MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act, 1956)

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CENTRE FOR DISTANCE AND ONLINE EDUCATION

CURRICULUM AND

SCHEME OF EXAMINATION

(MASTERS OF COMPUTER APPLICATION) (ONLINE DEGREE PROGRAMME)

BATCH: July 2026 ONWARDS

FOREWORD

This is to certify that this booklet contains the entire Curriculum and Scheme of Examination of Master of Computer Applications being offered at School of Computer Applications of this University. This has been duly vetted and finally approved by the Academic Council of the University vide its _____meeting held on __and changes, if any deemed appropriate, shall be duly incorporated after the necessary approval by the Academic Council.
This Curriculum and Scheme of Examination of Master of Computer Applications shall be implemented w.e.f. AY 2025-27.

Date:

PREAMBLE

The programme MCA is adapted to an outcome based education system which would enable the students to acquire the capabilities to meet the demands of society and industry at regional, national and global level. The Programme Education Objectives (PEOs) of MCA are consistent with the Vision and Mission of the Department as well as the University, and aim to produce globally successful IT professionals who are empowered to contribute to nation building through sound knowledge, technical skills and research aptitude. The POs and PSOs address the PEOs and aim to produce innovators, IT professionals, entrepreneurs and technocrats with high professional and social ethics.

The curriculum exhibits the requisite balance among the fundamental, core and elective subjects. This is to create a MCA student talent pool that can serve the IT technological needs of the software industry. Many courses are meant to meet the IT technological needs such as Big Data Analytics, Python Programming, R Programming, Network Security and Cryptography, Android Application Development, Mobile Computing and Database Administration etc. .

The curriculum includes courses focusing on employability, entrepreneurship and skill development which map strongly with the PO defining demonstration of technical knowledge and engagement in independent and life-long learning. Examples of such courses are Analytics of Business Strategy, Managing Sales Process and so on.

Certain courses are meant to create awareness about the environment and sustainability and inculcate professional ethics, meeting the requisites of POs defining these characteristic such as Employability Skills Enhancement etc.

The design of curriculum is done in accordance with the predetermined Programme Education Objectives. The syllabus content of each course is meticulously created to develop thorough understanding and gain in-depth knowledge in the subject. A number of theory courses are accompanied with laboratory courses to inculcate the practical skills. In order to ensure the effectiveness of teaching-learning process and true implementation of the curriculum, the course outcomes of each course are developed to meet the programme outcomes and programme specific outcomes, which are also reflected in the Course Articulation Matrix. Course outcome and programme outcome attainment is measured through direct and indirect tools including internal assessments, assignments, end semester examinations, dissertations and projects etc.

Although the curriculum had been designed after thorough deliberations involving experts from academia and industry, and considering the feedbacks obtained from various stakeholders, there is always a scope of regular revision and updation of the syllabus keeping in view the changing needs of the industry and society. Thus a well- articulated process is followed to revise the curriculum from time to time. The process begins with obtaining feedbacks from various stakeholders i.e. students, faculty, alumni and industryexperts. The feedbacks are analyzed andrelevant suggestions are incorporated in the curriculum through a Curriculum revision workshop under the supervision of Departmental Academic Committee (DAC). The revised curriculum is scrutinized by the Board of Studies (BOS) and suggestions of the BOS are also incorporated. The revised curriculum is then placed before the Board of Faculty for consideration which is further reviewed and approved by the Academic Council.

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

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CENTRE FOR DISTANCE AND ONLINE EDUCATION

VISION AND MISSION OF THE DEPARTMENT

VISION

Through online education, Manav Rachna stands tall to bring the most efficacious environment for providing higher quality academic and research-oriented education to the aspirants. Manav Rachna Online Education facilitates the goal of increasing access to enduring learning prospects to students and providing opportunities to make efficient use of scarce resources in light of the new economic realities of higher education.

MISSION

To provide an exclusive learning environment to students with flexible and meticulous online learning opportunities that will guide students to acquire the knowledge and skills as per the requirements of society at large. The aim of Manav Rachna Online Education is:

- To develop emerging skills through online learning methodologies to pursue their Academic and Professional goals.
- To impart profound knowledge and understanding of conceptual aspects of multidisciplinary learning.

ABOUT THE DEPARTMENT

The ultimate touchstone of quality education is the quality culture permeating in any education Institution. In today‘s world of digitization, technical education stands at the crossroads of keeping pace with the emerging needs of humankind along with fast changing trends in governance and scientific development. The global transformation, trend of learning by doing, relevance to people and nation development – Manav Rachna International Institute of Research and Studies is the right place to gear up with a world class competitive edge. We are trusted to nurture juvenile minds and prepare them to deal with challenges of their future endeavors. Continuing the Legacy of our Founder Dr. O.P Bhalla, Manav Rachna has launched —Manav Rachna Centre for Distance and Online Education‖ to provide quality programmes to those students who are not able to draw benefits from conventional systems of Education. Seven programmes in different streams namely Computer Applications, Management, Commerce, Business Administration and Economics will be offered by university in online mode with specialization in different domains. In Today‘s opportunistic world specialized education is essential for successful professional life. Manav Rachna Centre for Distance and Online Education has collaboration with prominent industry partners to provide global career opportunities to the students and prepare the students to acquire the increased technology intensive needs of today. In addition, Manav Rachna Centre for Distance and Online Education provides a multidisciplinary approach for the students to shape their career inside and outside their domain of education and to meet the evolving needs of the society. The commitment of multidisciplinary education is to broaden the participation of students in higher education and leads to a more diverse community. In a multidisciplinary approach, students are inspired to select divergent courses from different disciplines to expand their knowledge, discover themselves through creative thinking and learn the skills of collaboration. The online programmes will help the students to achieve an academic degree along with flexibility and relaxation. These online programs hold equal academic value to an on-campus degree and help students in developing themselves into an industry ready as equivalent to a conventional degree. Students can perfectly reshape their career and

future through impeccably designed online programmes. The renowned faculty, cutting –edge advanced curriculum, technology driven and a remarkable content delivery will be helpful in the successful implementation of online programs.

PROGRAM EDUCATION OBJECTIVES (PEOs)

The objective of the programme is to develop students to work in fields of Computer Applications in various sectors together with internet technologies, e-business applications etc. The MCA program is focused on exposing students to business application areas. The program provides a strong foundation with an integrated understanding of Information technology-based applications. The program is designed to impart the concepts, values, challenges, opportunities and latest trends in the field of Computer Science to develop a broad practical understanding of its context, purpose, and underlying functional areas. The MCA programme tends more towards software application development and exposure to thelatest software tools and techniques todevelop the applications. Following are Program Educational Objectives of MCA:

PEO 1. To prepare Postgraduates who will be successful professionals in industry, government, academia, research, entrepreneurial pursuit and consulting firms in the field of Computer Applications.

PEO 2. To provide students a solid foundation in computing fundamentals and techniques required to solve related problems and also to pursue higher studies and research.

PEO 3. To inculcate students in professional and ethical attitude, effective communication skills, multidisciplinary approach and an ability to relate computing issues to broader social context.

PEO 4. To provide students an academic environment for excellence, leadership and continuous learning, on technology and trends needed for a successful career.

PROGRAM SPECIFIC OBJECTIVES & PROGRAM OUTCOMES PROGRAM

SPECIFIC OBJECTIVES (PSO):

When the PEO's are achieved, the post graduates will be:

PSO 1. Ability to pursue careers in IT industry/ consultancy/ research and development, teaching and allied areas related to computer science.

PSO 2. Comprehend, explore and build up computer programs in the areas allied to Algorithms, System Software, Multimedia, Web Design and Big Data Analytics for efficient design of computer-based systems of varying complexity.

PROGRAM OUTCOMES (POs)

Programme outcomes are attributes of the graduates from the programme that are indicative of the graduates' ability and competence to work as an IT professional upon graduation. Program Outcomes are statements that describe what students are expected to do now or do by the time of post-graduation. They must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the program educational objectives down the road. The department of Computer Applications has the following PO's.

PO1. Computational Knowledge: Understand and apply mathematical foundation, computing and domain knowledge for the conceptualization of computing models from defined problems.

PO2. Problem Analysis: Ability to identify, critically analyze and formulate complex computing problems using fundamentals of computer science and application domains.

PO3. Design / Development of Solutions: Ability to transform complex business scenarios and contemporary issues into problems, investigate, understand and propose integrated solutions using emerging technologies

PO4. Conduct Investigations of Complex Computing Problems: Abilityto devise and conduct experiments, interpret data and provide well informed conclusions.

PO5. Modern Tool Usage: Ability to select modern computing tools, skills and techniques necessary for innovative software solutions

PO6. Professional Ethics: Ability to apply and commit professional ethics and cyber regulations in a global economic environment.

PO7. **Life-long Learning**: Recognize the need for and develop the ability to engage in continuous learning as a Computing professional.

PO8. Project Management and Finance: Ability to understand management and computing principles with computing knowledge to manage projects in multidisciplinary environments.

PO9. Communication Efficacy: Communicate effectively with the computing community as well as society by being able to comprehend effective documentations and presentations.

PO10. **Societal & Environmental Concern:** Ability to recognize economical, environmental, social, health, legal, ethical issues involved in the use of computer technology and other consequential responsibilities relevant to professional practice.

PO11. Individual & Team Work: Ability to work as a member or leader in diverse teams in a multidisciplinary environment.

PO12. Innovation and Entrepreneurship: Identify opportunities, entrepreneurship vision and use of innovative ideas to create value and wealth for the betterment of the individual and society.

MAPPING OF PEOs WITH POs and PSOs

Program Outcome(PO)/ Program Specific Outcome (PSO)		PEOs that are attained through concerned PO
PO1	Computational Knowledge: Understand and apply mathematical foundation, computing and domain knowledge for the conceptualization of computing models from defined problems.	**1,2**
PO2	Problem Analysis: Ability to identify, critically analyze and formulate complex computing problems using fundamentals of computer science and application domains.	**1,2**
PO3	Design / Development of Solutions: Ability to transform complex business scenarios and contemporary issues into problems, investigate, understand and propose integrated solutions using emerging technologies.	**1,2,3**
PO4	Conduct Investigations of Complex Computing Problems: Ability to devise and conduct experiments, interpret data and provide well informed conclusions.	**2,3**
PO5	Modern Tool Usage: Ability to select modern computing tools, skills and techniques necessary for innovative software solutions	**2**
PO6	Professional Ethics: Ability to apply and commit professional ethics and cyber regulations in a global economic environment.	**3**
PO7	Life-long Learning: Recognize the need for and develop the ability to engage in continuous learning as a Computing professional	**3,4**
PO8	Project Management: Ability to understand management and computing principles with computing knowledge to manage projects in multidisciplinary environments.	**2,3**
PO9	Communication Efficacy: Communicate effectively with the computing community as well as society by being able to comprehend effective documentations and presentations.	**3,4**
PO10	Societal & Environmental Concern: Ability to recognize economical, environmental, social, health, legal, ethical issues involved in the use of computer technology and other consequential responsibilities relevant to professional practice.	**3,4**
PO11	Individual & Team Work: Ability to work as a member or leader in diverse teams in multidisciplinary environment	**3,4**
PO12	Innovation and Entrepreneurship: Identify opportunities, entrepreneurship vision and use of innovative ideas to create value and wealth for the betterment of the individual and society.	**1,3**

PSO1	Ability to pursue careers in IT industry/ consultancy/ research and development, teaching and allied areas related to computer science.	**1,2,4**
PSO2	Comprehend, explore and build up computer programs in the areas allied to Algorithms, System Software, Multimedia, Web Design and Big Data Analytics for efficient design of computer-based systems of varying complexity.	**1,2,3**

SEMESTER SYSTEM AND CHOICE BASED CREDIT SYSTEM

Credit based system of study and student's performance/progress is measured by the number of credits that he/she has earned, i.e. completed satisfactorily. Based on the course credits and grade obtained by the student, grade point average is calculated

(a) Course credits assignment

Each course has a certain number of credits assigned to it depending upon its duration in periods for lecture, tutorial and laboratory/clinical practice in a week. A few courses/activities are without credit (s) and are referred to as Audit Pass Courses (APC) but are mandatory to pass as a partial fulfillment of the award of degree.

(b) Earning of credits

At the end of every course, a letter "Grade" shall be awarded in each course for which a student has registered. On obtaining a minimum Pass Grade, student shall accumulate the course credits as Earned Credits. A student's performance shall be measured by the number of credits that he/she has earned and by the weighted grade point average. Grades obtained in the audit courses shall not be counted for computation of grade point average, however shall be mandatory to pass as a partial fulfilment of award of degree.

For the Award of the Degree of a program Masters of Computer Applications, he/she has to earn minimum of 80 credits during the 2-year duration of the program **in 4 semesters.**

To earn the degree, students must earn 64 credits from compulsory courses and 16 credits from elective courses if they have chosen to undertake a "**Major Project**" in their final semester otherwise, they need to earn 60 credits from compulsory courses and at least 20 credits from elective courses to meet the degree requirements if they opted for the "**Semester**" option. The students will have the option to complete the elective courses basket from the elective/open- elective courses, through MOOCS or a combination of all three.

Students taking admission after completing three years UG programme will be at par with level 6 after completing first year of the MCA programme which is equivalent to PG Diploma. The students with the background of 4 years UG degree are eligible for admission directly into the second year of MCA and will be at par with level 6.5 at the completion.

All courses under "Compulsory Courses Basket", are required to be qualified and cleared/pass by each and every students enrolled under the programme and are semester-wise listed in the study scheme along with credits assigned to each course.

Compulsory Courses Basket:

a) **Foundation /Core courses**
b) **Ability Enhancement Courses (AEC)**: Environmental sciences with four credits, Basic Course on Indian Knowledge System (IKS), Constitution of India etc., to be offered throughout the University
c) **Skill Enhancement Courses** (SEC): CDC / Life-skill (Jeevan-Kaushal) courses and Universal Human Values (UHV), Courses based on DTI (Design Thinking and Innovation)/ RIC (Research Innovation Catalyst) etc.
d) **Internships / Term Paper / Projects**

Under Elective Courses Basket, there will be three types of courses:

- **Semester-wise courses** offered by the department itself
- **Open/Inter-disciplinary courses** offered at the Institute/University level notified from the office of Dean- Academics.
- **Massive Open Online Courses (MOOCs)** available on SWAYAM Platform or any other platform as recommended by UGC/AICTE and notified from the office of Dean-Academics.

Each course shall have credits assigned to it. Student shall be required to register courses every semester for as many courses/credits specified under "Elective Courses Basket" depending upon his/her interest, capability/pace of learning and availability of time slot (without any clash in time table) so as to earn all required total credits under the "Elective Courses Basket" during the entire programme duration.

However, for registration of courses [including courses under "Compulsory Courses Basket", "Elective Courses Basket" and Previous Semester Courses (wherein he/she was declared in-eligible on the basis of attendance or he/she could not clear the course within permissible given chances)], if any, the maximum limit in a semester shall be 30 credits.

Definition of keywords

- **Programme:** An educational programme leading to the award of a Degree, diploma or certificate.
- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
- **Semester:** Each semester consists of 15-18 weeks of academic work equivalent to 90 days of actual teaching days. The odd semester may be scheduled from July to December and even Semester from January to June.
- **CBCS:** Choice Based Credit System, It provides choice for students to select from the prescribed courses.
- **Course:** It is usually referred to as "subject. All courses need not carry the same weight/ credit. A course may comprise lectures/ tutorials/ practical's, field work, outreach activities/ project work/ vocational training/ viva/ seminars etc., or a combination of a few of these.
- **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching per week or two hours of practical work per week per week or three hours of field work per week. Alternatively, one credit translates into 15 hours of class room teaching, or 30 hours of Lab engagament, or 45 hours of field work/project in a semester.
- **Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It is expressed up to two decimal points.
- **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of total credits of all courses in all the semesters. It is also expressed up to two decimal points
- **Grade Point**: It is the numerical weight allotted to each letter grade on a 10-point scale.
- **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

CDOE MCA SCHEME (JULY 2026 ONWARDS)

MCA SEMESTER 1							
Course Type	**Course Name**	**Course Code**	**Internal marks/ Continuous Evaluation**	**External marks**	**Total**	**Duration of Exam**	**Credits**
Compulsory Courses							
Core	Mathematics for Computing	Oo6.0CA106C01H	30	70	100	3	4
Core	Data Structures & Algorithms	O6.0CA107C01H	30	70	100	3	4
Core	Advanced Operating Systems	O6.0CA108C01H	30	70	100	3	3
Core	Advanced DBMS	O6.0CA109C01H	30	70	100	3	3
Core	Python Programming for Intelligent Systems	O6.0CA110C01	30	70	100	2	1
SEC	Research Innovation Catalyst-I	O6.0CA100C05	100	-	100	-	0.5
SEC	Placement Competency Enhancement -I	O6.0CDC196C05	30	70	100	2	1
Audit Pass*	Fundamentals of Computer Systems	O6.0CA102C09A	30	70	100	3	0
Audit Pass*	Elements of Mathematics	O 6.0CA101C09A	30	70	100	3	0
Credits for Compulsory Courses							16.5
ELECTIVE COURSES							
Domain Elective	Elective I		30	70	100	3	3
Total Credits							19.5
Generic Elective	**Elective II		30	70	100	3	3
Total Credits							22.5

* Compulsory only for the students without background in Mathematics/Programming
** Students can opt one more elective course from Elective basket II or can choose to complete the similar course or interdisciplinary course from NPTEL or MOOC Platform during the MCA Programme

Specialization Courses

Course Type	Course Name	Course Code	Credit
Domain Elective (Elective I)	O6.0CA131E02H	Agentic & Generative AI	3
	O6.0CA132E02H	Social Network Analytics	
	O6.0CA133E02H	Cyber Security	
	O6.0CA134E02H	Introduction to Data Science	
	O6.0CA135E02H	DevOps Essential	
	O6.0CA136E02H	Internet of Things	
Generic Elective **Elective II	O6.0CA137E02H	Concepts of AI & ML	3
	O6.0CA138E02H	Introduction to Blockchain Technologies	
	O6.0CA139E02H	Advanced Web Technologies	
	O6.0CA140E02H	Soft Programming	
	O6.0CA141E02H	Gaming Technology	

MCA SEMESTER 2

Course Type	Course Name	Course Code	Internal marks/ Continuous Evaluation	External marks	Total	Duration of Exam	Credits
Compulsory Courses							
Core	Design & Analysis of Algorithms	O6.0CA230C01H	30	70	100	3	4
Core	Object-Oriented Programming using Java	O6.0CA231C01H	30	70	100	3	4
Core	Advaced Computer Networks	O6.0CA232C01	30	70	100	3	2
Core	Artificial Intelligence	O6.0CA233C01H	30	70	100	3	3
Core	Full Stack Development	O6.0CA234C01H	30	70	100	3	3
Domain Elective	Elective IV/V		30	70	100	3	3
SEC	Research Innovation Catalyst-II	O6.0CA219C05	100	-	100	-	0.5
SEC	Placement Competency-II	O6.0CDC296C05	30	70	100	2	1
Credits for Compulsory Courses							20.5
ELECTIVE COURSES							
Domain Elective	Elective III		30	70	100	3	3
Total Credits							23.5

