Development, Refactoring, Pair Programming, Continuous Integration, Testing Strategy, High-Level Scrum Process. Unified Software Process: Use-Case Driven, Inception Phase, Elaboration Phase, Construction Phase, Transition Phase, Phases and Iterations. Software Evolution: Evolution processes, Legacy Systems, Software Maintenance. Situations during software evolution and maintenance. Software Reengineering and Refactoring: Reasons to Reengineer and Refactor, Advantages, Refactoring Demo, Refactoring Risks, Cost of Refactoring, When Not to Refactor.

UNIT IV **9 lecture hours**

Software Architecture: What is Software Architecture? Advantages and use of architectural models. Architectural patterns. Different architectural patterns (Layered, MVC, Repository, Pipe and Filter). Design Patterns: Patterns Catalogue, Pattern Format, Factory Method Pattern, Strategy Pattern, Choosing a Pattern, Negative Design Patterns. Software Testing: Black Box Testing Failure, Fault and Error, Verification Approaches, Pros and Cons of Approaches, Testing Introduction, Alpha and Beta Testing, Black-Box Testing, Systematic Functional Testing Approach, Test Data Selection, Equivalence Partitioning and Boundary Value Analysis, Create and Evaluate Test Case Specifications, Generate Test Cases from Test Case Specifications, White- Box Testing: Coverage Criteria Intro, Statement Coverage, Control Flow Graphs, Test Criteria.

Text Books:

1. R. Pressman, Software Engineering, A Practitioner's Approach (7th ed.), McGraw Hill International, 2014. ISBN 978-9339212087.
2. Sommerville, Software Engineering (10th ed.), Person Publications Publishing Company, 2015. ISBN 978-0133943030.

Name of Program	Master of Computer Applications				
MCAO406	Artificial Intelligence for Creative Expression	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the requirement for the interdisciplinary application of programming languages. CO2: To build the logic for the given problem.
CO3: To develop programs and debug.

Course Contents

UNIT I **10 lecture hours**

Programming, programming language. Types of programming languages, high level vs low level, compilers, interpreters, assemblers, binary code. Datatypes, variables, keywords, identifiers, Importance of comments in programming. Implementation of scope rules. Static scoping and dynamic scoping.

UNIT II **11 lecture hours**

Programming constructs: conditional statements if statements, else statement, if-else statement. For loop, while loop, nesting loop. Do-while loop, infinite loops, break, continue statements. Arrays, one dimensional array, multidimensional array.

UNIT III **10 lecture hours**

Functions, in-built functions vs user-defined functions, importing libraries for using in-built functions. Pointers and its types, arrays of pointers, pointers, and functions. Passing parameters to functions, returning values from functions, recursion. Dynamic arrays, string, string variables, string handling functions.

UNIT IV **11 lecture hours**

Object-oriented paradigm. Fundamental concepts, objects, classes, encapsulation, and inheritance. Errors and warnings, rectifying errors and debugging. File handling, opening and closing file, input / output operations on file.

Text Books:

1. Arvind Kumar Bansal, Introduction to Programming Languages (1st ed.), Chapman and Hall/CRC, 2017. ISBN 9781138460818.
2. Aditya Kanetkar and Yashavant Kanetkar, Let Us Python (1st ed.), BPB, 2019. ISBN 9789389845009.

Reference Books:

1. Steve Klabnik and Carol Nichols, The Rust Programming Language (1st ed.), No Starch Press, 2019. ISBN 9781718500459.

Name of Program	Master of Computer Applications				
MCAO407	AI and Public Policy	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the creative expression possibilities of artificial intelligence.
CO2: To create artistic experiments and prototypes, in a variety of output forms like visual, textual, musical.
CO3: To examine the implication of AI in the field of creative expressions, which was human territory till now.

Course Contents:

UNIT I **14 lecture hours**

What is machine learning? Playing around with Wekinator and Tensorflow.js to start making some interactive work and get familiar with concepts of training the machine with some data, running a trained model and seeing interactive output. What are neural networks? Looking inside neural networks and how neural networks are trained, understanding what terms like weights of a network, activation function etc. mean. Convolutional neural networks and how that leads to Deep dream. Experiments with deep dream to visualize layers.

