UNIVERSITY OF DELHI

MASTER OF SCIENCE IN INFORMATICS

(M.Sc. Informatics)

(Effective from Academic Year 2025-26)

PROGRAMME BROCHURE

Institute of Informatics & Communication (IIC) University of Delhi South Campus New Delhi – 110021

As approved in the faculty meeting on _____

for consideration to FIAS.

1/4/25

Dean, FIAS

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About IIC

The Institute of Informatics & Communication (IIC) was established in 1997 with the vision of integrating diverse fields of Information Technology (IT) and adapting to the ever-evolving digital landscape. Over the years, IIC has continuously evolved to incorporate emerging trends and cutting-edge technologies, keeping pace with advancements in the industry. Initially focusing on computer hardware, software development, and telecommunications, the institute has expanded its expertise to include Cloud Computing, Generative AI (GAI), Cybersecurity, and Digital Transformation.

IIC is not only committed to academic excellence but also actively contributes to technology-driven societal advancements. The institute fosters an environment where innovative ideas thrive while maintaining respect for traditional knowledge. It also engages in product development and research initiatives that contribute to the digitalization of India and creates solutions that benefit both industry and society.

Our Objectives

IIC was founded with the following key objectives:

- To serve as an interdisciplinary center that bridges science, technology, humanities, and industry, ensuring students receive a well-rounded education.
- To offer an industry-relevant and socially impactful postgraduate program that is designed to equip students with advanced knowledge and practical skills.
- To conduct high-quality research and innovation in informatics, communication, AI, cybersecurity, and emerging technologies.
- To continuously revise and update the curriculum in line with technological advancements and industry demands.
- To support entrepreneurial initiatives, product development, and innovative solutions that contribute to the digital growth of India.

M.Sc. Informatics: A Future-Ready Program

IIC offers a M.Sc. (Informatics) degree program, designed to provide students with a strong foundation in advanced computing, AI, cybersecurity, and data-driven technologies. The curriculum blends theoretical knowledge with hands-on experience and prepares students for high-demand careers in IT, research, and emerging tech industries. The program fosters critical thinking, problem-solving abilities, and innovation and ensures graduates stay ahead in the rapidly evolving tech landscape.

Learning Approach and Skill Development

IIC follows a **dynamic and forward-thinking learning approach**, which includes:

- Classroom lectures, tutorials, and hands-on lab sessions ensure a balance between theory and practical application.

- Exposure to the latest trends in AI, cybersecurity, blockchain, and cloud computing, prepares students for modern technological challenges.
- Regular seminars, industry collaborations, and research projects, where students present ideas, improve communication skills, and engage with experts.
- Encouragement of innovation, entrepreneurship, and product development, allowing students to work on solutions that benefit society and support India's digital transformation.

Admission to the M.Sc. Informatics program is highly competitive, with a rigorous selection process ensuring that only the most dedicated and talented students join. IIC is committed to fostering a culture of research and excellence, collaborating with leading national and international institutions on cutting-edge projects. The institute's faculty and researchers have published extensively in top scientific journals, developed technological solutions for real-world challenges, and contributed to prestigious global conferences. Through its future-ready curriculum, strong research foundation, and industry partnerships, IIC remains at the forefront of technological innovation, shaping the next generation of leaders in informatics and communication technologies.

Programme Objectives (POs)

The Institute of Informatics and Communication offers a modern and competitive study program designed to align with global advancements in Informatics, Telecommunications, Artificial Intelligence (AI), and Cybersecurity. The curriculum integrates international standards set by leading scientific and professional associations, such as the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE). The program provides a strong scientific foundation and specialized knowledge, ensuring that graduates are well-equipped to meet the growing demands of the industry. It incorporates faculty expertise, industry feedback, and insights from external evaluations to deliver a future-ready education.

Key Objectives of the Program

- Foster a stimulating and engaging learning environment that excites students about their chosen field of study.
- Build strong theoretical and practical knowledge in Informatics, Telecommunications, Artificial Intelligence, Cybersecurity, and related technologies.
- Equip students with the skills and expertise needed to excel in industry roles, research, and innovation-driven careers.
- Provide insights into the latest advancements in AI, Big Data, Cloud Computing, Blockchain, Cybersecurity, and Quantum Computing.
- Offer education through a diverse range of activities, including laboratory work, industry collaborations, hackathons, internships, and project-based learning.
- Prepare students for advanced research and development (R&D) in AI, Cybersecurity, Data Science, and Emerging Technologies.
- Develop the ability to analyze, design, and implement scientifically sound solutions for real-world challenges in Intelligent Computing & Secure Networks.