Domain Elective III

Course Type	Course Name	Course Code	Credit
Domain Elective (Elective III)	O6.0CA231E02H	Deep Learning	3
	O6.0CA232E02H	Predictive Analytics	
	O6.0CA233E02H	Data Analytics and Visualisation using Python	
	O6.0CA234E02H	DevOps Software Engineering	
	O6.0CA235E02H	Ethical Hacking	
	O6.0CA236E02H	Gaming Technology	
	O6.0CA237E02H	IoT with Machine Learning	

Elective IV (Global Certification-I)					
Course Type	**Domain**	**Certificate Partner**	**Course Code**	**Course Name**	**Credits**
Domain Elective (Elective IV)	AIML	Microsoft	O6.0CA230C02H	Azure AI App and Agent Developer Associate	3
		Microsoft	O6.0CA231C02H	Machine Learning Operations (MLOps) Engineer Associate	
		NVIDIA	O6.0CA232C02H	Associate Generative AI LLMs (NCA-GENL)	
	Data Science	Microsoft	O6.0CA233C02H	Machine Learning Operations (MLOps) Engineer Associate	
		Microsoft	O6.0CA234C02H	Fabric Analytics Engineer Associate	
		NVIDIA	O6.0CA235C02H	Certified Associate AI Infrastructure & Operations (NCA-AIIO)	
	Cyber Security	EC-Council	O6.0CA236C02H	IoT Security Essentials	
		EC-Council	O6.0CA237C02H	DevSecOps Essentials	
		EC-Council	O6.0CA238C02H	Digital Forensics Essentials	
# Elective V					
Domain Elective (Elective V)	NA		O6.0CA238E02H	Supervised Learning	3
			O6.0CA239E02H	Blockchain Architecture	
			O6.0CA240E02H	Angular	
			O6.0CA241E02H	Web Application Development using PHP	
			O6.0CA242E02H	Software Programming in IoT	

 # if the student is not opting Elective IV, they can opt Elective course mentioned in Elective basket V

MCA SEMESTER 3

Course Type	Course Name	Course Code	Internal marks/ Continuous Evaluation	External marks	Total	Duration of Exam	Credits
Compulsory Courses							
Core	Applied Machine Learning	O6.5CA111C01H	30	70	100	3	3
Core	Data Engineering & Data Warehousing	O6.5CA112C01H	30	70	100	3	3
Core	Software Engineering and Agile Practices	O6.5CA113C01H	30	70	100	3	3
Core	Cloud Computing Technologies	O6.5CA114C01	30	70	100	3	3
Domain Elective	Elective VII/VIII		30	70	100	3	3
SEC	Innovation, Startup & IPR	O6.5CA101C05	100	-	100	-	2
Internship	Internship I	O6.5CA101C06	100	-	100	-	2
Credits for Compulsory Courses							19
ELECTIVE COURSES							
Domain Elective	Elective III		30	70	100	3	3
Total Credits							22

Domain Elective (VI)

Course Type	Course Name	Course Code	Credit
Domain Elective (Elective VI)	Natural Language Processing	06.5CA131E02H	3
	Decision Intelligence	06.5CA132E02H	
	SQL for Data Science	06.5CA133E02H	
	Web Application Security	06.5CA134E02H	
	Advannced Dev Ops	06.5CA135E02H	
	Cyber Forensics	06.5CA136E02H	
	Distributed Systems	06.5CA137E02H	
	Quantum Computing	06.5CA138E02H	

Elective VII (Global Certification-II)					
Course Type	**Domain**	**Certificate Partner**	**Course Code**	**Course Name**	**Credit**
Domain Elective	AIML	Microsoft	O6.5CA131C02H	Azure AI Cloud Developer Associate	3
		Microsoft	O6.5CA132C02H	AI Agent Builder Associate	
		NVIDIA	O6.5CA133C02H	Certified Associate Generative AI Multimodal (NCA-GENM)	
	Data Science	Microsoft	O6.5CA134C02H	Microsoft Certified: AI Agent Builder Associate	
		Microsoft	O6.5CA135C02H	Microsoft Fabric Data Engineer Associate	
		NVIDIA	O6.5CA136C02H	Certified Associate Accelerated Data Science (NCA-ADS)	
	Cyber Security	EC-Council	O6.5CA137C02H	Certified Threat Intelligence Analyst	
		EC-Council	O6.5CA138C02H	Certified Application Security Engineer	
		EC-Council	O6.5CA139C02H	Certified SOC Analyst	

## Elective VIII				
Elective	NA	O6.5CA139E02H	Unsupervised Learning	3
		O6.5CA140E02H	Applications of Blockchain	
		O6.5CA141E02H	Agile Methodologies and DevOps	
		O6.5CA142E02H	Immersive Technology & Media	
		O6.5CA143E02H	Data Management in IoT	

if the student is not opting Elective VII, they can opt Elective course mentioned in Elective basket VIII

MCA SEMESTER 4							
Course Type	**Course Name**	**Course Code**	**Internal marks/ Continuous Evaluation**	**External marks**	**Total**	**Duration of Exam**	**Credits**
Compulsory Courses							
Core	Cloud Native Application Development	O6.5CA205C01H	30	70	100	3	3
Core	DevOps & MLOps	O6.5CA206C01H	30	70	100	3	3
Core	Large Language Models	O6.5CA207C01H	30	70	100	3	3
Core	Project	O6.5CA200C07	30	70	100		6
OR							
Internship	InternshipII	O6.5CA202C07	20-22 Week Industrial Training				15
Credits for Compulsory Courses							15

	Core Credits	65	Mandatory courses for all students
27% Elective Courses	Domain Elective Credits	15	Student will earn these 15 credits from Elective baskets I, III IV, VI & VII
	Electives/NPTEL/Open Elective (OE) Credits	10	Students can earn the 10 credits during any of the four semesters of the programme from elective baskets II, V & VIII or from open electives/ MOOC Platforms
	Total Credits for the MCA Degree	90	

In addition to the prescribed Domain Elective Courses, students may choose from a range of Interdisciplinary Electives, Generic Electives, Online Courses (such as MOOCs/NPTEL), Open Electives, and other University-approved courses. The approved list of elective courses offered in a semester shall be notified before the commencement of the semester. Students shall register for elective courses in accordance with the University regulations, subject to the prescribed credit limits and the eligibility criteria applicable to the respective elective category.

For Successful completion of the three year MCA degree, the students need to earn 65 credits of compulsory courses, 23 credits of Elective Courses.

SEMESTER-I

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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O6.0CA106C01H: MATHEMATICS FOR COMPUTING

Credits: 4 Max. Marks: 100
Continuous Evaluation: 30

Duration of Examination: 3 Hrs End Semester Examination: 70

Pre-Requisites: Elementary Mathematics **Course Type:** Core

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

O6.0CA106C01H.1: Understand the fundamental concepts and principles of linear algebra, statistics, and optimization for computing applications.

O6.0CA106C01H.2: Apply mathematical and statistical techniques to solve computational and analytical problems.

O6.0CA106C01H.3: Analyze mathematical models and statistical methods to support data-driven decision-making and problem-solving.

O6.0CA106C01H.4: Evaluate computational and optimization models for improving efficiency and resource utilization.

O6.0CA106C01H.5: Develop mathematical and optimization-based solutions for real-world computing and engineering applications.

PART - A

Unit 1: Matrix Algebra and Linear Systems

1.1 Matrices and Matrix Operations
1.2 Types of Matrices
1.3 Rank and Inverse of a Matrix
1.4 Vector Spaces and Linear Transformations
1.5 Solution of Systems of Linear Equations
1.6 Homogeneous and Non-Homogeneous Linear Equations

Unit 2: Eigenvalues and Matrix Applications

1.1 Eigenvalues and Eigenvectors
1.2 Cayley-Hamilton Theorem
1.3 Singular Value Decomposition (SVD),
1.4 Applications of Linear Algebra in Computer Science

Unit 3: Fundamentals of Statistics

3.1 Measures of Central Tendency (Mean, Median, Mode)
3.2 Measures of Dispersion (Range, Variance, Standard Deviation)
3.3 Correlation and Regression
3.4 Fundamentals of Probability
3.5 Probability Distributions (Binomial, Poisson, and Normal)

PART - B

Unit 4: Statistical Inference

4.1 Population and Sample
4.2 Sampling Techniques
4.3 Sampling Distributions
4.4 Hypothesis Testing
4.5 t- Test

Unit 5: Fundamentals of Optimization

5.1 Optimization Problems

5.2 Objective Function and Constraints
5.3 Linear Optimization Problem (LPP): Graphical and simplex method
5.4 Applications in Computing

Unit 6: Advanced Optimization Techniques

6.1 Transportation Problem
6.2 Assignment problems
6.3 PERT (Program Evaluation and Review Technique)
6.4 CPM (Critical Path Metho

Suggested Readings:

1. Howard Anton, Chris Rorres & Anton Kaul, Elementary Linear Algebra: Applications Version, International Adaptation, 12th Edition (2025), Wiley.
2. Darryl Yong & Chris McMullen, Linear Algebra: A Modern Introduction, 2nd Edition (2025), CRC Press..
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani , (2025) updated edition)An Introduction to Statistical Learning , Springer.
4. Introduction to Operations Research, 12th Edition (2025), McGraw-Hill.

Note: Only the latest editions of the books are recommended.

List of Experiments
BEGINNER LEVEL (NSQF LEVEL: 1–3)

S. No.	Name of the Experiment	Bloom's Level with Cognitive Process
1	Perform matrix operations (addition, subtraction, multiplication, transpose) using MATLAB.	Apply (Matrix computations) / L3
2	Determine the rank and inverse of a matrix using MATLAB and verify the results.	Apply (Matrix analysis) / L3
3	Solve systems of linear equations using MATLAB (Gaussian Elimination and Matrix Inverse methods).	Apply (Solving linear systems) / L3
4	Compute eigenvalues and eigenvectors of a given matrix using MATLAB.	Apply (Eigenvalue computation) / L3
5	Verify the Cayley–Hamilton Theorem for a given matrix using MATLAB.	Apply (Theorem verification) / L3
6	Perform Singular Value Decomposition (SVD) of a matrix and interpret the results.	Apply (Matrix decomposition) / L3
7	Compute Mean, Median, Mode, Range, Variance, and Standard Deviation using MATLAB	Apply (Descriptive statistical analysis) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4–6)

S. No.	Name of the Experiment	Bloom's Level with Cognitive Process
8	Plot Binomial, Poisson, and Normal distributions using MATLAB and compare their characteristics.	Analyze (Probability distribution analysis) / L4

9	Perform hypothesis testing (t-Test) for a given dataset using MATLAB.	Apply (Statistical inference) / L3
11	Solve a Linear Programming Problem using the Graphical Method and MATLAB.	Analyze (Optimization modelling) / L4
12	Solve a Linear Programming Problem using the Simplex Method (MATLAB).	Apply (Optimization techniques) / L3

ADVANCED LEVEL (NSQF LEVEL: 7–10)

S. No.	Name of the Experiment	Bloom's Level with Cognitive Process	Programs Mapped with Ability Enhancement Courses (IKS / SDG / EVS / FinTech)
13	Solve a Transportation Problem using MATLAB and interpret the optimal solution.	Analyze (Optimization and decision-making) / L4	SDG
14	Develop and analyze a PERT network for project scheduling and determine project completion time.	Create (Project planning and scheduling) / L6	SDG
15	Develop a CPM network, identify the critical path, and compute project duration using MATLAB/Excel.	Create (Project management and optimization) / L6	SDG

Software Required

- **MATLAB** (R2022a or later recommended)
- **MATLAB Optimization Toolbox** *(optional for advanced optimization problems)*

Suggested Readings

1. MATLAB for Engineers, 6th Edition, Pearson.
2. MATLAB: A Practical Introduction to Programming and Problem Solving, 6th Edition, Butterworth-Heinemann (Elsevier).

Note: Only the latest editions of the books are recommended

Web Links

1. **https://ocw.mit.edu/courses/18-06sc-linear-algebra-fall-2011/**
2. **https://www.khanacademy.org/math/linear-algebra**
3. **https://nptel.ac.in/courses**
4. **https://mathworld.wolfram.com**
5. **https://tutorial.math.lamar.edu**
6. **https://mml-book.github.io/**

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

The evaluation will include two types of assessments:
(i) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%
Subjective (Short/Long) 40%
Discussion/Presentation 15%
Projects/Group Activities etc. 15%
(ii) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30%
Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA106 C01H.1	3	3		3		3	1	2	2	3	2	1	1	1
O6.0CA106 C01H.2	3	2	3	3	2	3	2	2	3	3	2	2	3	1
O6.0CA106 C01H.3	3	3	3	2	2	2	2	2		2	2	3	2	1
O6.0CA106 C01H.4	3	3	2	3	3	3	2	2		3	2	3	2	1
O6.0CA106 C01H.5	3	3	3	1			1	2	2	3	2	1	1	

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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O6.0CA107C01H:DATA STRUCTURES & ALGORITHMS

Credits: 4 Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs End Semester Examination: 70

Pre-Requisites: NA
Course Type: Core

Course Outcomes: At the end of the course, the students will be able to:
O6.0CA107C01H.1: Understand the fundamental concepts, principles, and techniques of data structures and algorithms.
O6.0CA107C01H.2: Apply appropriate data structures and algorithmic techniques to develop efficient computational solutions.
O6.0CA107C01H.3: Analyze the efficiency and performance of data structures and algorithms for solving computational problems.
O6.0CA107C01H.4: Evaluate alternative data structures and algorithms based on complexity, scalability, and application requirements.
O6.0CA107C01H.5: Design and develop optimized solutions using suitable data structures and algorithms for real-world applications.

UNIT 1: Algorithmic Foundations and Complexity Analysis
1.1 Overview of Data Structures
1.2 Abstract Data Types (ADT), Data Abstraction
1.3 Algorithm Design Paradigms: Divide & Conquer, Greedy, Dynamic
1.4 Mathematical Foundations of Algorithm Analysis: Asymptotic Notations, Recurrence Relations
1.5 Array and Dynamic array implementation and application
1.6 Linked list implementation

Unit 2: Advanced Linear Data Structures
2.1 Stacks design and implementation using array and linked lists
2.2 Circular Queue implementation using array and linked lists
2.3 Deque and Priority queue
2.4 Monotonic Stack and Monotonic Queue
2.5 Real-time Applications: Browser Cache, Undo-Redo Systems, CPU Scheduling, Event-driven Systems

Unit 3: Hierarchical and Balanced Tree structures
3.1 Trees Terminology
3.2 Binary Tree Traversal methods
3.3 Heap Structures
3.4 Binary Search Trees
3.5 AVL and Red Black Tree
3.6 Segment Tree
3.7 Huffman Tree and applications

Unit 4: Advanced Graph algorithms
4.1 Graphs representation
4.2 Disjoint Set Union (Union-Find)
4.3 Topological sorting
4.4 Cycle detection in graphs
4.5 Minimum Spanning Tree
4.6 Applications in social networks and GPS Navigation

Unit 5: Algorithmic Data Retrieval, Search and Ordering Techniques
5.1 File handling basics
5.2 Binary vs Text Files
5.3 Hash Tables and Hash Functions
5.4 Collision resolution
5.5 Bloom Filters

5.6 Cache-Friendly Data Structures

Unit 6: Modern data structures for large scale systems
6.1 Searching Techniques
6.2 Internal Sorting methods
6.3 External Sorting
6.4 Stable and Unstable Sorting
6.5 Introduction to Parallel Sorting

List of Experiments:

BEGINNER LEVEL

S. No.	Name of the Program	Bloom level with Cognitive process
1.	Write a program to perform various operations in the list: - Insertion - Deletion - Display	Apply (Using basic list operations)/ L3
2	Write a Program to sort the list using: - Bubble Sort - Quick Sort - Insertion sort - Merge Sort - Heap Sort Also, find the comparison on the basis of time complexity.	Apply (Sorting algorithm) / L3
3	Write a program to search the element using: - Linear Search - Binary Search Also, find the comparison on the basis of time complexity.	Apply (Basic search algorithm) / L3
4	Write a program to perform all operations: - For the Stack using an Array. - For the Queue using an Array. - For the Circular Queue using an Array. - Implement browser history using stacks.	Apply (Array manipulation, stack & queue operations) / L3
5	Write a program to evaluate the Postfix Notation.	Apply (Expression evaluation) / L3
6	Write a program to convert infix notation into Postfix Notation.	Apply (Expression conversion) / L3

INTERMEDIATE LEVEL

S.No	Name of the Program	Bloom level with Cognitive process
7	Write a program to perform the operations of the linked list: - Insertion - Deletion - Display	Apply (Linked list operation)/ L3
8	Write a program to perform the operations of the Circular linked list: - Insertion - Deletion - Display	Apply (Circular linked list) / L3
9	Write a program to perform all operations: - For Stack using Linked List. - For Queue using Linked List - For Circular Queue using Linked List	Apply (Linked list manipulation)/ L3
10	Write a program to perform concatenation of two linked lists and Implement Polynomial Representation and Addition using Linked Lists	Apply (Linked list manipulation)/ L3
11	Write a program to perform the operations of the Double linked list: - Insertion	

	- Deletion - Display	
12	Write a program to perform tree traversal methods.	Apply (Binary tree traversal) / L3
13	Write a program to perform insertion and deletion in the Binary Search Tree.	Apply (Binary Search Tree operations) / L3
14	Write a program to represent an undirected graph using the adjacency matrix to implement the graph and perform the operations with menu-driven options for the following tasks: 1. Create graph 2. Insert an edge 3. Print Adjacency Matrix 4. List all vertices that are adjacent to a specified vertex. 6. Exit program	Analyse (Graph operations, adjacency matrix) / L4
15	Simulation of Bloom Filter for Membership Testing	Apply L3

ADVANCED LEVEL

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
16	Kalnirnay: Conversion from Gregorian to Hindi calendar.	Analyse (Linked list manipulation) / L4	IKS
17	Design a system to optimize irrigation scheduling based on crop type, soil moisture, and weather.	Analyse (Linked list manipulation)/ L4	SDG
18	A queue-driven system to simulate the movement of planets across zodiac signs.	Analyse (Circular data structures)/ L4	IKS
19	A program that: -Uses efficient data structures to compute numerology -numbers for names. -Stores and organises results in a structured way. -Analyses frequency and patterns in numerology data.	Analyse (Linked list operation) / L4	IKS
20	A program to classify plant or animal species based on environmental features (e.g., habitat, pollution tolerance).	Analyse (Linked list operation)/ L4	EVS
21	System to track and visualise personal health metrics (e.g., step count, calories burned, sleep).	Analyse (Circular linked list) / L4	IKS
22	Design a system that organises and preserves Vedic texts in digital form, ensuring easy access to verses, rituals, and philosophical content for future generations.	Create (Circular linked list) / L6	IKS
23	System that identifies and classifies common suffixes in Sanskrit words, which is essential for understanding word formation and grammar.	Analyse (Linked list operation) / L4	IKS
24	Case study on Improving Quality Education through Efficient Data Structures	L2/ L3/ L4/ L5/ L6	SDG
25	System that automates loan processing tasks, including loan eligibility checking, interest estimation, and repayment scheduling.	L2/ L3/ L4/ L5/ L6	FinTech

Suggested Readings:

1. Seymour Lipschutz, 2014, Data Structures, McGraw Hill.
2. Tenenbaum, 2006, Data Structures using C & C++, Prentice-Hall.
3. Yashwant Kanetkar, 2008, Data Structures Through C, BPB Publications.