UNIT II **14 lecture hours**

Discussions around how AI is like a photography moment for art to give some art historical context to AI. Style transfer- real-time style transfer from pre-trained models. Run style transfer experiments through webcam input. Discussions around how artists are using style transfer.

UNIT III **7 lecture hours**

Recurrent neural networks- Text Modeling, Sketch (vector drawing) Modeling, Music Modeling. Introduction to sequential datasets in the context of art, like quickdraw, text corpuses and musical datasets and what can be done with such sequential data. Ethical considerations around widespread use of AI. Conceptual art pieces that comment on this issue.

UNIT IV **7 lecture hours**

Dimensionality reduction algorithms like TSNE, and how they can be used to form interactive ways of exploring data. Example art pieces using this. Generative models- Generative Adversarial Networks (GANs). Understanding the basic formulation of a GAN. Pipeline of how to train a GAN for art. GAN latent space arithmetic.

Text Books:

1. Marcus Du Sautoy, The Creativity Code, Art and Innovation in the Age of AI (1st ed.), Harvard University Press, 2020. ISBN 9780674244719.

Reference Books:

1. Kevin Ashley, Make Art with Artificial Intelligence, Make and Sell Your Art with AI, Blockchain and NFT (1st ed.), Independently published, 2021. ISBN 9798577189310.

Name of Program	Master of Computer Applications				
MCAO408	Data Structures and Algorithms	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate an overall understanding of PHP programming through various server.
CO2: To build modular web applications with different frameworks.
CO3: To design and develop webpages and web sites for the needs of an organization.

Course Contents:

UNIT I **10 lecture hours**

LAMP technology, Linux Operating System, Knowledge of various editors, PHP introduction, Operators in PHP, Logical and conditional operators use cases, Function Definition and Function Call, Function with arguments, Function with return value, call by value and call by references.

UNIT II **11 lecture hours**

Understanding variable scope, Global Variables and Static Variables, Include and Require, Built-in functions in PHP, Introduction to Array, Array in PHP, Creating an Array, Accessing Elements of an Array, Modifying Elements of an Array, Array and string related operations.

UNIT III **11 lecture hours**

OOPs Concepts, Defining Class in PHP, Object in PHP, Constructor, Constructor with Parameters, Introduction to Exception, Exception Handling mechanisms, Creating Custom Exceptions, Multiple Catch Blocks, Exception Propagation, Error Handling in PHP, Web designing principles.

UNIT IV **10 lecture hours**

HTML, CSS, Java script, Supporting tools and CMS, Introduction to MySQL, Learning the MySQL Data Types, Frequently used String functions in MySQL, Regular expressions and their uses in PHP, Cookies, Session variable, its session ID management, File handling in PHP.

Text Books:

1. Jeremy McPeak, Beginning JavaScript (5th ed.), Wrox Publication, 2015. ISBN 978-1118903339.

Reference Books:

1. Luke Welling and Laura Thomson, PHP and MySQL Web Development (5th ed.), Pearson, 2017. ISBN 978-0672329166.

Assessment Scheme:

Components	Internal Assessment	Mid Term Exam	End Exam	Total
Weightage (%)	45 %	20 %	35 %	100%

Name of Program	Master of Computer Applications				
MCAO409	Software Testing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain basic data structures for storage and retrieval of ordered or unordered data. Data structures include arrays, linked lists, binary, trees, heaps, and hash tables.
CO2: To implement algorithms for the creation, insertion, deletion, searching, and sorting of each data structure.
CO3: To examine and compare algorithms for efficiency using Big-O notation.

Course Contents

UNIT I **14 lecture hours**

Asymptotic notation, Recursion, Masters theorem, Array storage, Memory allocation in 2D array, Static vs dynamic memory allocation, Binary search, Array search, traverse, insertion, and deletions, Linked list, Linked list modifications (circular, doubly), Traverse, insertion, and deletions in linked list.

UNIT II **12 lecture hours**

Stack representation, Application of stacks, Traverse, insertion, deletions in stack, Queue representation, Application of queue, Modifications in queue (circular, priority), Traverse, insertion, deletions in queue, Tree representation, Binary tree, Heap representation, Extract min, search, insertion operations in heap.