Programme Learning Outcomes (PLOs)

Graduates of the Institute of Informatics and Communication will be well-equipped with comprehensive knowledge and practical skills. They will possess the ability to analyze, design, develop, and manage advanced ICT systems and applications, while also being prepared for lifelong learning, research, and professional growth in the ever-evolving digital landscape.

Knowledge and Understanding

- Develop a strong foundation in advanced computing and network security and skill them to design innovative, scientifically grounded ICT solutions.
- Understand the economic, managerial, and business aspects of running projects related to Informatics and Telecommunications.
- Recognize and address ethical, social, legal, and educational concerns related to emerging technologies such as AI ethics, data privacy, cybersecurity policies, and digital transformation.

Application of Knowledge and Practical Skills

- Apply theoretical knowledge in modern information systems, digital networks, cloud computing, IoT, and big data analytics.
- Possess practical skills in AI, machine learning, data-driven decision-making, and cybersecurity threat analysis.
- Develop sector-specific solutions for industries including healthcare, finance, smart cities, and digital forensics.
- Identify and effectively apply the right tools, frameworks, and programming languages to solve complex problems in data science, AI, blockchain, and edge computing.
- Conduct experiments, simulations, and data-driven research, analyze results, and interpret key findings using statistical and computational techniques.
- Work independently and collaboratively in cross-functional teams to design, develop, test, and optimize ICT systems.

Critical Thinking and Problem-Solving

- Identify, analyze, and solve problems related to the design, management, and evolution of ICT systems using AI and computational intelligence techniques.
- Conduct performance evaluation and benchmarking of hardware and software systems.
- Assess the efficiency, scalability, and robustness of AI and data-driven solutions.
- Critically evaluate scientific and technical publications, keeping up with breakthroughs in areas such as quantum computing, federated learning, and cybersecurity resilience.
- Understand the limitations of technology, its impact on society, and their ethical responsibility in its implementation, considering social, economic, environmental, and policy perspectives.
- Continuously update their knowledge to stay ahead in the rapidly evolving fields of AI, data science, and cybersecurity.

Communication and Collaboration

- Communicate technical concepts, problems, and solutions effectively through reports, presentations, and discussions.
- Work collaboratively in multidisciplinary teams, contributing to project design, system implementation, and performance optimization.
- Produce technical reports, research papers, and executive summaries for decision-making in AI-driven and data-intensive environments.

Lifelong Learning and Future Readiness

- Adapt to new methodologies, frameworks, and computational tools throughout all phases of an ICT system's lifecycle.
- Stay updated with scientific and technological advancements in AI, cybersecurity, blockchain, and data analytics.
- Continuously upgrade their skills through self-learning, certifications, and higher studies in advanced informatics and communication technologies.

- Be prepared for further research and development (R&D) in emerging fields like Explainable AI (XAI), Green Computing, and Human-AI Collaboration.

Programme Specific Outcomes (PSOs)

The MSc Informatics program is structured to provide a strong theoretical foundation, practical expertise, and industry-relevant skills across four semesters. Throughout the program, students develop technical proficiency, research aptitude, and problem-solving skills, enabling them to tackle complex challenges in Informatics, AI, and Cybersecurity. The structured blend of core courses, electives, and hands-on labs ensures graduates are well-prepared for industry roles, academic research, and entrepreneurial ventures in emerging technologies.

First Semester

The first semester establishes a strong foundation in Artificial Intelligence, Operating Systems, and Data Science, along with elective choices that allow students to tailor their learning based on their interests. The Computational Data Science Lab provides hands-on experience in data-driven problem-solving.

- **Artificial Intelligence: Principles and Techniques**
  Understanding fundamental AI concepts, search algorithms, knowledge representation, and machine learning techniques.
- **Operating Systems**
  Study of OS principles, process management, memory management, file systems, and security.
- **Data Science & Big Data Analytics**
  Techniques for handling large-scale data, statistical methods, machine learning applications, and distributed computing frameworks like Hadoop & Spark.
- This program offers flexibility for students to explore specialized elective courses based on student interest. Students may choose either a second DSE or a General Elective (GE) from the available options.
- **Computational Data Science Lab**
  Practical implementation of data science techniques, AI models, and big data frameworks through hands-on exercises and real-world datasets.