Note: Only the latest editions of the books are recommended.

Software required/Web links:

Python language/ Dev C++

https://www.tutorialspoint.com/data_structures_algorithms (Last visited Date: 21 February 2024)

https://www.includehelp.com/data-structure-tutorial (Last visited Date: 21 February 2024)

https://digimat.in/nptel/courses/video/106102064/L01.html (Last visited Date: 16 April 2025)

https://www.geeksforgeeks.org/huffman-coding-greedy-algo-3/ (Last visited date: 31 July 2026)

https://cp-algorithms.com/data_structures/segment_tree.html Last visited date: 31 July 2026)

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

The evaluation will include two types of assessments:
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COURSE ARTICULATION MATRIX:

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

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O6.0CA108C01H: ADVANCED OPERATING SYSTEMS

Credits:3 Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs End Semester Examination: 70

Pre-Requisite: Fundamentals of Operating System
Course Type: Core

Course Outcomes: At the end of the course, students will be able to
O6.0CA108C01H.1: Understand the concepts, architecture, and core principles of advanced operating systems.
O6.0CA108C01H.2: Apply operating system mechanisms and resource management techniques to solve computing problems.
O6.0CA108C01H.3: Analyze operating system services, I/O management and distributed computing environments.
O6.0CA108C01H.4: Evaluate operating system solutions based on performance, security, reliability, and scalability requirements.
O6.0CA108C01H.5: Design and develop efficient system-level solutions using modern operating system technologies and tools.

UNIT 1: Advanced Operating System Architecture
1.1 Evolution of Operating Systems
1.2 Operating System Architecture
1.3 Monolithic, Layered and Microkernel Architecture
1.4 Hybrid Kernel
1.5 System Calls
1.6 User Mode and Kernel Mode
1.7 Interrupts and Exceptions
1.8 Linux Kernel Overview

UNIT 2: Process and Memory Management
2.1 Process Scheduling
2.2 Multithreading
2.3 Thread Synchronization
2.4 Semaphores and Mutexes
2.5 Deadlocks
2.6 Virtual Memory
2.7 Paging and Demand Paging
2.8 Memory Mapping

UNIT 3: File Systems and Storage Management
3.1 File System Architecture
3.2 Directory Management
3.3 File Allocation Methods
3.4 Journaling File Systems
3.5 Disk Scheduling Algorithms
3.6 RAID Concepts

UNIT 4: Distributed and Real-Time Operating Systems
4.1Distributed Operating Systems
4.2 Network Operating Systems
4.3 Remote Procedure Calls (RPC)
4.4 Distributed File Systems
4.5 Real-Time Operating Systems

UNIT 5: Advanced I/O Management
5.1 I/O System Architecture
5.2 Device Drivers
5.3 Interrupt Handling Techniques
5.4 Storage I/O Optimization
5.5 Modern I/O Technologies
UNIT 6: Operating System Security and Emerging Trends
6.1 Authentication
6.2 Access Control
6.3 Secure Boot
6.4 Malware Protection
6.5 AI-assisted Resource Management
6.6 Edge Computing

List of Experiments:

BEGINNER LEVEL (NSQF LEVEL: 1-3)

S. No.	Name of the Program	Bloom's Level with Cognitive Process
1	Install Ubuntu Linux in a Virtual Machine (VirtualBox/VMware) and explore the Linux file system, terminal commands, and user management.	Apply (Linux Environment) / L3
2	Write shell scripts to perform file handling, process management, arithmetic operations, and decision-making.	Apply (Shell Scripting) / L3
3	Implement Linux system calls (fork(), exec(), wait(), exit()) using C programs.	Apply (System Calls) / L3
4	Create multiple processes and demonstrate Process Control Block (PCB) concepts using Linux utilities.	Apply (Process Management) / L3
5	Implement Inter-Process Communication (IPC) using Pipes, Named Pipes (FIFO), and Shared Memory.	Apply (IPC Mechanisms) / L3
6	Create multiple threads using POSIX Threads (Pthreads) and compare process vs. thread execution.	Apply (Multithreading) / L3

INTERMEDIATE LEVEL(NSQF LEVEL: 4-6)

S. No.	Name of the Program	Bloom's Level with Cognitive Process
7	Implement synchronization using Semaphores and Mutex Locks to solve the Producer–Consumer problem.	Analyse (Synchronization) / L4
8	Implement the Reader–Writer problem and Dining Philosophers problem using synchronization primitives.	Analyse (Synchronization Problems) / L4
9	Simulate CPU Scheduling Algorithms (FCFS, SJF, Priority, Round Robin) and compare performance metrics.	Analyse (CPU Scheduling) / L4
10	Implement Memory Allocation Algorithms (First Fit, Best Fit, Worst Fit) and compare memory utilization.	Analyse (Memory Allocation) / L4
11	Simulate Page Replacement Algorithms (FIFO, LRU, Optimal) and evaluate page fault rates.	Analyse (Virtual Memory) / L4
12	Implement Deadlock Avoidance using the Banker's Algorithm and demonstrate deadlock detection.	Analyse (Deadlock Handling) / L4

ADVANCED LEVEL LEVEL(NSQF LEVEL:7-10)

S. No.	Name of the Program	Bloom's Level with Cognitive Process	Programs Mapped with Ability Enhancement Courses
13	Analyze Linux system performance using **top**, **htop**, **vmstat**, **iostat**, and **sar** utilities.	Analyse (Performance Monitoring) / L4	SDG
14	Install Docker, create Docker images, manage containers, and deploy a containerized application.	Analyse (Containerization) / L4	SDG
15	Deploy a multi-container application using Docker Compose and analyze container networking.	Analyse (Docker Compose) / L4	SDG
16	Configure Kubernetes using Minikube and deploy Pods, Deployments, and Services.	Analyse (Kubernetes Deployment) / L4	SDG
17	Implement basic Linux security by configuring user permissions, file access control, and firewall settings.	Evaluate (Operating System Security) / L5	SDG
18	**Mini Project:** Develop a Linux Process Monitoring Tool, CPU Scheduler Simulator, Memory Management Simulator, or Docker-based System Monitoring Dashboard.	Create (Mini Project) / L6	SDG

Suggested Readings:

1. Silberschatz, A., Galvin, P. B., & Gagne, G., "Operating System Concepts", 11th Ed., John Wiley & Sons, 2024.
2. Tanenbaum, A. S., & Bos, H., "Modern Operating Systems", 5th Ed., Pearson Education, 2022.
3. Stallings, W., "Operating Systems: Internals and Design Principles", 10th Ed., Pearson Education, 2023.
4. Love, R., "Linux Kernel Development", 3rd Ed., Addison-Wesley Professional, Latest Reprint.
5. Arpaci-Dusseau, R. H., & Arpaci-Dusseau, A. C., "Operating Systems: Three Easy Pieces", Latest Edition, Arpaci-Dusseau Books, 2023.
6. Coulouris, G., Dollimore, J., Kindberg, T., & Blair, ., **Distributed Systems: Concepts and Design"**, **6th Ed.**, Pearson Education, 2024

Note: Only latest editions of the books are recommended

Web links:

1. Ubuntu Linux (Latest LTS): Ubuntu Downloads *(Last visited: July 2026)*
2. VirtualBox: Oracle VirtualBox *(Last visited: July 2026)*
3. Docker Documentation: Docker Documentation *(Last visited: July 2026)*
4. Kubernetes Documentation: Kubernetes Documentation *(Last visited: July 2026)*
5. Linux Kernel Documentation: Linux Kernel Documentation *(Last visited: July 2026)*
6. GNU GCC Compiler: GNU Compiler Collection (GCC) *(Last visited: July 2026)*
7. Git: Git SCM *(Last visited: July 2026)*
8. Visual Studio Code: Visual Studio Code *(Last visited: July 2026)*

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70%

Assessment Tools:

Assignment/
Tutorials
Sessional
tests
Surprise questions during lectures/Class Performance
Term end examination

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PO-CO statement	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PS O2
O6.0CA1 08C01H.1	3	2	1	2									3	2
O6.0CA1 08C01H.2	2	3	3	2	2								3	3
O6.0CA1 08C01H.3	2	2	3	3	3		2						3	3
O6.0CA1 08C01H.4	2	3	2	3	3	2	3	3	2		2	2	3	3
O6.0CA1 08C01H.5	2	3	3	2	2		2	3	3	2	2		2	2

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O6.0CA109C01H: ADVANCED DBMS

Credits:3 Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs End Semester Examination: 70

Pre-Requisite: Fundamentals of DBMS
Course Type: Core

Course Outcomes
O6.0CA109C01H.1: Understand the fundamental concepts, architectures, and principles of advanced database systems.
O6.0CA109C01H.2: Apply database design principles and programming techniques to develop efficient database solutions.
O6.0CA109C01H.3: Analyze database management techniques to ensure efficient, scalable, and reliable data processing and its management.
O6.0CA109C01H.4: Evaluate database solutions based on performance, security, reliability, and emerging technological requirements.
O6.0CA109C01H.5: Design and develop database applications using appropriate database technologies to address real-world problems.

UNIT 1: Database Modeling and Data Architecture
1.1 Conceptual, Logical, and Physical Data Models
1.2 Entity-Relationship (ER) Modeling
1.3 Enhanced ER (EER) Model
1.4 Mapping ER Models to Relational Schemas
1.5 Database Design Methodology
1.6 Data Integrity and Constraints

UNIT 2: Database Design and Optimization
2.1 Functional Dependencies
2.2 BCNF, 4NF, 5NF
2.3 Denormalization
2.4 Indexing Techniques
2.5 Query Optimization
2.6 Execution Plans
2.7 Materialized Views
2.8 Partitioning

UNIT 3: Transaction Processing and Concurrency
3.1 Transaction Management
3.2 ACID Properties
3.3 Serializability
3.4. Deadlock Detection and Prevention
3.5. Locking Protocols
3.6. Timestamp Protocol
3.7. Optimistic Concurrency Control

UNIT 4: Distributed and NoSQL Databases
4.1. Distributed Database Architecture
4.2. Fragmentation
4.3. Replication
4.4. CAP Theorem
4.5. Key-Value Databases
4.6. Document Databases
4.7. Column Family Databases
4.8. Graph Databases

UNIT 5: Database Security and Recovery

5.1. Authentication
5.2. Authorization
5.3. Role-Based Access Control
5.4. SQL Injection
5.5. Encryption
5.6. Backup Strategies
5.7. Log-based Recovery
5.8. Shadow Paging

UNIT 6: Emerging Trends in Databases

6.1. Cloud Databases
6.2. DBaaS
6.3. Big Data Databases
6.4. Data Warehousing
6.5. Data Lakes
6.6. AI in Database Optimization
6.7. Blockchain Databases

List of Experiments

BEGINNER LEVEL (NSQF LEVEL: 1–3)

S. No.	Name of the Program	Bloom Level with Cognitive Process / Course Outcome
1	Install and configure **MySQL/PostgreSQL**. Create a database and explore the DBMS interface.	**Apply (Database Installation & Configuration) / L3 CO1**
2	Write advanced SQL queries using **JOIN, GROUP BY, HAVING, ORDER BY, LIMIT, DISTINCT** clauses on a sample database.	**Apply (Advanced SQL Queries) / L3 CO2**
3	Implement **Nested Queries** and **Correlated Queries** using employee and student databases.	**Apply (Nested & Correlated Queries) / L3 CO2**
4	Create and use **Views** and **Indexes** to improve data retrieval performance.	**Apply (Views & Indexing) / L3 CO1**
5	Implement **Aggregate Functions** and **Window Functions** (RANK, DENSE_RANK, ROW_NUMBER, LEAD, LAG).	**Apply (SQL Analytical Functions) / L3 CO2**
6	Develop User Defined Functions (UDFs) for customized database operations.	**Apply (User Defined Functions) / L3 CO2**

Intermediate Level (NSQF 4–6)

S. No.	Name of the Program	Bloom Level with Cognitive Process / Course Outcome
7	Develop **Stored Procedures** to automate database operations.	**Analyze (Stored Procedures) / L4 CO2**
8	Create **Database Triggers** for INSERT, UPDATE, and DELETE operations.	**Analyze (Database Triggers) / L4 CO2**
9	Perform **Transactions**, **COMMIT**, **ROLLBACK**, and **SAVEPOINT** operations.	**Analyze (Transaction Management) / L4 CO4**
10	Demonstrate **Concurrency Control** using locking mechanisms and transaction isolation levels.	**Analyze (Concurrency Control) / L4 CO4**
11	Optimize SQL queries using **EXPLAIN PLAN** and compare execution costs before and after optimization.	**Analyze (Query Optimization) / L4 CO1**
12	Implement Normalization (3NF/BCNF) and Functional Dependency analysis using sample databases.	**Analyze (Database Normalization) / L4 CO1**

ADVANCED LEVEL (NSQF LEVEL: 7–10)

S. No.	Name of the Program	Bloom Level with Cognitive Process / Course Outcome	Programs Mapped with Ability Enhancement Courses
13	Implement **Database Backup and Recovery** using full, incremental, and log-based backup techniques.	**Evaluate (Backup & Recovery) / L5 CO4**	**SDG**
14	Configure **Database Security**, create users, roles, privileges, and implement Role-Based Access Control (RBAC).	**Evaluate (Database Security) / L5 CO4**	**SDG**
15	Implement Advanced Indexing techniques and analyze their impact on query performance.	**Create (Advanced Indexing Techniques) / L6 CO1**	**SDG**
16	Develop a **Mini Database Application** integrating SQL (integrate MongoDB if required) for data storage, retrieval, and reporting.	**Create (**Database Application Development**) / L6 CO1, CO2, CO3, CO4**	**SDG**

Suggested Readings

1. Silberschatz, Korth & Sudarshan – Database System Concepts.
2. Elmasri & Navathe – Fundamentals of Database Systems.
3. Ramakrishnan & Gehrke – Database Management Systems.
4. C.J. Date – An Introduction to Database Systems.
5. Pramod Sadalage & Martin Fowler – NoSQL Distilled.
6. Martin Kleppmann – Designing Data-Intensive Applications.

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

The evaluation will include two types of assessments:
(i) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%

Subjective (Short/Long) 40%
Discussion/Presentation
15% Projects/Group
Activities etc. 15%
(ii) For Summative assessment (End Semester Examination or End-Term Examination):
Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30% Short/Long Questions: 70%

Assessment Tools:

Assignment/Tu
torials
Sessional tests
Surprise questions during lectures/Class
Performance Term end examination

COURSE ARTICULATION MATRIX:

PO-CO statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2
O6.0CA109C01H.1	3	3	2	2	3	-	1	-	-	-	-	1	3	2
O6.0CA109C01H.2	3	2	3	2	3	-	1	-	1	-	1	2	3	3
O6.0CA109C01H.3	2	3	3	3	2	-	2	1	1	1	1	2	2	3
O6.0CA109C01H.4	3	2	3	2	3	2	1	1	1	1	-	-	2	2
O6.0CA109C01H.5	2	3	2	3	3	3	2	1	1	2	1	1	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
(Deemed to be a University under section 3 of the UGC Act 1956)

O6.0CA110C01: PYTHON PROGRAMMING FOR INTELLIGENT SYSTEMS

Credits: 1 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: NA | **Course Type:** Core

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

O6.0CA110C01.1: Understand the fundamental concepts, syntax, and programming constructs of Python.
O6.0CA110C01.2: Apply Python programming techniques to develop solutions for computational and data processing problems.
O6.0CA110C01.3: Analyze programming problems and implement efficient solutions using appropriate Python libraries, data structures, and algorithms.
O6.0CA110C01.4: Evaluate Python-based solutions for correctness, efficiency, modularity, and usability.
O6.0CA110C01.5: Design and develop intelligent Python applications to solve real-world problems using suitable tools and libraries.