UNIT III **16 lecture hours**

Graph representation, BFS, DFS algorithms, Divide and conquer algorithm, Sorting techniques, Greedy algorithm, Coin exchange problem, Frog jump problem (proof of correctness), Dynamic algorithm, MCM, 0-1 and fractional knapsack.

Text Books:

1. Narasimha Karumanchi, Data Structures and Algorithmic Thinking with Go (1st ed.), CareerMonk Publications, 2020. ISBN 9781949870909.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms (4th ed.), The MIT Press, 2022. ISBN 9780262367505.

Reference Books:

1. Florian Dedov, A Complex Subject Simply Explained (Runtime Complexity, Big O Notation, Programming) (1st ed.), Amazon Digital Services LLC - KDP Print US, 2020. ISBN 9798678017192.
2. Jay Wengrow, A Common-Sense Guide to Data Structures and Algorithms (2nd ed.), O'Reilly, 2020. ISBN 9781680508059.

Name of Program	Master of Computer Applications				
MCAO410	Computing Start-ups	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To articulate the various software testing methods.
CO2: To make use of the various test cases for different types and level of testing.
CO3: Proposed an idea for start-up and applicability of technology (Idea to Start-up).

Course Contents:

UNIT I **10 lecture hours**

Software testing, testing objectives. Principles of Software Testing, Testing and debugging, Test metrics and measurements.

UNIT II **11 lecture hours**

Verification, Validation and Testing, Software Quality and Reliability, Software defect, Manual and Automation Testing, Software Testing Life Cycle, Phases of STLC, Test Case Preparation.

UNIT III **10 lecture hours**

Testing Techniques: White Box Testing, Black Box Testing, Unit Testing, Integration Testing, User Acceptance Testing, Alpha and Beta Testing, Smoke Testing, Sanity Testing, Regression Testing.

UNIT IV **11 lecture hours**

Formal Testing, Informal Testing, Monkey Testing, Re-Testing, Load/Stress Testing, Ad hoc Testing: Pair testing, Exploratory testing, Iterative testing, Defect seeding.

Text Books:

1. S. Limye, Software Testing - Principles, Techniques and Tools (1st ed.), McGraw Hill Education, 2017. ISBN 9780070139909.

Reference Books:

1. R. S. Pressman, Software Engineering: A Practitioners Approach (7th ed.), McGraw Hill, 2019. ISBN 978-0073375977.

Name of Program	Master of Computer Applications				
MCAO411	Career Skills for IT Companies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: Understanding of computing start-ups.
CO2: How technology can change or upswing the scenario.
CO3: Proposed an idea for start-up and applicability of technology (Idea to Start-up).

Course Contents:

UNIT I **20 lecture hours**

What Does It Mean to Be a Startup Entrepreneur? Engaging Others with Actionable Next Steps, Benefits vs. Features, Simple Strategies to Get Unstuck, The Financial Model, The Legal Setup of Your Startup, Meetings and Communication Skills.

UNIT II **22 lecture hours**

Startup Grants: Can Government Programs Stimulate Entrepreneurship? Venture Capital and Angel Investors Incubators and Accelerators Incubators and Accelerators, Moving Past the Startup Stage, How Universities Can Support Their Startups Today.

Text Books:

1. S. Limye, Software Testing - Principles, Techniques and Tools (1st ed.), McGraw Hill Education, 2017. ISBN 9780070139909.

Reference Books:

1. R. S. Pressman, Software Engineering: A Practitioners Approach (7th ed.), McGraw Hill, 2019. ISBN 978-0073375977.

Name of Program	Master of Computer Applications				
MCAO412	Cyber security: Impact on Govts, Policies and Economics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To impart aptitude, reasoning, technical and soft skills that would aid in the employability of the students.
CO2: To develop both personal and professional skills effectiveness.
CO3: To help students to gain a confidence for the upcoming placements.

Course Contents:

UNIT I **14 lecture hours**

Introduction to Problem Solving; Prime Numbers; GCD; LCH; HCF; Theorems of Divisibility; Divisibility Rules; Remainder Theorem; Counting; Arithmetic Progression; Geometric Progression; Harmonic; Progression; Averages; Allegations; Ratio; Proportion; Variation; Interest; Time and Work; Negative Work; Product Constancy; Equivalence Method; Efficiency; Pipes and Cisterns; Boats; Relative Motion; Opposite Motion; Straight Lines; Polygons; Triangles; Quadrilaterals; Circles; Tangent; Eclipse; Star; Functions; Tabular, Graphical, Even Odd, Inverse; Inequalities; Logarithmic; Graphical View of Logarithmic; Properties of Inequalities: Notion of Ranges, Linear Inequality, Quadratic Inequality; Permutation; Circular Permutation; Combination; Probability; Real Life Estimation of Probability: Conjunction AND, Conjunction OR; Concept for Odds for and Odd Against; Set Theory; Operations; Algebra; Coordinate Theory; Cartesian Coordinate System; Rectangular Coordinate Axes.

UNIT II **14 lecture hours**

Data Interpretation: Representation of Data, Nature of Data, Capturing of Data, Organization of Data, Tables, Bar Charts, X-Y Charts, Pie Charts, Cases; Logical Reasoning; Reasoning Analogies; Artificial Language; Calendar; Cause and Effect; Clocks; Critical Path; Directions; Data Interpretation; Deduction Reasoning; Statement Analysis; Data Sufficiency; Puzzles; Pattern Series; Embedded Images; Figure Matrix; Picture Series; Pattern Series; Shape Construction; Statement and Assumptions; Statement and Conclusions; Syllogism; Verbal Reasoning.

UNIT III **14 lecture hours**

Communication Skills; Listening Skills; Team Building; Assertiveness; Group Discussions; Personal Interview; HR Communications; Specific Applications; Essay; Memo; CV; Business Letter; Press Release; Policy and Project Proposal; Report; Minutes; Email; Social Media for Professional Purposes; Editing Documents; Crisis Communication; Getting your Ideas Across.

Studio Work / Laboratory Experiments:

Problems based on search engines and common open-source software to perform common methods of exploratory and predictive analysis. Application of text analysis techniques for data analysis. Performing sentiment analysis.

Text Books:

1. Arun Sharma, How to Prepare for LOGICAL REASONING (6 ed.), McGraw Hill Education, 2021. ISBN 9354600557.
2. Arun Sharma, Quantitative Aptitude (8 ed.), McGraw Hill Education, 2018. ISBN 9789353160180.
3. Hans Gutbord, Handbook for Professional Communication (1 ed.), Verlag GD Publishing Limited and Co KG, 2020. ISBN 9783744870788.

Reference Books:

Name of Program	Master of Computer Applications				
MCAO413	AI and Society	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:
CO1: To explain the broader picture of cybersecurity at the world stage.
CO2: To articulate the arguments for Cybersecurity related policy frameworks.
CO3: To examine the cybersecurity related challenges facing the world.

Course Contents:

UNIT I **10 lecture hours**

Definition of Cybersecurity; Key Concepts in Cybersecurity; Threats to Cybersecurity; Compromises to IP, Deviations in QoS, & Espionage or Trespass; Forces of Nature, Human Error or Failure & Information Extortion; Sabotage or Vandalism, Software Attacks & Technical Hardware Failures; Technical Software Failure, Technological Obsolescence, and Theft. Security Technologies; Access Control; Firewalls; Intrusion Detection and Prevention Systems; Virtual Private Networks, Vulnerabilities in Information Assets, Understanding Vulnerabilities and Vulnerability Assessment, Vulnerability Assessment: Tools and Techniques, Vulnerability Remediation Strategies, Configuration and Change Management in Vulnerability Assessment.

UNIT II **10 lecture hours**

Governance, Risk Management, and Compliance (GRC) approach to Managing Cybersecurity; Management of Cybersecurity; Cybersecurity Personnel: Roles and Responsibilities; Cybersecurity & Personnel Issues; Cybersecurity Governance and Planning; Cybersecurity Strategic Planning; Cybersecurity Planning for Contingencies; Cybersecurity Risk Management; Risk Management: Models and Methodologies; Preparation for Risk Management; Risk Assessment; Risk Treatment; Cybersecurity Policy; Enterprise Cybersecurity Policy; Issue Specific Cybersecurity Policies; System Specific Security Policies; Developing and Implementing Effective Cybersecurity Policy; Enterprise Cybersecurity Policy; Performance Measures in Cybersecurity; Specifying Cybersecurity Measurements; Law and Regulation in Cybersecurity; Key Security Laws; Privacy Laws.