UNIT 1: Fundamentals of Python with Operators & Data Types
1.1 Need of Python Programming
1.2 Installation and Working with Python
1.3 Variables, Data Types & Keywords
1.4 Input-Output, Indentation and comments
1.5 Python basic Operators
1.6 Declaring and using Numeric data types: int, float, complex
1.7 Using string data type and string operations
1.8 Defining list and list slicing
1.9 Use of Tuple data type
1.10 Introduction to Dictionaries

UNIT 2: Python Program Flow Control
2.1 Conditional blocks using if, else and Nested If-else
2.2 Simple For loops in python
2.3 For loop using ranges, string, list and dictionaries
2.4 Use of while loops in python
2.5 Loop manipulation using pass, continue, break and else
2.6 Programming using Python conditional and loops block

Unit 3: Python Strings, List and Dictionary Manipulations
3.1 Building blocks of python programs
3.2 Understanding string inbuilt methods
3.3 List manipulation using inbuilt methods
3.4 Tuple manipulation using inbuilt methods
3.5 Dictionary manipulation
3.6 Programming using string, list and dictionary in build functions
3.7 Introducing the Chaotic Balls Animation

UNIT 4: Python Functions, Modules & Packages

4.1 Organizing Python codes using functions
4.2 Organizing Python Projects into modules
4.3 Importing own module as well as external modules
4.4 Understanding Packages
4.5 Powerful Lambda function in python
4.6 Programming using functions, modules and external packages
4.7 Case Study on identifying the replicated data

UNIT 5: Exception Handling & File Handling

5.1 Basics of Exception
5.2 Exception Handling
5.3 Try, Finally & Except clause
5.4 Multiple Except Blocks
5.5 Built-in & User-Defined Exceptions
5.6 Safeguarding file operation using exception handling
5.7 Handling and helping developers with error code
5.8 Opening & Closing Files
5.9 Understanding read functions, read (), readline() and readlines()
5.10 Understanding write functions, write () and writelines()
5.11 File Positions & Directory Methods
5.12 Case Study in Neural Data Analysis

UNIT 6: Graphical User Interfaces

6.1 Behavior of terminal-based programs and GUI-based programs
6.2 Coding simple GUI-based programs & other useful GUI resources.
6.3 Using the Tkinter Module
6.4 Display text with Label Widgets
6.5 Organizing Widgets with Frames
6.6 Button Widgets and Info Dialog Boxes
6.7 Getting Input with Entry Widget & Using Labels as Output Fields
6.8 Radio Buttons, Check Buttons.
6.9 Simple Graphics and Image Processing: Overview of Turtle Graphics
6.10 Two-dimensional Shapes, Colors and RBG System, Image Processing.
6.11 How to automate the life cycle of any project using AutoML tools
6.12 Case Study on Fake News Detection
6.13 Case study on time series forecasting models to predict sales of a product

List of Experiments:

BEGINNER LEVEL

S.No.	Name of the Program	Bloom Level with Cognitive Process
1.	Write a program to perform various operations in the list: - Insertion - Deletion Display	Apply (Using basic list operations)/ L3
2	Write a program to find the arithmetic operations on matrices: - Sum and Subtraction - Product of 2 matrices Transpose of a matrix	Apply (Performing arithmetic operations on matrices)/ L3
3	Write a Program to sort the list using: - Bubble Sort - Quick Sort - Insertion sort	Apply (Sorting algorithm) / L3

	- Merge Sort - Heap Sort Also, find the comparison on the basis of time complexity.	
4	Write a program to search the element using: - Linear Search - Binary Search Also, find the comparison on the basis of time complexity.	Apply (Basic search algorithm) / L3
5	Write a program to perform all operations: - For the Stack using an Array. - For the Queue using an Array. For the Circular Queue using an Array.	Apply (Array manipulation, stack & queue operations) / L3
6	Write a program to evaluate the Postfix Notation.	Apply (Expression evaluation) / L3
7	Write a program to convert infix notation into Postfix Notation.	Apply (Expression conversion) / L3

INTERMEDIATE LEVEL

S.No.	Name of the Program	Bloom Level with Cognitive Process
9	Write a program to perform the operations of the Circular linked list: - Insertion - Deletion Display	Apply (Circular linked list) / L3
10	Write a program to perform all operations: - For Stack using Linked List. - For Queue using Linked List For Circular Queue using Linked List	Apply (Linked list manipulation)/ L3
11	Write a program to perform concatenation of two linked lists.	Apply (Linked list manipulation)/ L3
12	Write a program to perform the operations of the Double linked list: - Insertion,Deletion,Display	
13	Write a program to perform tree traversal methods.	Apply (Binary tree traversal) / L3
14	Write a program to perform insertion and deletion in the Binary Search Tree.	Apply (Binary Search Tree operations) / L3
15	Write a program to represent an undirected graph using the adjacency matrix to implement the graph and perform the operations with menu-driven options for the following tasks: 1. Create graph 2. Insert an edge 3. Print Adjacency Matrix 4. List all vertices that are adjacent to a specified vertex. 6. Exit program	Analyse (Graph operations, adjacency matrix) / L4

ADVANCED LEVEL

S.No.	Name of the Program	Bloom Level with Cognitive Process	Programs Mapped with Ability Enhancement Courses
17	Create charts using Matplotlib.	Apply (L3)	AI & Data Science
18	Perform file automation using the OS module.	Apply (L3)	DevOPS
19	Develop a menu-driven Python application.	Apply (L3)	Software Development
20	Create a Real-Time Data Visualization Dashboard using live datasets.	Create (Dashboard Development) / L6	AI & Data Science
21	System that identifies and classifies common suffixes in Sanskrit words, which is essential for understanding word formation and grammar.	Analyse (Linked list operation) / L4	IKS

Suggested Readings:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 3rd Edition, O'Reilly Media, 2024.
2. Charles Dierbach, Introduction to Computer Science Using Python: A Computational Problem-Solving Focus, 2nd Edition, Wiley, 2020.
3. Wesley J. Chun, Core Python Applications Programming, 3rd Edition, Pearson Education, 2015.
4. Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser, Data Structures and Algorithms in Python, 2nd Edition, Wiley, 2024.
5. Reema Thareja, Python Programming: Using Problem Solving Approach, 2nd Edition, Oxford University Press, 2023.
6. Charles R. Severance, Python for Everybody: Exploring Data Using Python 3, Updated Edition, Shroff Publishers/O'Reilly, 2023.Note: Only the latest editions of the books are recommended.

Software required/ Web links:

1. Python Official Documentation
2. Python Package Index (PyPI)
3. NumPy Documentation
4. Pandas Documentation
5. Matplotlib Documentation
6. Tkinter Documentation (Python Docs)
7. Requests Library Documentation
8. Beautiful Soup Documentation
9. SQLite Documentation
10. Real Python Tutorials

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Evaluation Policy:

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(iii) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

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MCQs 30%
Subjective (Short/Long) 40%

Discussion/Presentation 15%
Projects/Group Activities etc. 15%
(iv) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30%
Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA110C01.1	3	2	1	-	2	-	2	-	-	-	-	-	2	3
O6.0CA110C01.2	3	3	2	-	2	-	2	-	-	-	-	-	2	3
O6.0CA110C01.3	2	3	3	1	3	-	2	1	1	-	1	1	3	3
O6.0CA110C01.4	2	3	3	2	3	1	2	-	-	-	-	-	3	3
O6.0CA110C01.5	2	3	3	2	3	1	2	1	1	1	1	2	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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O6.0CA100C05: RESEARCH INNOVATION CATALYST-I

Credits: 0.5

Max. Marks: 100
Continuous Evaluation: 100
End Semester Examination: NA

Pre-Requisites: Basic Knowledge of Research and Innovation

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

O6.0CA100C05.1**:** Understand the fundamental concepts, principles, ethics, and processes of research and innovation.

O6.0CA100C05.2**:** Apply appropriate research methodologies, literature review techniques, and scholarly resources to investigate research problems.

O6.0CA100C05.3**:** Analyse research problems, experimental findings, and data to derive meaningful interpretations and conclusions.

O6.0CA100C05.4**:** Evaluate research outcomes using appropriate validation techniques, ethical practices, and quality standards.

O6.0CA100C05.**5:** Prepare and present research documents by applying scientific writing, citation practices, and effective communication skills.

Unit 1: Fundamentals of Research and Innovation

1.1 Introduction to Research and Innovation: Concepts, Types, and Importance
1.2 Emerging Research and Innovation Trends
1.3 Motivation, Ethics, and Best Practices in Research (Do's and Don'ts)
1.4 Identifying Research Problem, gaps & Framing Research Questions

Unit 2: Scientific Literature Review and Research Resources

2.1 Literature Survey: Purpose, Understanding & Organization of Literature
2.2 Searching Research Literature using Scholarly Databases like Google Scholar, Web of Science, Scopus, PubMed, ABDC, EBSCO etc
2.3 Scholarly Networking Platforms: ResearchGate, Mendeley, Academia.edu
2.4 Identifying Research Gaps through Literature Review

Unit 3: Research Methodology and Experimental Design

3.1 Research Methodologies: Qualitative, Quantitative & Mixed Methods
3.2 Hypothesis Formulation and Research Objectives
3.3 Research & Experimental Design, Simulation, and Case Study Planning
3.4 Procurement of Materials, Datasets, and Resources

Unit 4: Data Collection, Analysis, and Interpretation

4.1 Execution/Implementation via requisite method
4.2 Data Recording, and Tabulation
4.3 Conducting Experiments, Simulations, and Case Studies
4.4 Prototype Development (where applicable)
4.5 Data Analysis and Interpretation
4.6 Validation of Results and Hypothesis Testing
4.7 Comparative Analysis, Conclusions, and Identification of Future Research Scope

Unit 5: Scientific Writing and Research Documentation

5.1 Scientific and Technical Writing
5.2 Citation Practices and Plagiarism
5.3 Journals & Conferences -Types, Indexing & Quality Metrics
5.4 Referencing Styles and Bibliography Management Tools (APA, IEEE, MLA, Zotero)

Unit 6: Report Writing, and Research Presentation

6.1 Preparation of Research Reports
6.2 Compilation and Critical Analysis of researched Work
6.3 Presentation Preparation using MS PowerPoint and Other Tools
6.4 Final Research Documentation

References:

1. http://nptel.ac.in/courses/121106007/
2. Preview: Research, Innovation and Social Relevance | SWAYAM

Course Articulation Matrix:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
O6.0CA100C05.1	3	2	–	–	–	–	–	3	–	1	–	2
O6.0CA100C05.2	2	3	–	2	2	–	–	1	–	–	–	2
O6.0CA100C05.3	2	3	3	3	2	–	–	1	–	–	1	2
O6.0CA100C05.4	2	3	2	3	3	–	–	1	–	1	–	2
O6.0CA100C05.5	1	2	–	–	2	–	–	3	–	3	–	2
O6.0CA100C05.6												

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O6.0CDC196C05: Placement Competency Enhancement-I

Credits: 1	Max. Marks: 100
	Continuous Evaluation: 30
Duration of Examination: 3 Hrs	End Semester Examination: 70

Course Outcomes: The students will be able to:
O6.0CDC196C05.1: Enhance their reading and writing skills and accurately construct simple and complex sentences.
O6.0CDC196C05.2: Enhance their personal effectiveness and become proficient in acing interviews.
O6.0CDC196C05.3: Solve problems based on verbal reasoning
O6.0CDC196C05.4: Solve problems based on number system, Percentage, Profit, Ratio, Time, Speed Distance
O6.0CDC196C05.5: Apply advanced problem-solving techniques encompassing algorithms, arrays, searching, sorting, strings, recursion, OOP, and bit manipulation to solve complex programming challenges effectively.
O6.0CDC196C05.6: Demonstrate competence in integrating algorithmic thinking and Object-Oriented Programming principles to develop solutions for real-world problems.

PART – A (VERBAL ABILITY)

Unit 1: Communication Accuracy

1.1 Relevance of Verbal Ability and Preparatory Guidelines
1.2 Functional Grammar – Subject Verb Agreement
1.3 Tenses – Perfect, Simple, Continuous
1.4 Common Errors and rectification, Idioms and Phrases
1.5 Word Power Building Skills - Root word technique, antonyms, synonyms, verbal analogies

Unit 2: Reading & Writing Skills

2.1 Objectives of Reading, Definition & Types of Reading & Importance of Reading
2.2 Reading Techniques: SQ3R, Active Reading, Detailed, Speed Reading
2.3 Practice Exercises: Short & Medium Passages
2.4 Sentences, Phrases, Types of Sentences, Parts of Sentences
2.5 Paragraph Writing: Construction, Linkage & Cohesion
2.6 Email writing using given phrases

PART – B (INTERVIEW ENHANCEMENT)

Unit 3: Personal Effectiveness

1.1 Communication Enhancement
1.2 Teamwork, Leadership & Entrepreneurship Skills
1.3 Time Management
1.4 Design Thinking
1.5 Managing Personal Finance

Unit 4: Interview Preparation-1

4.1. Developing the employability mindset and Researching the employer
4.2. Preparing for Self -Introduction
4.3. Drafting Cover letters / Emails
4.4. Dressing Do's & Don'ts
4.5 Group Discussion

PART – C (APTITUDE)

Unit 5: Arithmetic

5.1 Numbers
5.2 Percentages
5.3 Profit and Loss
5.4 Simple Interest & Compound Interest
5.5 Ratio & Proportion
5.6 Partnership
5.7 Time Speed & Distance

Unit 6: Reasoning

6.1 Blood Relation
6.2 Coding Decoding
6.3 Direction Sense

PART – D

Unit 7: Problem Solving

7.1. Mathematical Algorithm: Foundational problems (Factorial, HCF, GCD, LCM), Prime Number & Factorization, Sieve Algorithm.
7.2. Advance Patterns (based on Loops, Conditional statement)

Unit 8: Array

8.1. Array 1D & 2D: Static, Dynamic size, Kadane's algorithm
8.2. 2-pointer approach (same direction with same pace, same direction with different pace, and opposite direction)
8.3. Sliding window technique

Unit 9: Searching & Sorting

9.1 Linear, Binary Search (iterative and recursive),
9.2. Problem-solving using various sorting algorithms

Unit 10: Strings

10.1. String ASCII codes, Anagram, Substring & Subsequence
10.2. Pattern searching (Naive Algorithm, KMP Algorithm, Z algorithm, Boyer Moore Algorithm)
10.3. Rabin Karp Algorithm

Unit 11: Recursion

11.1. Boundary/Corner base case condition, Tail recursion
11.2. Recursion using arrays and strings

Unit 12: OOPS & Bit Manipulation

12.1. Class, objects, Constructors, Static members, Function overloading and related concepts, Abstraction, Encapsulation, Inheritance, Polymorphism
12.2. Bit Manipulation and Bitmasking

Recommended Texts and Readings:

1. Aggarwal, R. S. (2018). Quantitative aptitude for competitive exams (7th ed.). S. Chand & Company Pvt. Ltd.
2. Sharma, A. (2014). How to prepare for logical reasoning for CAT (4th ed.). Tata McGraw Hill Education.
3. Wren, P. C., & Martin, H. (2017). High school English grammar and composition (Revised ed.). S. Chand & Company Pvt. Ltd.
4. Lewis, N. (2015). Word power made easy (1st ed.). Penguin Random House Pvt. Ltd.
5. Prasoon, S. Group discussion
6. Reed, J. (2017). Why you? 101 interview questions you'll never fear again (1st ed.). Penguin Books.
7. Karumanchi, N. (2016). Data structures and algorithms made easy (5th ed.). CareerMonk Publications.

8. https://www.forbes.com/sites/bernardmarr/2022/07/26/10-most-important-leadership-skills-for-the-21st- century-workplace-and-how-to-develop-them/?sh=70b7ec254de6 (Last accessed - May 17, 2024)

Evaluation Policy:

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MCQs 30%
Subjective (Short/Long) 40%
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Objective Type Questions: 30%
Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Course Articulation Matrix:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CDC196C05.1	2	-	-	-	-	-	-	-	2	-	-	-	2	-
O6.0CDC196C05.2	-	-	-	-	-	3	3	-	-	-	-	-	3	3
O6.0CDC196C05.3	-	2	-	-	-	-	-	-	-	-	-	-	2	-
O6.0CDC196C05.4	-	2	-	-	-	-	-	-	-	-	-	-	2	-
O6.0CDC196C05.5	-	3	3	-	2	1	-	-	-	-	-	2	-	2
O6.0CDC196C05.6	-	3	3	-	-	1	-	-	-	-	2	2	-	2

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O6.0CA102C09A: Fundamentals of Computer Systems

Credits: Audit pass	Max. Marks: 100
	Continuous Evaluation: 30
Duration of Examination: 3 Hrs	End Semester Examination: 70

Pre-Requisite: None
Course Type: Audit Pass

Course Outcomes: At the end of the course, students will be able to:
O6.0CA102C09A.1 Understand the structured programming designs and the basic elements of Computer Programming.
O6.0CA102C09A.2 Describe and differentiate various types of Open Source Software.
O6.0CA102C09A .3. Construct program code using simple and nested selection/decision control structure to make decision.
O6.0CA102C09A .4 Use pre& post tested loop/repetitive control structure while writing program code to process same sequence of tasks/activities.
O6.0CA102C09A .5. Apply various open source tools for improving development efficiency.

UNIT 1: Introduction to Programming
- 1.1 History of Programming,
- 1.2 Difference b/w Programming Languages
- 1.3 System Development Life Cycle
- 1.4 Introduction to OOP
- 1.5 Introduction to Python : Installation, Python IDE
- 1.6 Syntax Rules and Basic Program
- 1.7 Numbers and Math Functions

UNIT 2:Programming Standards
- 2.1 Flow Chart
- 2.2 Pseudo Code and Hierarchy Chart
- 2.3 Syntax Errors
- 2.4 Logical Errors and Runtime Errors
- 2.5 Detailed Working of a Compiler
- 2.6 Difference Between Compiler and Interpreter.

UNIT 3: Programming Controls
- 3.1 Controls and Properties
- 3.2 Variables and Arithmetic Operations
- 3.3 Writing Program that Handle a Control Events
- 3.4 Strings
- 3.5 Data type conversions
- 3.6 Built –in functions

UNIT 4: Introduction to Open Source
- 4.1. Why open source, What is Open Source, Open Source Principles
- 4.2. Software License provider, Free Software Vs Open Source Software
- 4.3. Open Source Standards, Methodologies, Philosophy
- 4.4. Case Studies: Apache, Linux ,Mozilla Firefox

UNIT 5: Open Source Programming Languages

5.1. Various Open Source Programming Languages.
5.2. Programming Language Case Study: Python, Java, PHP
5.3. Open Source vs Closed Source Programming.
5.4. Server Side vs Client Side Programming.
5.5. Front-End and Back-End

UNIT 6: Open Source Programming Tools

6.1. Starting and Maintaining an Open Source Project
6.2. Open Source Ethics.
6.3. Open Source IDE's and Editors (Eclipse, Atom, Sublime Text).
6.4. Source Code Management (Git)
6.5. Open Source Project Repositories(GitHub, SourceForge, Google Code etc.)

Suggested Readings:

1. E. Balaguruswami, 2016, Programming in ANSI 'C', Tata McGraw- Hill, 7th Edition
2. Ashok Kamthane, 2006, Programming with ANSI and TURBO C, Pearson
3. Karl Fogel, 2005, Producing Open Source Software, Oreilly Media
4. Mark Pilgrim, 2004, Dive into Python, Apress Publications

Note: Only latest editions of the books are recommended.

Software required/ Web links:

Turbo C
Python 3.x
https://www.tutorialspoint.com/cprogramming/index.htm (last visited date: 2[illegible] February 2024)
https://www.cprogramming.com/tutorial/c-tutorial.html (last visited date: [illegible] February 2024)

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA102C09A.1	1				2	1	3	2	1	-			2	1
O6.0CA102C09A.2		3	2	1			3			3		1		3
O6.0CA102C09A.3	1	3	2	2	2				1				2	1
O6.0CA102C09A.4	2	1		1	2							1	2	2
O6.0CA102C09A.5	1	1	2		2	1				2			2	2

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O6.0CA101C09A : ELEMENTS OF MATHEMATICS

Credits: Audit pass | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: None
Course Type: Audit pass

Course Outcomes: At the end of the course the student will be able to:
O6.0CA101C09A.1: Explain the fundamental concepts of sets, relations, functions, and algebraic structures used in mathematical problem-solving.
O6.0CA101C09A.2: Apply principles of set theory, relations, functions, and counting techniques to solve mathematical and computational problems.
O6.0CA101C09A.3: Solve problems involving the Binomial Theorem, permutations, combinations, and coordinate geometry using appropriate mathematical methods.
O6.0CA101C09A.4: Analyze basic algebraic structures, including groups, rings, and fields, and interpret their applications in computing and discrete mathematics.
O6.0CA101C09A.5: Apply mathematical concepts and analytical reasoning to model and solve real-world and computing-related problems.

UNIT 1: Set Theory
1.1 Concepts of Sets
1.2 Method of Representation
1.3 Types of Sets
1.4 Venn Diagram
1.5 Set Operations
1.6 Partitioning of a set
1.7 Application of Set Theory

UNIT 2: Relation and Function
2.1 Definition of Relation
2.2 Application of relation
2.3 Definition of function
2.4 Cartesian product
2.5 Concepts of Domain, Co-Domain and Range
2.6 Application of Relations and Functions

UNIT 3: Binomial Theorem
3.1 Basics of Binomial theorem
3.2 Binomial Coefficients
3.3 Middle Terms
3.4 Absolute Term
3.5 Applications of binomial theorem (positive index)

UNIT 4: Principle of Counting
4.1 Principle of Mathematical Induction
4.2 Permutations
4.3 Application of Permutations
4.4 Combinations
4.5 Application of Combinations

UNIT 5: Co-ordinate Geometry
5.1 Quadrant Planes

5.2 Distance Formula
5.3 Section Formula
5.4 Bisection Formula,
5.5 Slope of Line
5.6 Equations of straight Line
5.7 Angle between two lines.

UNIT 6: Basics of Algebraic Structures
6.1 Concepts of Algebraic Structures
6.2 Groups
6.3 Types of Groups
6.4 Rings
6.5 Field
6.6 Application of Algebraic Structures

Suggested Readings:

1. Erwin Kreyszig, Advanced Engineering Mathematics (2025) Wiley,(latest edition).
2. Discrete Mathematics and Its Applications — Kenneth H. Rosen, 9th Edition (2023), McGraw-Hill.
3. Higher Algebra — S. Hall and S. R. Knight, Revised Edition (2023 Reprint), Arihant Publications.
4. Advanced Engineering Mathematics — Erwin Kreyszig, 11th Edition (2019),

Note: Only latest editions of the books are recommended.

Evaluation Policy:

The evaluation will include two types of assessments:
(vii) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is:
MCQs 30%
Subjective (Short/Long) 40%
Discussion/Presentation 15% Projects/Group Activities etc. 15%
(viii) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type
Questions: 30%
Short/Long
Questions: 70%

Assessment Tools:

Assignment/Tutorials Sessional tests
Surprise questions during
lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PS O1	PSO2
O6.0CA101C09 A.1	1		1	2	2		3						3	1
O6.0CA101C09 A.2	1	1	2	3	1		2						3	1
O6.0CA101C09 A.3	1	2	2	1	2								2	1
O6.0CA101C09 A.4	1	1	2	1	1		3						1	2
O6.0CA101C09 A.5	1	1	2	1			2	3					2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
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O6.0CA131E02H:GENERATIVE AI AND AGENTIC AI

Credits:3 Max. Marks: 200
Continuous Evaluation: 120
Duration of Examination: 3 Hrs End Semester Examination: 80

Pre-Requisite: NA
Course Type: Domain Elective

Course Outcomes: At the end of the course, students will be able to:
O6.0CA131E02H.1: Understand the concepts, architectures, and foundationa l principles of Generative AI, Large Language Models (LLMs), and Agentic AI.
O6.0CA131E02H.2: Apply generative AI techniques, prompting strategies, retrieval methods, and foundation models to develop intelligent AI applications.
O6.0CA131E02H.3: Analyze agentic AI architectures, autonomous workflows, reasoning mechanisms, and multi-agent systems for solving complex tasks.
O6.0CA131E02H.4: Evaluate generative and agentic AI systems based on performance, reliability, safety, ethics, privacy, and responsible AI principles.
O6.0CA131E02H.5: Design and develop intelligent AI solutions using generative AI, agentic AI frameworks, and modern AI tools to address real-world problems.

UNIT 1: Introduction to Generative AI
1.1 Basics of Artificial Intelligence, Machine Learning, Deep Learning, and Generative AI.
1.2 Traditional AI vs Generative AI
1.3 Journey from Simple Language Models to Modern Foundation Models
1.4 Tokens, Embeddings, Context Window, and How AI Generates Answers.
1.5 Types of Generative AI: Text, Images, Code, Audio, and Video.
1.6 Real-Life Applications of Generative AI in Education, Healthcare, Finance, Business, and Software Development

UNIT 2: Large Language Models and Prompting
2.1 Introduction to neural networks, attention, and transformers
2.2 How large language models work in an intuitive way
2.3 Prompt engineering: zero-shot, one-shot, few-shot, chain-of-thought style prompting
2.4 Structured outputs, prompt templates, and prompt testing
2.5 Hallucination, grounding, and response quality issues
2.6 Evaluation basics for generated responses

UNIT 3: Building Generative AI Applications
3.1 API-based use of foundation models
3.2 Embeddings and semantic search
3.3 Retrieval-Augmented Generation (RAG)
3.4 Fine-tuning, instruction tuning, and when not to fine-tune
3.5 Building chatbots, question-answering systems, content generation tools, and coding assistants
3.6 Introduction to open-source models and model selection

UNIT 4: Foundations of Agentic AI
4.1 What is agentic AI and how it differs from a chatbot
4.2 Core components of an AI agent: goals, memory, planning, reasoning, action, and feedback
4.3 Tool calling and function calling
4.4 ReAct-style reasoning, task decomposition, and planning loops
4.5 Single-agent and multi-agent systems
4.6 Human-in-the-loop and approval-based workflows

UNIT 5: Designing and Deploying Agentic Systems
5.1 Agent workflows for research, coding, customer support, and data analysis

5.2 Agent frameworks and orchestration concepts
5.3 Agent memory, state management, and context handling
5.4 Guardrails, observability, logging, and monitoring
5.5 Reliability, evaluation, and failure handling in agentic systems
5.6 Deployment considerations: latency, cost, privacy, and security

UNIT 6: Responsible AI, Case Studies, and Future Trends
6.1 Bias, fairness, safety, and explainability in generative and agentic AI
6.2 Copyright, privacy, data protection, and academic integrity
6.3 Risks of autonomous action and unsafe tool execution
6.4 Case studies of enterprise assistants, coding copilots, tutoring systems, and research assistants
6.5 Emerging trends: multimodal agents, agentic RAG, autonomous workflows, and personalized AI systems
6.6 Limits of current systems and future research directions

Suggested Readings
1. Goodfellow, Bengio, and Courville, *Deep Learning*, MIT Press.
2. Jurafsky and Martin, *Speech and Language Processing*, latest edition.
3. Russell and Norvig, *Artificial Intelligence: A Modern Approach*, latest edition.
4. Anthropic, OpenAI, Google, and other major model-provider technical documentation on prompting, safety, and tool use.

Note: Only latest editions of the books and current platform documentation are recommended.

List of Experiments
BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Explore popular generative AI tools and compare outputs for the same prompt.	Understand (Tool Familiarization) / L2
2	Write and test zero-shot, one-shot, and few-shot prompts for text generation.	Apply (Prompt Engineering) / L3
3	Generate structured outputs such as tables, JSON, and summaries from prompts.	Apply (Structured Generation) / L3
4	Create embeddings for small text documents and perform semantic similarity search.	Apply (Embeddings) / L3
5	Build a simple FAQ chatbot using a hosted LLM API.	Apply (LLM Application) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6	Implement a Retrieval-Augmented Generation pipeline over custom documents.	Apply (RAG Pipeline) / L3
7	Compare closed-source and open-source model outputs on quality, cost, and speed.	Analyse (Model Comparison) / L4
8	Build a domain assistant for academic, healthcare, or business use with citations.	Apply (Domain Assistant) / L3
9	Evaluate generated responses using factuality, relevance, and helpfulness criteria.	Analyse (LLM Evaluation) / L4

10	Create a content-generation workflow with prompt templates and safety filters.	Apply (Workflow Design) / L3

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Build a tool-using AI agent for web research or document question answering.	Analyse (Tool Calling Agent) / L4	Employability
12	Implement a planner-executor agent workflow with memory and logging.	Create (Agent Workflow) / L6	Innovation
13	Develop a multi-agent system for collaborative problem solving.	Create (Multi-Agent Design) / L6	Entrepreneurship
14	Add guardrails, human approval, and fallback handling to an autonomous agent.	Evaluate (Responsible Agentic AI) / L5	Ethics and SDG
15	Complete a mini project on a real-world generative or agentic AI use case.	Create (Integrated Project) / L6	SDG

Software required / Web links

- Python, Jupyter Notebook or Google Colab
- Open-source libraries for LLM application development
- Access to one hosted model API and one open-source model environment

Assessment Tools

- Assignment/Tutorials
- Sessional test
- Surprise questions during lectures/Class Performance
- Experiments in lab
- File work/Class Performance
- Viva (Question and answers in lab)
- Term end examination

COURSE ARTICULATION MATRIX

CO statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
0CA131E02H.1	3	2	1	1	2	1	1	1	1	1	1	1	3	2
0CA131E02H.2	3	3	2	2	3	1	1	1	2	2	1	1	3	3
0CA131E02H.3	3	3	3	2	3	2	1	1	2	2	1	1	3	3
0CA131E02H.4	3	2	3	3	2	2	1	2	2	2	1	1	3	3
0CA131E02H.5	3	3	3	3	3	2	2	2	2	2	1	1	3	3

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O6.0CA132E02H:SOCIAL NETWORK ANALYTICS

Credits: 3 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: NA
Course Type: Domain Elective

Course Outcomes: At the end of the course, students will be able to
O6.0CA132E02H.1: Understand the concepts, graph-theoretic foundations, and structural properties of social networks.
O6.0CA132E02H.2: Apply network analysis techniques and analytical tools to model, visualize, and analyze social network data.
O6.0CA132E02H.3: Analyze network structures, centrality measures, communities, and network evolution to derive meaningful insights.
O6.0CA132E02H.4: Evaluate social network models, information diffusion, link prediction, and real-world applications using appropriate analytical methods.
O6.0CA132E02H.5: Design and develop data-driven solutions for social network analysis using modern tools and techniques to address real-world problems.

UNIT 1: Introduction to Social Networks and Graph Theory
1.1 Introduction to Social Network Analysis (SNA)
1.2 Historical Development and Applications of SNA
1.3 Types of Networks: Directed, Undirected, Weighted and Multiplex Networks
1.4 Basic Graph Theory Concepts: Nodes, Edges and Degree
1.5 Network Representation: Adjacency Matrix and Adjacency List
1.6 Methods of Social Network Data Collection
1.7 Ethical Considerations in Social Network Data Analysis

UNIT 2: Network Measures and Properties
2.1 Density and Diameter of a Network
2.2 Path Length and Distance
2.3 Clustering Coefficient
2.4 Reciprocity and Transitivity
2.5 Small-World Phenomenon
2.6 Scale-Free Networks and Power-Law Degree Distribution
2.7 Random Graph Models (Erdos-Renyi Model)

UNIT 3: Centrality and Prestige Measures
3.1 Degree Centrality
3.2 Closeness Centrality
3.3 Betweenness Centrality
3.4 Eigenvector Centrality
3.5 PageRank Algorithm
3.6 Prestige and Structural Hole Analysis

UNIT 4: Community Detection and Network Structure
4.1 Concept of Community in Networks
4.2 Cliques, Clans and Clubs
4.3 Girvan-Newman Algorithm
4.4 Modularity-Based Community Detection
4.5 Hierarchical Clustering of Networks
4.6 Block Modelling and Structural Equivalence

UNIT 5: Link Prediction and Network Dynamics

5.1 Link Prediction Problem and Applications
5.2 Similarity-Based Methods (Common Neighbours, Jaccard Coefficient, Adamic-Adar)
5.3 Network Evolution Models
5.4 Diffusion and Information Cascades
5.5 Influence Maximization
5.6 Homophily and Assortative Mixing

UNIT 6: Applications and Tools of Social Network Analytics
6.1 Social Network Analytics in Marketing and Recommendation Systems
6.2 Social Network Analytics in Epidemiology and Disease Spread Modelling
6.3 Social Network Analytics in Organisational and Collaboration Networks
6.4 Sentiment Analysis on Social Media Networks
6.5 Overview of Network Analytics Tools
6.6 Case Studies of Real-World Social Networks

Suggested Readings:

1.Wasserman, S. and Faust, K., "Social Network Analysis: Methods and Applications", Cambridge University Press.
2.Easley, D. and Kleinberg, J., "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press.
3.Newman, M.E.J., "Networks: An Introduction", Oxford University Press.
4.Scott, J., "Social Network Analysis: A Handbook", Sage Publications.

Note: Only latest editions of the books are recommended.

List of Experiments:

BEGINNER LEVEL(NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1.	- Introduction to Network Analysis Tools and Libraries - Install and explore NetworkX / Gephi. - Import a sample dataset and visualise a basic graph.	Apply (Using Network Tools)/ L3
2.	Construct a graph using adjacency matrix and adjacency list representations for a given dataset.	Apply (Graph Representation)/ L3
3.	Compute basic network measures: degree, density and diameter of a sample network.	Apply (Network Measures)/ L3
4.	Visualise a social network graph with different layout algorithms.	Apply (Network Visualisation)/ L3
5.	Identify connected components and isolated nodes in a given network dataset.	Apply (Connected Components)/ L3

INTERMEDIATE LEVEL(NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6.	Compute degree, closeness and betweenness centrality for nodes in a real-world network dataset.	Apply (Centrality Measures)/ L3
7.	Implement and analyse the PageRank algorithm on a sample web/social graph.	Apply (PageRank)/ L3
8.	Detect communities in a network using the Girvan-Newman algorithm.	Apply (Community Detection)/ L3
9.	Perform modularity-based community detection	Apply (Modularity Optimisation)/ L3

10.	Analyse the clustering coefficient and transitivity of a given social network.	Apply (Clustering Analysis)/ L3

ADVANCED LEVEL(NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	File Sharing and Similarity-Based Link Prediction - Implement link prediction using similarity-based methods on a dynamic network dataset.	Analyse (Link Prediction)/ L4	SDG
12	Model information diffusion and cascades on a social network graph.	Analyse (Diffusion Modelling)/ L4	SDG
13	Perform sentiment analysis on social media data and map the results onto a network structure.	Analyse (Sentiment & Network Mapping)/ L4	SDG
14	Conduct a case study analysing a real-world large-scale social network using centrality, community detection and visualisation techniques.	Analyse (Comprehensive Network Case Study)/ L4	SDG

Suggested Readings:

1.Hansen, D., Shneiderman, B. and Smith, M.A., "Analyzing Social Media Networks with NodeXL", Morgan Kaufmann.
2.Zafarani, R., Abbasi, M.A. and Liu, H., "Social Media Mining: An Introduction", Cambridge University Press.
3.Kadushin, C., "Understanding Social Networks: Theories, Concepts, and Findings", Oxford University Press.

Note: Only the latest editions of the books are recommended. Software

Software Required:

1. Python with NetworkX and Matplotlib libraries
https://www.python.org/
2. Gephi (open-source network visualisation software)
https://gephi.org/
3. R with the igraph package
https://cran.r-project.org/bin/windows/base/

Assessment Tools:

- Assignment/Tutorials
- Sessional test
- Surprise questions during lectures/Class Performance
- Experiments in lab
- File work/Class Performance
- Viva (Question and answers in lab)
- Term end examination

COURSE ARTICULATION MATRIX:

PO-CO statement	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA132E02H.1		2		1		1	3						2	1
O6.0CA132E02H.2	2	2	2				3			1			3	2
O6.0CA132E02H.3		3		1			2						2	
O6.0CA132E02H.4	2	3			1		2		1		1		1	2
O6.0CA132E02H.5	2	2	1	2	1		3	1		1		1	2	2

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O6.0CA133E02H : CYBER SECURITY

Credits: 2 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: NA
Course Type: Domain Elective

Course Outcomes: At the end of the course, the student will be able to:
O6.0CA133E02H.1: Understand the fundamental concepts, principles, and practices of cybersecurity.
O6.0CA133E02H.2: Apply cybersecurity techniques and tools to identify, prevent, and mitigate security threats.
O6.0CA133E02H.3: Analyze cybersecurity risks, vulnerabilities, and security mechanisms to protect computing systems and networks.
O6.0CA133E02H.4: Evaluate cybersecurity solutions based on security, privacy, risk management, and emerging technological requirements.
O6.0CA133E02H.5: Design and implement secure computing solutions using appropriate cybersecurity technologies and best practices.