UNIT III **10 lecture hours**

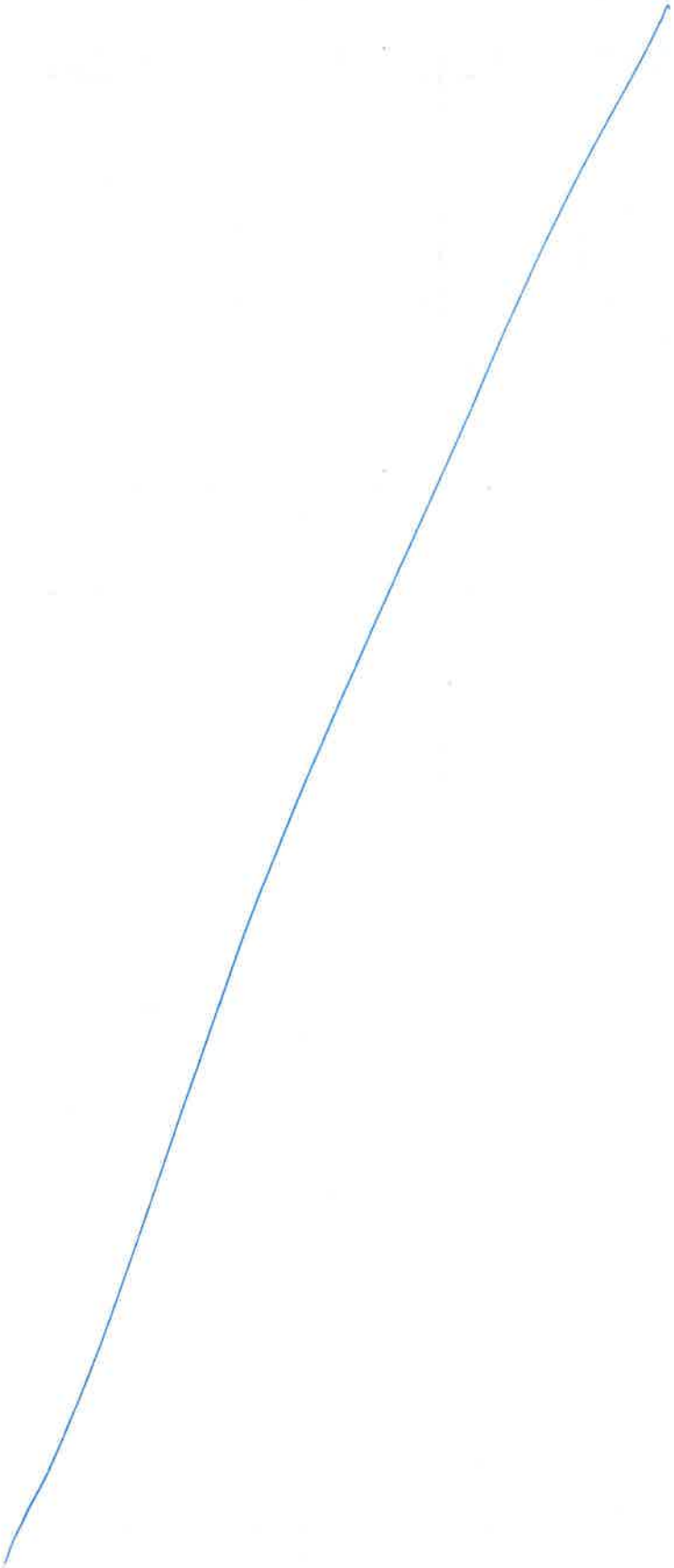
The Role of Intelligence and Information Sharing; Design and Operation of the Internet; Internet Naming and Routing Protocols; Cyber Exploits; Major Cyber Attacks; Secure Communications and Authorization; Cyber Conflict; Cyber Economics; Contingency Planning; Contingency Planning Methodology; Business Impact Analysis; CP Strategies - Data Backup and Recovery; Incident Response; Incident Response Planning; Incident Response: Detection, Containment and Recovery, Disaster Recovery; Disaster Recovery Planning; Disaster Classifications; Planning for Disasters; Disaster Preparation.

UNIT IV **12 lecture hours**

History and Role of United nations in setting the norms and guidelines for cybersecurity challenges across the borders; Application in International laws to Cyberspace; Case studies of few countries exploiting the internet space to their advantage; Cybersecurity issues with the increase in Global data centres; Cloud Computing and exponential increase in data storage systems; Cyber control systems; Cyber command systems; Cyber warfare; Cyber Soldiers.
and battalions; Cyber resilience; Use of Cyberspace as part of defence strategy; State surveillance; Cyber freedom; trade-off between privacy and security; Case studies to new dimensions of cybersecurity for public, Govts and Economies.

Text Books:

1. Why Hackers Win, Power and Disruption in the Network Society, By Patrick Burkart, Tom McCourt (1st ed.), University of California Press, 2019. ISBN 9780520300132.



Name of Program	Bachelor of Applications				
MCAO14	Search EngineOptimization	L	T	P	C
Owning School/Department	Department of Computer Science Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand main search engine optimization techniques for business websites.
CO2: Analyze keyword research, writing optimized content, getting web pages indexed by search engines and tracking the outcomes.
CO3: Implement gain access to new online tools and resources to help implement successful SEO campaigns.

Course Contents:

UNIT I **11 lecture hours**

Search engine, Search engine optimization (SEO), need of SEO, Googlebot (Google Crawler), Types Of SEO technique, Google's SEO Algorithm updates, planning and strategies for SEO, SEO tools, Technical SEO, Technical SEO Ranking factors, Type of meta tags, effect on SEO, Website architecture Optimization, Breadcrumbs, Permalinks optimization, Canonicalization, Setup of CDN, SSL, Improve Website Performance, Speed using Plugin, perform the Page Speed Test, XML and HTML sitemap creation and optimization, Add and verify a website in Google Console, Google Analytics setup and monitoring.

UNIT II **12 lecture hours**

Keyword, importance of Keyword Research, types of keywords, Analysis of keywords using Tools, easy to rank keywords, Analysis of Keyword, find Ranking Keyword of competitor, selecting right keywords, Top ranking Keywords of your sites, Find hidden ranking keywords of your website, LSI Keywords: Easy Strategies To find LSI Keywords, Content Research, Content Structure, Content Planning with Keywords, Internal links, Outbound link, Schema Markup.

UNIT III **8 lecture hours**

YouTube SEO Ranking Factors, Video Optimization, Title Optimization, Description Optimization, Thumbnail Optimization, Increase YouTube Subscribers Organically, SEO Strategy from Google Search Console & Google Analytics, maintain the position of existing ranking keywords, keep Eyes On Competitor Ranking Keywords.

Text Books :

1. Das, S., Search Engine Optimization and Marketing: A Recipe for Success inDigital Marketing (1st ed.), CRC Press, 2021. ISBN 978-0367278786.

Reference Books :

1. Clarke, A., SEO 2022: Learn Search EngineOptimization with Smart Internet Marketing on line **416** LLC 2022. ISBN 9780578333380,0578333384

Name of Program	Bachelor of Applications				
MCAO15	Growth Hacking	L	T	P	C
Owning School/Department	Department of Computer Science Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Integrate the data-driven and adaptive culture of Growth Hacking to improve digital marketing results.
CO2: Tell better stories and write marketing content to improve conversion rates.
CO3: Understand the economics of customer interactions and may build business tools that automate repetitive tasks in order to gain access to new data.

UNIT I **11 lecture hours**

Search engine, Search engine optimization (SEO), need of SEO, Googlebot (Google Crawler), Types Of SEO technique, Google's SEO Algorithm updates, planning and strategies for SEO, SEO tools, Technical SEO, Technical SEO Ranking factors, Type of meta tags, effect on SEO, Website architecture Optimization, Breadcrumbs, Permalinks optimization, Canonicalization, Setup of CDN, SSL, Improve Website Performance, Speed using Plugin, perform the Page Speed Test, XML and HTML sitemap creation and optimization, Add and verify a website in Google Console, Google Analytics setup and monitoring.

UNIT II **12 lecture hours**

Keyword, importance of Keyword Research, types of keywords, Analysis of keywords using Tools, easy to rank keywords, Analysis of Keyword, find Ranking Keyword of competitor, selecting right keywords, Top ranking Keywords of your sites, Find hidden ranking keywords of your website, LSI Keywords: Easy Strategies To find LSI Keywords, Content Research, Content Structure, Content Planning with Keywords, Internal links, Outbound link, Schema Markup.