UNIT 1: Introduction to cyber security
1.1 Cybersecurity Concepts
1.2 Needs for Security
1.3 Challenges of Securing Information
1.4 Malware, Social Engineering and Other Attacks
1.5 Protecting against Malware Attacks
1.6 Legal, Ethical and Professional Issues in Information Security
1.7 Security Design Principles
1.8 Security Controls
1.9 Introduction to Cryptography
1.10 Cryptographic Techniques
1.11 Digital Signatures
1.12 Public-Key Infrastructure
1.13 Digital Certificates
1.14 Protocols for Secure Communication

UNIT 2: Introduction to Risk Management
2.1 Threats and Vulnerabilities
2.2 Risk Identification
2.3 Risk Assessment
2.4 Risk Control Strategies
2.5 Business Continuity Planning and Strategies
2.6 Information Security Policy, Standards and Practices
2.7 Information Security Frameworks

UNIT 3: Communication and Network Security
3.1 Types of Firewalls
3.2 Firewall Architectures
3.3 Virtual Private Networks (VPNs)
3.4 Types of Intrusion Detection Systems (IDS/IPS)
3.5 Strengths and Limitations of IDPS
3.6 Deployment and Implementation of IDPS
3.7 Honeypots
3.8 Administering a Secure Network

UNIT 4: Application Security
4.1 Web Application Attacks

4.2 Threat Modelling
4.3 Secure Software Development
4.4 Secure Coding Concepts
4.5 Security Assessment and Testing

UNIT 5: Identity and Access Management
5.1 Authentication and Account Management
5.2 Access Control Models
5.3 Trust Frameworks
5.4 Best Practices for Access Control
5.5 Identity and Access Services

UNIT 6: Trends in Cybersecurity
6.1 Cloud Security
6.2 Cloud Security Concepts
6.3 Security Approaches for Cloud Computing Assets
6.4 Cloud Security as a Service
6.5 Enterprise Cloud Security and Governance
6.6 Mobile Security
6.7 Internet of Things (IoT) Security and Privacy Requirements
6.8 An Internet of Things Security Framework
6.9 AI/ML Securit

List of Experiments
BEGINNER LEVEL

S. No.	Name of the Program	Bloom Level with Cognitive Process
1	Study and identify common cybersecurity threats, vulnerabilities, and security controls through case-based analysis.	Understand (Cybersecurity fundamentals) / L2
2	Demonstrate malware detection and analysis using Windows Defender and VirusTotal.	Apply (Malware identification and analysis) / L3
3	Perform password strength analysis and implement secure password policies using password auditing tools.	Apply (Password security) / L3
4	Implement Caesar Cipher and Vigenère Cipher encryption and decryption using Python.	Apply (Classical cryptography) / L3
5	Implement AES and RSA algorithms using Python libraries for secure encryption and decryption.	Apply (Modern cryptography) / L3
6	Generate and verify Digital Signatures using OpenSSL.	Apply (Digital signature implementation) / L3
7	Generate Self-Signed Digital Certificates using OpenSSL and configure HTTPS communication.	Apply (PKI and secure communication) / L3

INTERMEDIATE LEVEL

S. No.	Name of the Program	Bloom Level with Cognitive Process
8	Perform network scanning using Nmap to identify hosts, open ports, and running services.	Apply (Network scanning and enumeration) / L3
9	Perform vulnerability assessment of a web application using OWASP ZAP.	Apply (Web vulnerability assessment) / L3
10	Configure Windows Firewall to allow and block network traffic using custom rules.	Apply (Firewall configuration) / L3
11	Configure Linux Firewall (UFW/IPTables) for network traffic filtering.	Apply (Linux firewall administration) / L3
12	Configure and establish a Virtual Private Network (VPN) connection for secure communication.	Apply (VPN implementation) / L3
13	Install, configure, and monitor network traffic using Snort Intrusion Detection System (IDS).	Apply (Intrusion detection) / L3
14	Capture and analyze network packets using Wireshark to identify communication protocols and suspicious traffic.	Analyse (Network traffic analysis) / L4
15	Perform authentication and access control configuration by creating users, groups, and assigning permissions in Windows/Linux.	Apply (Identity and Access Management) / L3

ADVANCED LEVEL

S. No.	Name of the Program	Bloom Level with Cognitive Process	Programs Mapped with Ability Enhancement Courses
16	Demonstrate SQL Injection attacks on a vulnerable web application and implement preventive techniques.	Analyse (Application security testing) / L4	FinTech
17	Perform Cross-Site Scripting (XSS) testing using DVWA/OWASP Juice Shop and implement mitigation strategies.	Analyse (Web application security) / L4	FinTech
18	Configure cloud security settings and Identity & Access Management (IAM) policies in Microsoft Azure or AWS Free Tier.	Analyse (Cloud security implementation) / L4	SDG
19	Study Internet of Things (IoT) security by analyzing vulnerabilities and implementing basic security controls.	Analyse (IoT security) / L4	SDG
20	Design and implement a comprehensive cybersecurity solution integrating firewall, IDS, VPN, encryption, and secure authentication for an enterprise network.	Create (Enterprise cybersecurity solution) / L6	SDG

Suggested Readings

1. Principles of Information Security – Michael E. Whitman & Herbert J. Mattord, Cengage Learning.
2. Cryptography and Network Security: Principles and Practice – William Stallings, Pearson.
3. Computer Security: Principles and Practice – William Stallings & Lawrie Brown, Pearson.
4. J. Piwprzyk, T. Hardjono, 2003, Fundamentals of Computer Security, Springer
5. Nina Godbole, Sunit Belpure, 2011, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Publication Wiley
6. Mike Shema, 2014, Anti-Hacker Tool Kit, McGraw Hill

Note: Only the latest editions of the books are recommended.

Software Required / Web Links

Software

- Kali Linux
- Ubuntu Linux
- Python 3.x
- OpenSSL
- Wireshark
- Nmap
- OWASP ZAP
- Snort IDS
- DVWA (Damn Vulnerable Web Application)
- OWASP Juice Shop
- VirtualBox / VMware Workstation
- Microsoft Azure / AWS Free Tier

Web Links

- https://owasp.org/www-project-zap/
- https://nmap.org
- https://www.wireshark.org
- https://www.snort.org
- https://owasp.org/www-project-juice-shop/
- https://portswigger.net/web-security
- https://www.w3schools.com/cybersecurity/

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

The evaluation will include two types of assessments:
(i) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%
Subjective (Short/Long) 40%
Discussion/Presentation 15%
Projects/Group Activities etc. 15%
(ii) For Summative assessment (End Semester Examination or End Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30%

Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA133E02H.1	3		2		1			2					3	3
O6.0CA133E02H.2	2	3	2	1	2	2	1						2	2
O6.0CA133E02H.3	2	3	2	2	3		2	1					3	3
O6.0CA133E02H.4	2	3	3	1	3			1					3	2
O6.0CA133E02H.5	2	2	2	2	3		2	2	1			2	3	3

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O6.0CA134E02H: INTRODUCTION TO DATA SCIENCE

Credits: 3 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: Basic Knowledge of Mathematics and Python
Course Type: Domain Elective

Course Outcomes: Students will be able to:

O6.0CA134E02H.1: Understand the fundamental concepts, components, applications, and workflows of Data Science.
O6.0CA134E02H.2: Apply statistical analysis, data preprocessing, and visualization techniques using appropriate Data Science tools and libraries.
O6.0CA134E02H.3: Analyze datasets using Data Science concepts and methods to identify patterns, relationships, and meaningful insights from real-world data.
O6.0CA134E02H.4: Design and evaluate basic data-based models and communicate their results while considering data ethics, privacy, and responsible Data Science practices.

UNIT 1: Introduction to Data Science
1.1 Introduction to Data Science
1.2 Understanding Data: Definition and Types
1.3 Importance and Applications of Data Science
1.4 Key Components of Data Science
1.5 Data Science vs Data Analytics

UNIT 2: Languages of Data Science-I
2.1 Introduction to Python for Data Science
2.2 Packages and APIs for Data Science
2.3 Working with Datasets and Models
2.4 Popular Data Science Libraries: NumPy, Pandas, and Scikit-learn

UNIT 3: Languages of Data Science-II
3.1 Introduction to R
3.2 Exploring RStudio for Data Science
3.3 Data Science Workflow: Jupyter Notebooks and Version Control with Git

UNIT 4: Data Exploration and Pre-processing
4.1 Understanding Data: Types and Sources
4.2 Data Cleaning Techniques: Handling Missing Data, Outliers, and Inconsistencies
4.3 Data Transformation and Feature Engineering

UNIT 5: Data Analysis and Modelling
5.1 Introduction to Statistical Analysis
5.3 Statistical Measures: Central Tendency, Variability, and Correlation
5.3 Visualization Techniques and Tools: Matplotlib, Seaborn, and Tableau
5.4 Data Visualization Techniques: Plotting, Charts, Graphs

UNIT 6: Data Ethics and Privacy
6.1 Ethical considerations in Data Science
6.2 Privacy issues in Data Science

6.3 Anonymization, data anonymization techniques, and data protection regulation
6.4 Introduction to responsible Data Science practices and guidelines

List of Experiments
BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Explore a dataset using Python and identify different data types, variables, and basic data characteristics.	Understand (Data Science Familiarization) / L2
2	Use NumPy and Pandas to create, load, filter, and manipulate a small dataset.	Apply (Data Handling) / L3
3	Perform basic statistical analysis on a dataset using mean, median, mode, range, and standard deviation.	Apply (Statistical Analysis) / L3
4	Create basic charts and graphs using Matplotlib to visualize patterns in a dataset.	Apply (Data Visualization) / L3
5	Perform basic data cleaning by handling missing values, duplicate records, and simple inconsistencies in a dataset.	Apply (Data Cleaning) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6	Perform exploratory data analysis on a dataset using Pandas and appropriate statistical measures.	Analyse (Exploratory Data Analysis) / L4
7	Identify and handle outliers in a dataset using suitable statistical or visualization techniques.	Analyse (Outlier Analysis) / L4
8	Apply data transformation and simple feature engineering techniques to prepare data for analysis or modelling.	Apply (Data Transformation) / L3
9	Analyse the relationship between variables using correlation and suitable visualizations.	Analyse (Correlation Analysis) / L4
10	Build a simple data-based model using Scikit-learn and evaluate its basic performance.	Analyse (Data Modelling) / L4

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Develop a complete data science workflow from data collection and preprocessing to visualization and basic modelling using a suitable dataset.	Evaluate (Data Science Workflow) / L5	Employability
12	Compare two suitable data-based models on a given dataset and evaluate their performance using appropriate measures.	Evaluate (Model Comparison) / L5	Innovation

13	Develop a data visualization dashboard or interactive report to communicate meaningful insights from a dataset.	Create (Data Communication) / L6	Entrepreneurship
14	Apply data anonymization and privacy-preserving techniques to a sample dataset and evaluate their importance in responsible data science.	Evaluate (Responsible Data Science) / L5	Ethics and SDG
15	Complete a mini project on a real-world data science problem involving data preparation, analysis, visualization, and a basic data-based model.	Create (Integrated Data Science Project) / L6	SDG

Suggested Readings

1. Peter Bruce, 2020, Practical Statistics for Data Scientists, 2e: 50+ Essential Concepts Using R and Python, O′Reilly
2. Andrew Park, 2020, Data Science for Beginners

Note: Only latest editions of the books and current platform documentation are recommended.

Software required / Web links

- Python, Jupyter Notebook or Google Colab
- https://www.w3schools.com/datascience/ (last visited date: 22 February 2024)
- https://www.javatpoint.com/data-science (last visited date: 22 February 2024)

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

The evaluation will include two types of assessments:
(i) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%
Subjective (Short/Long) 40%
Discussion/Presentation 15%
Projects/Group Activities etc. 15%
(ii) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30%
Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials

Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA119E02.1	3	2		3	2		2						3	2
O6.0CA119E02.2	3	2	2	3	3	1	1						3	2
O6.0CA119E02.3	3	3	2	2	2	1	1		2	1			3	2
O6.0CA119E02.4	3	3	3	2	2	1	1	1	2	2	1	1	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)

O6.0CA135E02H : DEVOPS ESSENTIALS

Credits: 3 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: Knowledge of Object oriented Programming
Course Type: Domain Elective

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

O6.0CA135E02H.1 Understand the fundamental concepts, principles, benefits, culture, tools, and processes of DevOps and version control systems.
O6.0CA135E02H.2 Apply Git and Jenkins to implement source code management, continuous integration, continuous delivery, and automated software development workflows.
O6.0CA135E02H.3 Analyze Infrastructure as Code and configuration management techniques using Terraform and Ansible for automated infrastructure provisioning and server configuration.
O6.0CA135E02H.4 Evaluate Docker, Docker Swarm, and Kubernetes for containerization, orchestration, scalability, and application deployment.
O6.0CA135E02H.5 Create an integrated DevOps solution incorporating source control, CI/CD, infrastructure automation, containerization, cloud deployment, monitoring, and DevOps culture.

UNIT 1: Introduction to DevOps
1.1 Concepts of DevOps and its history
1.2 DevOps Principles
1.3 DevOps Benefits
1.4 DevOps Culture
1.5 DevOps Tools
1.6 DevOps Processes

UNIT 2: Source Control Management with Git
2.1 Introduction to Git
2.2 Git Fundamentals
2.3 Git Workflow
2.4 Git Collaboration
2.5 Git Integration

UNIT 3: Continuous Integration & Delivery with Jenkins
3.1 Introduction to continuous integration and its essentials
3.2 Jenkins creating pipelines
3.3 Jenkins and its architecture
3.4 Jenkins tools management
3.5 Introduction to continuous delivery
3.6 Setting up Jenkins for continuous delivery

UNIT 4: Infrastructure as Code with Terraform
4.1 Introduction to infrastructure as code
4.2 Understanding Terra form and its features
4.3 Deploying infrastructure with Terraform
4.4 Introduction to configuration management
4.5 Understanding Ansible and its features
4.6 Configuring servers with Ansible

UNIT 5: Containerization with Docker

5.1 Introduction to containerization

5.2 Understanding Docker and its features

5.3 Docket Networking

5.4 Docker Swarm

5.5 Introduction to Container Orchestration

5.6 Understanding Kubernetes and its features

UNIT 6: **Monitoring and Logging**

6.1 Introduction to monitoring and logging

6.2 Understanding monitoring tools such as Prometheus and Grafana

6.3 Configuring logging with tools such as ELK stack Logical link Control (LLC)

6.4 Understanding cloud services and its role in DevOps

6.5 Deploying and managing applications in cloud environment

6.6 Understanding the DevOps culture and collaboration

6.7 Implementing DevOps culture in organizations

List of Experiments

BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Implement a simple program to install Git and create a local repository. Create a file, add it to the staging area, commit the changes, and display the commit history.	Understand (Tool Familiarization) / L2
2	Create a Git repository and demonstrate the basic Git workflow using add, commit, status, and log commands.	Apply ((Git Workflow) / L3
3	Create a GitHub repository, connect it to a local repository, and push source-code changes from the local system to the remote repository.	Apply (Repository Collaboration) / L3
4	Create a GitHub repository, connect it to a local repository, and push source-code changes from the local system to the remote repository.	Apply (CI Configuration) / L3
5	Write a basic Terraform configuration file to create a simple infrastructure resource and demonstrate Terraform initialization, planning, and application.	Apply (Infrastructure Provisioning) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6	Create a Git branching workflow with main and feature branches. Make changes in both branches and demonstrate merging and conflict resolution.	Apply (Branch Management) / L3
7	Create a Jenkins Pipeline that automatically retrieves code from Git, builds the application, runs a test, and reports the build status.	Apply (Pipeline Automation) / L3
8	Develop an Ansible playbook to install and configure a web server on one or more target machines and verify the configuration.	Analyze (Configuration Automation) / L4
9	Create a Dockerfile for a simple web application, build a Docker image, run it as a container, and expose the application through a mapped port.	Evaluate (Containerization) / L5

10	Configure a Docker network and deploy two containers that communicate with each other through the custom network.	Apply (Container Networking) / L3

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Design a complete CI/CD pipeline using Git and Jenkins that automatically builds, tests, packages, and deploys a containerized application whenever new code is pushed to the repository.	Create (CI/CD Pipeline Design) / L6	Employability
12	Develop a Terraform and Ansible automation workflow that provisions infrastructure using Terraform and subsequently configures the provisioned servers using Ansible.	Create (Infrastructure Automation) / L6	Innovation
13	Deploy a containerized application on Kubernetes by creating suitable Deployment and Service configurations and demonstrate application scaling and rolling updates.	Evaluate (Container Orchestration) / L5	Employability
14	Design a DevOps monitoring solution using Prometheus and Grafana to collect application or infrastructure metrics and create a dashboard displaying key performance indicators.	Create (Monitoring Solution Design) / L6	Innovation
15	Develop an end-to-end DevOps workflow integrating Git, Jenkins, Terraform, Ansible, Docker/Kubernetes, cloud deployment, and monitoring, and demonstrate automated application delivery from source code to production.	Create (Integrated DevOps Solution) / L6	Entrepreneurship

Suggested Readings:

1. Gene Kim, Jez Humble, Patrick Debois, and John Willis, 2019, The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, Revolution press.
2. Jez Humble and David Farley, 2018, Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Addison Welsey.

Note: Only latest editions of the books are recommended.

Weblinks:

https://www.tutorialspoint.com/market/course/industrial_engineering_operations_research/index.jsp (Last Visited Date: 21st February, 2024)

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

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Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%
Subjective (Short/Long) 40%
Discussion/Presentation 15%
Projects/Group Activities etc. 15%
(ii) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30%
Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA135E02H.1	3	2	1	1	2	1	2	1	1	1	2	1	3	2
O6.0CA135E02H.2	3	3	2	2	3	1	2	1	1	1	2	2	3	3
O6.0CA135E02H.3	3	3	3	3	3	1	2	1	1	1	2	3	3	3
O6.0CA135E02H.4	3	3	3	3	3	1	2	2	2	2	3	3	3	3
O6.0CA135E02H.5	3	3	3	3	3	2	3	3	2	3	3	3	3	3

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O6.0CA136E02H: IOT FUNDAMENTALS AND APPLICATIONS

Credits:3 Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs End Semester Examination: 70

Pre-Requisite: NA
Course Type: Domain Elective

Course Outcomes: At the end of the course, students will be able to
O6.0CA136E02H.1: Understand the fundamental concepts, architecture, and enabling technologies of Internet of Things (IoT).
O6.0CA136E02H.2: Apply IoT technologies and tools to develop connected systems for real-world applications.
O6.0CA136E02H.3: **Analyze** IoT systems, communication technologies, and data acquisition mechanisms for diverse application scenarios.
O6.0CA136E02H.4: **Evaluate** IoT solutions considering performance, security, scalability, and emerging technological trends.
O6.0CA136E02H.5: Design and develop IoT-based applications to address real-world problems using appropriate hardware and software platforms.

UNIT 1: Introduction to Internet of Things (IoT)
1.1 Evolution of the Internet and the Internet of Things (IoT)
1.2 Definition, Characteristics of IoT
1.3 IoT Architecture and Functional Components
1.4 IoT Ecosystem
1.5 Challenges in IoT
1.6 IoT Applications

UNIT 2: IoT Devices and Communication Technologies
2.1 IoT Devices and Smart Objects
2.2 Sensors and Actuators: Characteristics, Types, and Applications
2.3 Embedded Platforms: Arduino, ESP32, and Raspberry Pi (Overview)
2.4 IoT Communication Protocols: MQTT, CoAP, AMQP
2.5 IoT Communication Protocols: HTTP, WebSocket
2.6 IPv6 and 6LoWPAN for IoT

UNIT 3: IoT Connectivity Technologies
3.1 Machine-to-Machine (M2M) Communication
3.2 IoT Connectivity Requirements
3.3 Bluetooth and Bluetooth Low Energy (BLE)
3.4 ZigBee, RFID, and NFC
3.5 Wi-Fi and Cellular IoT (NB-IoT, LTE-M)
3.6 LoRaWAN and Sigfox
3.7 IoT Gateways

UNIT 4: Sensor Networks
4.1 Introduction to Wireless Sensor Networks (WSN)
4.2 Features and Characteristics of WSN
4.3 WSN Architecture
4.4 Sensor Nodes: Components and Challenges
4.5 Sensor Web, Routing, Object Detection, and Tracking
4.6 UAVs and Flying Ad Hoc Networks (FANETs)

UNIT 5: IoT Implementation using Arduino

5.1 Introduction to Arduino and microcontrollers
5.2 Arduino key features, board types & specifications
5.3 Arduino Uno- pin configuration & architecture
5.4 Arduino IDE: setup & sketch structures
5.5 Interfacing of various types of sensors & actuators with Arduino board
5.6 IoT Cloud Platforms (ThingSpeak/Blynk – Overview)

UNIT 6: Emerging Trends and IoT Applications

6.1 Edge and Fog Computing
6.2 Digital Twins
6.3 Industry 4.0 and 5.0
6.4 Smart Home, Smart City, and Smart Healthcare
6.5 Smart Agriculture and Industrial IoT
6.6 IoT Security and Privacy

Suggested Readings:

1. Vijay Madisetti and Arshdeep Bahga, 2014, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT.
2. Pethuru Raj and Anupama C. Raman, 2017, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases",CRC.
3. Francis daCosta, 2013, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications.
4. Cuno Pfister, 2011, "Getting Started with the Internet of Things", O"Reilly Media.
5. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 2014, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Academic Press

Note: Only latest editions of the books are recommended.

List of Experiments:

BEGINNER LEVEL(NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1.	Study of Arduino IDE and Arduino Board	Understand/ L2
2.	Write and execute a program to blink an LED	Apply L3
3.	Interface a Push Button with Arduino	Apply /L3
4.	Interface an LDR Sensor for automatic light detection	Apply / L3
5.	Interface a Temperature & Humidity Sensor (DHT11/DHT22)	Apply / L3

INTERMEDIATE LEVEL(NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6.	Interface an Ultrasonic Sensor for distance measurement	Apply /L3

7.	Interface a Servo Motor using Arduino	Apply / L3
8.	Display Sensor Data on Serial Monitor	Apply / L3
9.	Interface Multiple Sensors with Arduino	Apply/ L3
10.	Connect Arduino to Wi-Fi using ESP8266/ESP32	Apply / L3

ADVANCED LEVEL(NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Upload Sensor Data to ThingSpeak Cloud	Analyse / L4	SDG
12	Visualize IoT Data on a Cloud Dashboard	Analyse / L4	SDG
13	Mini Project: Develop an IoT-based Weather Monitoring System	Create / L4	SDG
14	Mini Project: Develop a Smart Agriculture Monitoring System	Create/ L4	SDG

Suggested Readings:

- Raj Kamal, Internet of Things: Architecture and Design Principles, 3rd Edition, McGraw Hill Education, 2023.
- Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2015.

Note: Only the latest editions of the books are recommended. Software

required/Web links:

- Arduino Documentation: https://docs.arduino.cc/
- ThingSpeak Documentation: https://thingspeak.mathworks.com/
- MQTT Documentation: https://mqtt.org/

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

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Subjective (Short/Long) 40%

Discussion/Pre
sentation 15%
Projects/Group
Activities etc.
15%
(ii) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

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Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials Sessional tests
Surprise questions during
lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

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O6.0CA136E02H.1	3	2			1								2	1
O6.0CA136E02H.2	2	3	2	1	2								3	2
O6.0CA136E02H.3	2	2	3	3	3		1		1		2	1	3	3
O6.0CA136E02H.4	2	3	2	1	2		1	1		1		2	2	3
O6.0CA136E02H.5	2	3	2	1	2								3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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O6.0CA104E02: CONCEPTS OF AI & MACHINE LEARNING

Credits: 3	Max. Marks: 100
	Continuous Evaluation: 30
Duration of Examination: 3 Hrs	End Semester Examination: 70

Pre-Requisite: NA
Course Type: Domain Elective

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

Course Outcomes: At the end of the course, students will be able to:
6.0CA137E02H.1 Understand the fundamental concepts, foundations, approaches, problem-solving techniques, terminology, and different types of Artificial Intelligence and Machine Learning.
6.0CA137E02H.2 Apply regression, gradient descent, probabilistic models, regularization, logistic regression, and classification techniques to solve machine learning problems.
6.0CA137E02H.3 Analyze modelling techniques including Support Vector Machines, kernel functions, dimensionality reduction, shrinkage methods, and classification techniques for different datasets.
6.0CA137E02H.4 Evaluate neural networks, decision trees, graphical models, hypothesis testing, parameter estimation, and ensemble methods using appropriate evaluation measures.
6.0CA137E02H.5 Create suitable supervised learning solutions using generative models, Naïve Bayes, decision trees, bagging, and boosting for real-world classification problems

Unit 1: Introduction:
- 1.1 Foundations and approaches of AI
- 1.2 Problem solving in Artificial Intelligence and current trends
- 1.3 Introduction: Machine learning, Terminologies in machine learning
- 1.4 Types of machine learning: supervised, unsupervised, semi-supervised learning
- 1.5 Discriminative Models: Least Square Regression
- 1.6 B Gradient Descent Algorithm, Univariate and Multivariate Linear Regression

Unit 2: Modelling technique:
- 2.1 Prediction Modeling
- 2.2 Probabilistic interpretation, Regularization,
- 2.3 Logistic regression, multi class classification
- 2.4 Support Vector Machines- Large margin classifiers
- 2.5 Nonlinear SVM,
- 2.6 Kernel functions, SMO algorithm

Unit 3: ML Operations
- 3.1 Dimensionality Reduction Subset Selection
- 3.2 Shrinkage Methods
- 3.3 Principle Components Regression Linear Classification
- 3.4 Logistic Regression
- 3.5 Linear Discriminant Analysis Optimization
- 3.6 Classification-Separating Hyperplanes Classification

Unit 4: Neural Networks:
- 4.1 Artificial Neural Networks (Early models, Back Propagation, Initialization, Training & Validation) Parameter Estimation (Maximum Likelihood Estimation, Bayesian Parameter Estimation)
- 4.2 Decision Trees Evaluation Measures
- 4.3 Hypothesis Testing Ensemble Methods
- 4.4 Graphical Models

Unit 5: Unsupervised Learning:

1.1 Clustering, Gaussian Mixture Models

1.2 Spectral Clustering Ensemble Methods Learning Theory

1.3 Reinforcement Learning

1.4 Dimensionality Reduction

1.5 Principal Component Analysis (PCA),

Unit 6: Supervised Learning:

6.0 Generative models : Linear Discriminative Analysis,

6.1 Na¨ıve Bayes classifier

6.2 Decision trees

6.3 Ensemble models – Bagging and Boosting.

BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Implement a simple Python program to demonstrate the difference between supervised and unsupervised learning using a small sample dataset.	Understand (Concept Demonstration) / L2
2	Implement univariate linear regression on a small dataset and predict the output for a given input value.	Apply (Regression Implementation) / L3
3	Write a program to implement gradient descent for minimizing the cost function of a simple linear regression model.	Apply (Gradient Descent Implementation) / L3
4	Build a logistic regression model to classify a binary dataset and calculate its accuracy.	Apply (Binary Classification) / L3
5	Implement PCA on a dataset and reduce its features from a higher dimension to two principal components.	Apply (Dimensionality Reduction) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6	Implement a multivariate linear regression model and compare its predicted values with actual values using an appropriate evaluation measure.	Apply (Multivariate Prediction) / L3
7	Train an SVM classifier using a linear kernel on a classification dataset and visualize the separating hyperplane.	Apply (Large-Margin Classification) / L3
8	Implement nonlinear SVM using an RBF kernel and compare its classification performance with a linear SVM.	Analyze (Kernel-Based Comparison) / L4
9	Implement a decision tree classifier, evaluate its performance using accuracy, precision, recall, and F1-score, and interpret the results.	Evaluate (Model Evaluation) / L5
10	Implement a neural network using backpropagation for a classification problem and evaluate its training and validation performance.	Apply (Neural Network Training) / L3

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Implement Gaussian Mixture Model (GMM) clustering and compare its clusters with those produced by a traditional clustering technique.	Analyze (Clustering Comparison) / L4	Innovation
12	Implement PCA followed by logistic regression and analyze how dimensionality reduction affects the classification performance of the model.	Analyze (Pipeline Analysis) / L4	Employability
13	Develop an ensemble classification model using Bagging and Boosting, and evaluate which method provides better performance on the selected dataset.	Evaluate (Ensemble Performance Evaluation) / L5	Employability
14	Implement Naïve Bayes, Decision Tree, and Logistic Regression classifiers on the same dataset and critically evaluate their performance using multiple evaluation metrics.	Evaluate (Comparative Model Evaluation) / L5	Entrepreneurship
15	Design and implement a complete supervised learning pipeline involving data preprocessing, feature selection, model training, hyperparameter tuning, and ensemble classification, and justify the choice of the final model.	Create (ML Solution Design) / L6	SDG

Suggested Readings

1. Ethem Alpaydin,2020, Introduction to Machine Learning, Prentice Hall of India.
2. Tom Mitchell, 2019,Machine Learning, McGraw Hill Education.
3. Stephen Marsland, 2020, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC
4. Christpher M. Bishop, 2017, Pattern Recognition and Machine Learning, Springer

Note: Only latest editions of the books and current platform documentation are recommended.

Software required / Web links

1. Web Links: https://www.ibm.com/topics/machine-learning (Last Visited Date: 21st February, 2024)
2. Web Links: https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-ml/ (Last Visited Date: 21st February, 2024)

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Evaluation Policy:

The evaluation will include two types of assessments:

(i) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%
Subjective (Short/Long) 40%
Discussion/Presentation 15%
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Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

PO-CO statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
O6.0CA137E02H.1	3	2	1	1	1	1	2	1	1	1	1	1	3	2
O6.0CA137E02H.2	3	3	2	2	3	1	2	1	1	1	1	2	3	3
O6.0CA137E02H.3	3	3	3	3	3	1	2	1	2	2	2	3	3	3
O6.0CA137E02H.4	3	3	2	3	3	2	2	1	2	2	2	2	3	3
O6.0CA137E02H.5	3	3	3	3	3	2	3	2	2	3	3	3	3	3

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O6.0CA138E02H: INTRODUCTION TO BLOCKCHAIN TECHNOLOGIES

Credits: 3	Max. Marks: 100
	Continuous Evaluation: 30
Duration of Examination: 3 Hrs	End Semester Examination: 70

Pre-Requisite: Fundamentals of Cybersecurity
Course Type: Domain Elective

Course Outcomes: At the end of the course, the student will be able to:
O6.0CA138E02H.1: Understand the fundamental concepts, architecture, and principles of blockchain and distributed ledger technologies.
O6.0CA138E02H.2: Apply blockchain technologies and cryptographic techniques to develop secure and decentralized solutions.
O6.0CA138E02H.3: Analyze blockchain platforms, consensus mechanisms, and smart contract frameworks for diverse application scenarios.
O6.0CA138E02H.4: Evaluate blockchain solutions based on security, scalability, privacy, and performance requirements.
O6.0CA138E02H.5: Design and develop blockchain-based applications to address real-world challenges using appropriate blockchain technologies.

UNIT 1: Introduction to Blockchain
1.1 The Need for Blockchain: Problems with Centralized Systems (with everyday examples)
1.2 Centralized, Decentralized and Distributed Systems
1.3 Distributed Ledgers and their Characteristics
1.4 Structure of a Block: Block Header, Transactions, Genesis Block and Chaining of Blocks
1.5 Design Primitives: Immutability, Transparency and Provenance
1.6 Types of Blockchain: Public, Private and Consortium
1.7 Benefits, Limitations and Basic Security Issues of Blockchain

UNIT 2: Cryptographic Foundations of Blockchain
2.1 Cryptographic Hash Functions: Properties and SHA-256 (conceptual treatment with demonstrations)
2.2 Avalanche Effect and Tamper Detection
2.3 Merkle Trees: Concept and Role in a Block
2.4 Public and Private Keys: An Overview of Asymmetric Cryptography
2.5 Digital Signatures: Signing and Verification of Transactions
2.6 Wallets and Addresses (Hot and Cold Wallets)
2.7 Permissions and Privacy in Blockchain Networks

UNIT 3: Consensus Protocols
3.1 The Double Spending Problem and the Need for Consensus
3.2 Introduction to Bitcoin as the First Blockchain Application
3.3 Mining and Proof of Work (PoW): Working with Simple Examples
3.4 Proof of Stake (PoS): An Overview
3.5 Scalability Aspects of Blockchain Consensus Protocols (introductory level)
3.6 Permissioned Blockchains: Design Goals
3.7 Consensus in Permissioned Blockchains: Voting-based Approaches (conceptual overview)
3.8 Forks: Soft Fork and Hard Fork (brief introduction)

UNIT 4: Smart Contracts and Ethereum
4.1 Introduction to Ethereum and how it differs from Bitcoin
4.2 Ether, Gas and Transaction Fees (conceptual treatment)
4.3 Smart Contracts: Concept, Life Cycle and Real-Life Analogies
4.4 Introduction to Solidity: Structure of a Contract, State Variables and Functions
4.5 Writing Simple Contracts using Remix IDE (Hello World, Simple Storage)
4.6 Deploying and Interacting with Contracts on a Test Network
4.7 Decentralized Applications (DApps): An Overview

UNIT 5: Hyperledger Fabric
5.1 Introduction to Hyperledger and Enterprise Blockchains
5.2 Decomposing Consensus in Permissioned Networks (conceptual overview)
5.3 Hyperledger Fabric Components: Peers, Orderer, Channels, Chaincode and Membership Service Provider
5.4 Transaction Flow in Hyperledger Fabric (high-level walkthrough)
5.5 Fabric SDK and Front End: An Overview
5.6 Comparison of Hyperledger Fabric with Ethereum

UNIT 6: Applications of Blockchain
6.1 Blockchain in Financial Software and Systems (FSS): Settlements, KYC, Capital Markets and Insurance
6.2 Blockchain in Trade/Supply Chain: Provenance of Goods, Visibility, Trade/Supply Chain Finance, Invoice Management and Discounting
6.3 Case Studies from India: Land Records, e-Governance and Academic Certificates
6.4 Current Trends and Career Opportunities in Blockchain (brief overview)

Suggested Readings:

1. Andreas Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", 2nd Ed., 2017, Shroff/O'Reilly.
2. Melanie Swan, "Blockchain: Blueprint for a New Economy", 2015, O'Reilly.
3. Imran Bashir, "Mastering Blockchain", 3rd Ed., 2020, Packt Publishing.
4. Kumar Saurabh and Ashutosh Saxena, "Blockchain Technology: Concepts and Applications", 2020, Wiley India.

Note: Only latest editions of the books are recommended

List of Experiments:
BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No.	Name of the Program	Bloom level with Cognitive process
1.	Visualize the working of a blockchain using an online blockchain demo (andersbrownworth.com/blockchain): observe blocks, hashing, chaining and the effect of tampering with data.	Apply (Blockchain Visualization)/ L3
2.	Demonstrate the working of the SHA-256 hash function using online tools/Python and verify the avalanche effect by making small changes in input data.	Apply (Hashing)/ L3
3.	Generate a public-private key pair, digitally sign a message and verify the signature using a guided Python script/online tool.	Apply (Digital Signatures)/ L3
4.	Create a cryptocurrency wallet using MetaMask on an Ethereum test network, obtain test Ether from a faucet and perform a transaction between two accounts.	Apply (Wallets & Transactions)/ L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No.	Name of the Program	Bloom level with Cognitive process
5.	Implement a simple blockchain in Python using a guided template: create	Apply (Building a

S.No.	Name of the Program	Bloom level with Cognitive process
	blocks, link them using hashes and demonstrate tamper detection.	Blockchain)/ L3
6.	Extend the Python blockchain by adding a simple Proof of Work mechanism and observe the effect of difficulty level on mining time.	Apply (Proof of Work)/ L3
7.	Explore a live blockchain using a block explorer (Etherscan/Blockchain.com): examine block structure, transaction details, fees and confirmations.	Apply (Block Explorer Analysis)/ L3
8.	Write, compile and deploy basic smart contracts ("Hello World" and Simple Storage) using Solidity in Remix IDE and interact with their functions.	Apply (Smart Contract Basics)/ L3

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
9.	Develop and deploy a simple voting/student record smart contract in Solidity (guided) on an Ethereum test network and analyze the recorded transactions. (May be extended as Mini Project in groups.)	Analyse (Smart Contract Application)/ L4	SDG
10.	Instructor-led walkthrough of the Hyperledger Fabric test network: run the sample network, invoke the sample chaincode and analyze the transaction flow in a permissioned blockchain.	Analyse (Permissioned Blockchain)/ L4	SDG

Suggested Readings:

- Ritesh Modi, "Solidity Programming Essentials", 2nd Ed., Packt Publishing.
- Imran Bashir, "Mastering Blockchain", 3rd Ed., Packt Publishing.

Note: Only the latest editions of the books are recommended.

Software required/Web links:

- Blockchain Demo – https://andersbrownworth.com/blockchain (Last visited Date: 30 July 2026)
- Remix IDE – https://remix.ethereum.org (Last visited Date: 30 July 2026)
- MetaMask – https://metamask.io (Last visited Date: 30 July 2026)
- Hyperledger Fabric Documentation – https://hyperledger-fabric.readthedocs.io (Last visited Date: 30 July 2026)
- NPTEL: Blockchain and its Applications – https://nptel.ac.in/courses/106105235 (Last visited Date: 30 July 2026)
- Python 3.x, Web Browser with MetaMask Extension

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Assessment Tools:

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Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA138E02H.1	3	2	1	1	1	-	-	-	1	-	-	2	2	1
O6.0CA138E02H.2	3	2	2	1	2	-	-	-	1	-	-	2	2	1
O6.0CA138E02H.3	3	3	2	2	2	-	-	-	1	-	-	2	2	2
O6.0CA138E02H.4	3	3	2	2	3	-	-	1	2	1	-	2	3	2
O6.0CA138E02H.5	2	2	2	1	2	1	-	1	2	1	1	2	2	2

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O6.0CA139E02H : ADVANCED WEB TECHNOLOGIES

Credits: 3 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: Web Development concepts
Course Type: Domain Elective

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

O6.0CA139E02H.1**:** Understand the fundamental concepts of .NET, C#, and object-oriented programming for developing application solutions.
O6.0CA139E02H.2**:** Apply C# and ASP.NET techniques to design and develop interactive web applications using appropriate controls, data-bound controls, and state management techniques.
O6.0CA139E02H.3**:** Apply ADO.NET, LINQ, and Entity Framework concepts to connect web applications with databases and manage data effectively.
O6.0CA139E02H.4**:** Design and develop web services using XML, SOAP, WSDL, and WCF for communication between applications.
O6.0CA139E02H.5**:** Design and implement secure and functional web application solutions using .NET technologies to address real-world problems.