UNIT III **11 lecture hours**

Negative SEO, avoid duplicate content on your website, Black hat SEO, Mistake by website owners, Bad practice on the website, Common Negative SEO practices, Defense against negative SEO, local SEO, Local SEO factors, Google My Business (GMB), optimize GMB Listing, Element's optimization on GMB listing, Citations, citations in Local SEO.

UNIT IV **8 lecture hours**

YouTube SEO Ranking Factors, Video Optimization, Title Optimization, Description Optimization, Thumbnail Optimization, Increase YouTube Subscribers Organically, SEO Strategy from Google Search Console & Google Analytics, maintain the position of existing ranking keywords, keep Eyes On Competitor Ranking Keywords.

Text Books :

1. Das, S., Search Engine Optimization and Marketing: A Recipe for Success inDigital Marketing (1st ed.), CRC Press, 2021. ISBN 978-0367278786

Reference Books :

1. Clarke, A., SEO 2022: Learn Search EngineOptimization with Smart Internet Marketing Strategies (1st ed.), Simple Effectiveness LLC, 2022. ISBN 9780578333380,0578333384

Name of Program	Bachelor of Applications				
MCAO416	Digital Marketing	L	T	P	C
Owning School/Department	Department of Computer Science Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand, visualize, and analyse online applications based on recent digital marketing trends.
CO2: Develop an in depth understanding of digital marketing and its applications.
CO3: To create a digital marketing plan, identifying digital channels, their advantages, and limitations, to perceiving ways of their integration taking into consideration the available budget.

Course Contents:

UNIT I **10 lecture hours**

Branding and Communications, Branding, Brand Engagement Strategy, Branding for International Markets, Marketing Communications, Marketing Data Identification and Collection, Marketing Data Integration and Exploratory Data Analysis, Predictive Analytics and Decision Making. Social Media and Content Marketing, Content Marketing Specialization, Paid Advertising and social media, Community Management, Marketing Communications, Campaign Planning, Developing creativecommunications. Public Relations.

UNIT II **11 lecture hours**

Search Engine Optimization (SEO), Search Engine Marketing (SEM), Keywords, On-Site SEO: Optimize UX & Design, Off-Site SEO: Link-building. Programmatic & Display Advertising, Search Engine Marketing with Google Ads (SEM), Keyword Selection, Create Text Ads, CPC Bidding, Navigate Google Ads, SEM Metrics & Optimization, Jobs in SEM, Display Advertising, Display Ads& Targeting, Sales Models, Display Ads in Google Ads, Video Advertising, Jobs in Display Advertising. Email Marketing, Email List Generation, Create an Effective Email Campaigns, Create an Email Plan, Measure Results, Measure & Optimize with Google Analytics Measurability, Understand Your Audience, Evaluate Acquisition, Understand Behavior, Evaluate Conversions, Optimize Campaign Budgets.

UNIT III **11 lecture hours**

Web Analytics, Robust Digital Marketing Strategy, designing a Web Presence, Social Media Marketing, Landscape, Channels, Content, Content Marketing, Implement & Monitor Campaigns, Measure Impact, Jobs in Social Media Marketing, Social Media Advertising, Platforms for Social Ads, Facebook, Facebook — Create Ad Sets, Facebook — Create and Manage Ads, Jobs in Social Media Advertising.

UNIT IV **10 lecture hours**

Digital Marketing, Digital Marketing Framework, Digital Marketing Metrics and Channels, Customer Centricity, understanding your Business, your Customer, Marketing Channels, Marketing Objectives & KPIs, Content Strategy, Content planning, Content creation, Distribute & Promote Content, Optimize Website UX & Landing Pages, Measure Impact.

Text Books :

1. McGruer, D, Dynamic Digital Marketing: Master the World of Onlineand Social Media Marketing to Grow Your Business (1st ed.), Wiley, 2020. ISBN 978 1119635888.

Reference Books :

1. Kingsnorth, S, Digital Marketing Strategy: An Integrated Approach toOnline Marketing (2nd ed.), Kogan Page, 2019. ISBN 978-0749484224.