Unit: 1. Introduction to Dot Net and C#

1.1 Introduction: Visual Studio, Visual Studio IDE, Development Environment Setup,
1.2 .NET Overview, CLR, Assemblies (monolithic vs. component-based applications), Execution Model,
1.3 Client-Side vs. Server-Side Programming, Debugging using Visual Studio,
1.4 Creating Different types of Projects in Visual Studio(Web, Desktop, Library),
1.5 Variables, Constants, Strings, Data Types, Arrays Different Types of Arrays and Operations on Arrays,
1.6 Decision statements, Loop statements, Exception Handling using try – catch –finally, Name Space

Unit 2. OOP C#

2.1 Classes and Objects Instance Variables, Methods, Constructors, Properties,
2.2 Access Specifiers, Static members and methods
2.3 Inheritance Levels of Inheritance, Constructor and Inheritance, Polymorphism,
2.4 Interfaces, Abstract classes, Delegates, Indexers, Sealed Classes,
2.5 Exception handling Collections and Generics Bounded and Unbounded Collections,
2.6 Generic Programming, Generic classes, Functions, Constraints on Generic Programming

Unit 3. Databases and C#

3.1 File Handling Text Files,
3.2 Binary Files, String Processing, Serialization and Deserialization
3.3 ADO.Net Connected and Disconnected,
3.4 Architecture of ADO. Net, Commands, Datasets, Data Readers, Data Adapters,
3.5 Working with Stored Procedures LINQ and the ADO.NET Entity Framework LINQ Introduction,
3.6 Mapping Your Data Model to an Object Model, Introducing Query Syntax 08

Unit 4. Asp.Net Web Applications

1.1 Inheriting an Interface, Windows Forms ,
4.3 MsgBox, Dialog Box, Handling Mouse and Keyboard Events
4.3 Basic Control Programming for following controls , Button , Label, Textbox, Rich Textbox, Radio Button , Checkbox, List Box, Checked List Box, Tree View, Picture Box, Tab Control

Unit 5. Data and State Management in ASP.NET

5.1 ASP.NET Websites with Themes
5.2 Master Pages, Data Source Controls,
5.3 Data Bound Controls,
5.4 ASP.NET State Management-Client Side and Server Side. ASP.NET and AJAX 10

Unit 6. Web Services

6.0 XML, Web Services Architecture, UDDI, SOAP and its Format,
6.1 WSDL, Create and Consuming XML Web Service Simple and Databases,
6.2 WCF- Architecture, End Points, Types of Contracts,
6.3 Web Applications and Security

List of Experiments

BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Create a simple C# console application using variables, constants, data types, strings, and arrays.	Understand (C# and .NET Familiarization) / L2
2	Implement decision-making and looping statements in C# to solve simple computational problems.	Apply (Control Statements) / L3
3	Create and use classes, objects, constructors, methods, and properties in a C# application.	Apply (Classes and Objects) / L3
4	Implement inheritance and polymorphism in C# using a simple real-world example.	Apply (Inheritance and Polymorphism) / L3
5	Develop a simple Windows Forms application using basic controls such as Button, Label, TextBox, RadioButton, and CheckBox.	Apply (Windows Forms Application) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6	Implement interfaces, abstract classes, and delegates in a C# application.	Apply (C# Advanced OOP) / L3
7	Implement exception handling and collections/generics in C# to manage application data.	Analyse (Exception and Collection Handling) / L4
8	Create a C# application to read, write, serialize, and deserialize data using files.	Apply (File Handling and Serialization) / L3
9	Develop an ADO.NET application to connect to a database and perform basic insert, update, delete, and retrieve operations.	Apply (Database Connectivity) / L3
10	Develop a simple ASP.NET web application using data-bound controls and a database.	Analyse (ASP.NET Data Handling) / L4

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Develop an ASP.NET website using themes, master pages, and appropriate web controls.	Analyse (ASP.NET Web Application) / L4	Employability
12	Implement client-side and server-side state management in an ASP.NET application and compare their usage.	Evaluate (State Management) / L5	Innovation
13	Create and consume a simple XML Web Service using XML, SOAP, WSDL, and basic database operations.	Create (Web Service Development) / L6	Entrepreneurship
14	Develop a simple WCF service using appropriate endpoints and contracts and consume it through a web application.	Evaluate (WCF Service Development) / L5	Ethics and SDG
15	Develop a mini project using C#, ASP.NET, and database connectivity to solve a simple real-world web application problem.	Create (Integrated Web Application) / L6	SDG

Suggested Readings

5. Ajit Singh, 2022, Advanced Web Technologies 2022, Amazon Digital Services LLC – Kdp
6. A B Nimbalkar, 2017, Advanced Web Technologies, Nirali Prakashan

Note: Only latest editions of the books and current platform documentation are recommended.

Software required / Web links

- **Microsoft Visual Studio Community** – Integrated development environment for C# and .NET application development.

Web Links:

- https://www.scribd.com/document/501648827/Advance-Web-technology
- https://learn.microsoft.com/en-us/dotnet/
- https://learn.microsoft.com/en-us/aspnet/

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

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COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
O6.0CA109E02.1	3	2	2		2		2						3	1
O6.0CA109E02.2	3	3	3	2	3		2		1				3	2
O6.0CA109E02.3	3	3	2	2	3		2						3	2
O6.0CA109E02.4	3	2	3	2	3		2		1				3	2
O6.0CA109E02.5	2	3	3	2	3	1	2	1	2	1	1	1	3	2

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O6.0CA141E02H : GAMING TECHNOLOGY - I

Credits: 3	Max. Marks: 100
	Continuous Evaluation: 30
Duration of Examination: 3 Hrs	End Semester Examination: 70

Pre-requisites: NA

Course Type: Domain Elective

Course Outcomes: The students would be able:

6.0CA141E02H.1 Understand the fundamental concepts, components, genres, design processes, player characteristics, platforms, and principles of games and video games.

6.0CA141E02H.2 Apply game design concepts, creative techniques, character development principles, game worlds, and storytelling methods to develop basic game concepts.

6.0CA141E02H.3 Analyze different game genres, player motivations, game worlds, character–avatar relationships, storytelling structures, and level design principles for different game experiences.

6.0CA141E02H.4 Evaluate game concepts, design choices, storytelling mechanisms, character designs, level layouts, and gameplay elements based on player experience, creativity, usability, and technical considerations.

6.0CA141E02H.5 Create a complete game design solution incorporating level design, interactive storytelling, gameplay mechanics, platform considerations, online gaming issues, security, and social aspects.

Unit 1: Games and Video Games

1.1 What Is a Game?
1.2 Conventional Games Versus Video Games,
1.3 Games for Entertainment,
1.4 Serious Games Designing and Developing Games: An Approach to the Task,
1.5 Key Components of Video Games & The Structure of a Video Game
1.6 Stages of the Design Process, Game Design Team Roles, Game Design Documents,
1.7 The Anatomy of a Game Designer

Unit 2: Genres of Game

2.1 What Is a Genre?
2.2 The Classic Game Genres
2.3 Understanding Your Player: Vanden Berghe‘s Five Domains of Play,
2.4 Demographic Categories, Gamer Dedication,
2.5 The Dangers of Binary Thinking
2.6 Understanding Your Machine: Home Game Consoles, Personal Computers, Portable Devices Other Devices

Unit 3: Game Concepts

3.1 Getting an Idea
3.2 From Idea to Game Concept
3.3 Game Worlds: What Is a Game World?
3.4 The Purposes of a Game World
3.5 The Dimensions of a Game World
3.6 Realism

Unit 4: Creative and Expressive Play

1.1 Self-Defining Play, Creative Play, Other Forms of Expression,
1.2 Game Modifications Character Development: The Goals of Character Design,
1.3 The Relationship Between Player and Avatar,
1.4 Visual Appearances, Character Depth, Audio Design

Unit 5: Storytelling

5.1 Why Put Stories in Games?
5.2 Key Concepts,
5.3 The Storytelling Engine
5.4 Linear Stories, Nonlinear Stories, Granularity,
5.5 Mechanisms for Advancing the Plot, Emotional Limits of Interactive Stories,
5.6 Scripted Conversations and Dialogue Trees,
5.7 When to Write the Story, Other Considerations

Unit 6: General Principles of Level Design

6.1 What Is Level Design?
6.2 Key Design Principles, Layouts,
6.3 Expanding on the Principles of Level Design,
6.4 The Level Design Process, Pitfalls of Level Design Design
6.5 Issues for Online Gaming: What Are Online Games? Advantages of Online Games,
6.6 Disadvantages of Online Games, Design Issues,
6.7 Technical Security, Persistent Worlds, Social Problems

List of Experiments

BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Identify and document the key components of a video game and prepare a basic Game Design Document (GDD) for a simple game idea.	Understand (Game Design Familiarization) / L2
2	Create a basic 2D game concept by defining its genre, target players, objective, rules, and core gameplay mechanics.	Apply (Game Concept Development) / L3
3	Design a simple game world by defining its setting, environment, dimensions, characters, and level objectives.	Apply (Game World Design) / L3
4	Design a basic player character and avatar, including visual appearance, abilities, personality, and relationship with the player.	Apply (Character Design) / L3
5	Create a short linear game story containing an introduction, conflict, climax, and conclusion, along with basic character dialogue.	Apply (Interactive Storytelling) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No	Name of the Program	Bloom level with Cognitive process
6	Analyze two different game genres and compare their game mechanics, player motivations, objectives, and target audience.	Analyze (Genre Comparison) / L4
7	Design a nonlinear game storyline containing multiple player choices and alternative story outcomes.	Apply (Nonlinear Story Design) / L3
8	Develop a level layout for a 2D game and explain how obstacles, rewards, challenges, progression, and player flow are incorporated.	Analyze (Level Layout Analysis) / L4
9	Evaluate the character design and player-avatar relationship of an existing game based on visual appearance, character depth, abilities, and player engagement.	Evaluate (Character Design Evaluation) / L5
10	Create a dialogue tree for a game character that provides players with multiple conversation choices and different responses.	Apply (Dialogue Tree Design) / L3

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Design and develop a complete Game Design Document (GDD) for an original game including genre, target audience, game mechanics, game world, characters, story, audio, and platform requirements.	Create (Game Design Documentation) / L6	Employability
12	Analyze and redesign an existing game level by identifying level-design problems, player-flow issues, difficulty balance, rewards, and progression, and propose an improved layout.	Evaluate (Level Design Improvement) / L5	Innovation
13	Develop a branching interactive story system with multiple choices, dialogue trees, plot mechanisms, and alternative endings for a game scenario.	Create (Interactive Story Design) / L6	Innovation
14	Design an online multiplayer game concept addressing gameplay, persistent worlds, player interaction, technical security, privacy, and potential social problems.	Create (Monitoring Solution Design) / L6Create (Online Game Design) / L6	SDG
15	Develop an integrated game prototype/design solution combining game mechanics, character development, game world, storytelling, audio, level design, player interaction, and platform considerations.	Create (Integrated Game Design) / L6	Entrepreneurship

Suggested Books:

2. Rob Miles, Introduction to Programming Through Game Development Using Microsoft XNA Game Studio, Academic Edition, Microsoft Press.
3. Finney, Kenneth C, Advanced 3D game programming all in one, First edition, Course Technology Press.
4. Michael Chung, Game Programming Paradigms, Pocket Gems.
5. La Mothe, André, Tricks of the Windows game programming gurus, Second Edition, Sams Publishing.

Note: Only latest editions of the books are recommended.

Software required/ Web links:

1. https://developer.mozilla.org/en-US/docs/Games/Tutorials Last Visited Date: 22-02-2024
2. https://gamedevacademy.org/how-to-make-a-game/ Last Visited Date:22-02-2024

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O6.0CA141E02H.1	3	2	1	1	2	1	2	1	2	2	1	1	3	2
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O**6.0CA141E02H**.4	3	3	3	3	3	2	2	2	3	3	3	3	3	3
O**6.0CA141E02H**.5	3	3	3	3	3	2	2	3	3	3	3	3	3	3

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6.0CA140E02H : SOFT PROGRAMMING

Credits: 3 | Max. Marks: 100
Continuous Evaluation: 30
Duration of Examination: 3 Hrs | End Semester Examination: 70

Pre-Requisite: Basic of AI
Course Type: Domain Elective

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

O6.0CA140E02H.1: Understand the fundamental concepts, techniques, architectures, and applications of Soft Computing.
O6.0CA140E02H.2: Apply neural network techniques, learning methods, and architectures to solve simple computational problems.
O6.0CA140E02H.3: Apply fuzzy set theory, fuzzification, defuzzification, and fuzzy rule-based techniques to solve simple decision-making problems.
O6.0CA140E02H.4: Apply Genetic Algorithm techniques, including selection, crossover, mutation, and fitness evaluation, to solve optimization problems.
O6.0CA140E02H.5: Analyze a given problem and select a suitable Soft Computing technique or hybrid approach for solving it.
O6.0CA140E02H.6: Design and implement Soft Computing solutions using appropriate techniques to address real-world problems.

Unit 1: Introduction:

1.1 What is Soft Computing
1.2 Difference between Hard and Soft
1.3 Computing
1.4 Requirement of Soft computing
1.5 Major Areas of Soft Computing
1.6 Applications of Soft

Unit 2: Neural Networks:

2.1 What is Neural Network
2.2 Learning rules and various activation functions
2.3 Single layer Perceptron
2.4 Back Propagation networks
2.5 Architecture of Backpropagation (BP)
2.6 Networks, Backpropagation Learning
2.7 Variation of Standard
2.8 Back propagation Neural Network
2.9 Introduction to Associative Memory

Unit 3: Fuzzy Systems:

3.1 Fuzzy Set theory
3.2 3.2 Fuzzy versus Crisp set
3.3 Fuzzy Relation
3.4 Fuzzification
3.5 Minmax Composition
3.6 Defuzzification Method
3.7 Fuzzy Logic and Rule based systems
3.8 Predicate logic
3.9 Fuzzy Decision Making

Unit 4: Genetic Algorithm:

1.1 History of Genetic Algorithms (GA)
1.2 Working Principle
1.3 Various Encoding methods
1.4 Fitness function
1.5 GA Operators- Reproduction
1.6 Crossover, Mutation
1.7 Convergence of GA
1.8 Bit wise operation in GA
1.9 Multi-level Optimization

Unit 5: Hybrid Systems:

1.1 Sequential Hybrid Systems
1.2 Auxiliary Hybrid Systems
1.3 Embedded Hybrid Systems
1.4 Neuro-Fuzzy Hybrid Systems
1.5 Neuro-Genetic Hybrid Systems
1.6 Fuzzy-Genetic Hybrid Systems.

Unit 6: Fuzzy Backpropagation Networks:

1.1 LR type Fuzzy numbers
1.2 Fuzzy Neuron
1.3 Fuzzy BP Architecture
1.4 Learning in Fuzzy BP
1.5 Application of Fuzzy BP Networks

List of Experiments

BEGINNER LEVEL (NSQF LEVEL: 1-3)

S.No	Name of the Program	Bloom level with Cognitive process
1	Explore basic Soft Computing techniques and implement common activation functions such as step and sigmoid functions.	Understand (Soft Computing Familiarization) / L2
2	Implement a Single-Layer Perceptron for binary classification using a simple dataset.	Apply (Perceptron Implementation) / L3
3	Implement a Backpropagation Neural Network for classification using a small dataset.	Apply (Neural Network Implementation) / L3
4	Implement fuzzy sets and perform fuzzification and defuzzification for a simple real-world problem.	Apply (Fuzzy Set Processing) / L3
5	Develop a simple fuzzy rule-based system for an application such as temperature control or student performance evaluation.	Apply (Fuzzy Rule-Based System) / L3

INTERMEDIATE LEVEL (NSQF LEVEL: 4-6)

S.No.	Name of the Program	Bloom level with Cognitive process
6	Implement a Genetic Algorithm using selection, crossover, and mutation operators to solve a simple optimization problem.	Apply (Genetic Algorithm Implementation) / L3
7	Compare different Genetic Algorithm parameters and analyse their effect on solution quality and convergence.	Analyse (GA Parameter Analysis) / L4

8	Implement fuzzy relations and perform max-min composition for a given fuzzy decision-making problem.	Analyse (Fuzzy Relation Analysis) / L4
9	Compare different activation functions and learning parameters in a Backpropagation Neural Network and analyse their effect on performance.	Analyse (Neural Network Analysis) / L4
10	Apply a Genetic Algorithm to solve a simple real-world optimization problem such as scheduling or resource allocation.	Analyse (Optimization Problem Analysis) / L4

ADVANCED LEVEL (NSQF LEVEL: 7-10)

S.No.	Name of the Program	Bloom level with Cognitive process	Programs mapped with Ability Enhancement Courses
11	Develop a simple Neuro-Fuzzy system for prediction or classification using a suitable dataset.	Evaluate (Neuro-Fuzzy System) / L5	Employability
12	Implement a simple Neuro-Genetic hybrid system using a Genetic Algorithm to optimize Neural Network parameters.	Evaluate (Neuro-Genetic System) / L5	Innovation
13	Develop a simple Fuzzy-Genetic hybrid system for a decision-making or optimization problem.	Create (Hybrid System Design) / L6	Entrepreneurship
14	Implement a Fuzzy Backpropagation Network for a simple classification or prediction problem and evaluate its performance.	Create (Fuzzy BP Network) / L6	Ethics and SDG
15	Complete a mini project using one or more Soft Computing techniques to solve a simple real-world problem.	Create (Integrated Soft Computing Project) / L6	SDG

Suggested Readings:

1. S.Rajasekaran, G. A. Vijayalakshmi, 2013, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, , PHI.
2. E. Goldberg, 1989, Genetic Algorithms: Search and Optimization, Addison Wesley.
3. Chin Teng Lin, C. S. George Lee, 1996, Neuro-Fuzzy Systems, PHI.

Note: Only latest editions of the books are recommended.

Software required/ Web links:

1. https://www.cet.edu.in/noticefiles/274_soft%20computing%20LECTURE%20NOTES.pdf
(Last Visited Date: 22 February, 2024)
2. http://lancet.mit.edu/ga/dist/galibdoc.pdf (Last Visited Date:22 February, 2024)
3. **scikit-fuzzy** – Python library for fuzzy logic and fuzzy set operations (scikit-fuzzy Official Documentation)
4. Python, Jupyter Notebook or Google Colab

Instructions for paper setting: Seven questions are to be set in total. First question will be multiple choice covering entire syllabus and will be compulsory to attempt and will be of 18 marks. Three questions

will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 13 marks.

Evaluation Policy:

The evaluation will include two types of assessments:
(i) Continuous or formative assessments (in the form of end semester examination or term examination. Weightage of assessments are as follows:

For continuous or Formative assessment (in semester): Maximum 30 percent. The categorization for the same is: MCQs 30%

Subjective (Short/Long) 40%
Discussion/Presentation 15%
Projects/Group Activities etc. 15%
(ii) For Summative assessment (End Semester Examination or End-Term Examination): Minimum: 70 percent. Categorization for the same is:

Objective Type Questions: 30%
Short/Long Questions: 70%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO-PO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6.0CA140E02H.1	3	2			2		2						3	3
6.0CA140E02H.2	3	3	2	2	2		2						3	3
6.0CA140E02H.3	3	2	2	2	2		2						3	3
6.0CA140E02H.4	3	3	2	2	2		1					1	3	3
6.0CA140E02H.5	3	3	3	2	2		2					2	3	3
6.0CA140E02H.6	3	3	3	3	3	2	2	1	1	1	1	2	3	3