This semester provides a balanced mix of theoretical foundations, computational techniques, and practical skills, preparing students for advanced AI-driven problem-solving and research.

Second Semester

The second semester builds on foundational concepts by introducing Advanced Data Structures, Computer Networks, and Database Management, along with elective flexibility to allow students to tailor their learning. The Data Management & Optimization Lab provides practical exposure to handling large-scale data and optimizing computational workflows.

- **Advanced Data Structures**
  In-depth study of data organization techniques, graph algorithms, dynamic programming, and advanced tree structures.
- **Computer Networks and Communication**

Concepts of network architecture, protocols, data transmission, security, and emerging trends in communication networks.

- **Database Management & NoSQL Technologies**
  Covers relational database design, query optimization, transaction management, and modern NoSQL databases like MongoDB, Cassandra, and Redis.
- A specialized elective course tailored to the student's chosen domain. Students can either continue with a **DSE** or opt for an **interdisciplinary GE** from another department.
- **Data Management & Optimization Lab**
  Hands-on experience with database design, query execution, distributed computing frameworks, and performance optimization techniques.

This semester strengthens students' expertise in data-driven technologies, networking, and advanced computational techniques, preparing them for cutting-edge industry roles and research opportunities.

Third Semester

The third semester focuses on advanced topics in AI, machine learning, and cybersecurity while allowing students to explore specialized electives. The Deep Learning & Advanced Analytics Lab provides hands-on experience with state-of-the-art AI techniques.

- **Cybersecurity Risk Management & Compliance**
  Covers risk assessment methodologies, compliance frameworks (ISO 27001, NIST, GDPR), ethical hacking, and security governance.
- **Advanced Topics in Machine Learning and AI**
  Explores cutting-edge ML techniques, generative AI, reinforcement learning, explainable AI (XAI), and AI ethics.
- Elective courses focusing on **emerging technologies and research-oriented topics**.
- **Deep Learning & Advanced Analytics Lab**
  Hands-on implementation of deep learning architectures (CNNs, RNNs, transformers), reinforcement learning, AI-driven analytics, and scalable AI models.

This semester strengthens expertise in cybersecurity, AI research, and advanced analytics, equipping students with the skills needed for industry roles and academic research in cutting-edge AI and security fields.

Fourth Semester

The fourth semester focuses on advanced computing paradigms, information system design, and quantum computing, along with specialized electives. The Web Applications & Services Lab provides hands-on experience in developing scalable web solutions.

- **Information System Design and Management**
  Covers system analysis, architecture design, IT governance, enterprise information systems, and strategic IT management.
- **Quantum Computing Fundamentals**
  Introduction to quantum mechanics, quantum algorithms (Shor's, Grover's), quantum cryptography, and quantum machine learning.
- Students can opt for three DSEs or choose two DSEs and a GE based on their interests.

- **Web Applications & Services Lab**
  Hands-on experience with full-stack development, cloud-based services, API development, and modern web frameworks (React, Node.js, Django, etc.).

This semester provides a comprehensive understanding of system design, quantum computing, and web technologies, preparing students for industry roles in software development, AI, cybersecurity, and advanced computing research.

Educational Approach and Laboratory Integration

The MSc Informatics program ensures that each course across all four semesters is closely integrated with dedicated hands-on laboratory experiments. This practical approach enhances students' understanding by enabling them to apply theoretical concepts to real-world problems through structured laboratory work. IIC always designs the educational methodology to develop critical thinking, analytical skills, and collaborative problem-solving abilities. The learning process encourages students to:

- Analyze complex scientific and technological problems and develop practical solutions.
- Work independently and in teams, effectively coordinating and managing group projects.
- Engage actively in lectures, laboratory sessions, and project-based learning.

Classroom and laboratory sessions form a crucial part of the learning experience. These sessions provide a platform where students and faculty exchange knowledge, share experiences, and enhance learning collectively. To fully benefit from this approach, students are expected to:

- Attend lectures and lab sessions regularly as per the schedule.
- Arrive on time and actively participate in discussions and practical exercises.
- Engage in the complete learning process to grasp both theoretical and applied aspects of the subject.

IIC integrates modern e-learning tools to complement traditional classroom teaching. These include:

- Online lecture notes and educational materials.
- Digital platforms for project submissions and academic announcements.
- Supplementary learning resources for deeper exploration of course content.

However, while these digital tools enhance the learning process, they cannot replace physical presence in lectures, laboratories, or assessments. Participation in hands-on activities, in-class discussions, and laboratory-based evaluations remains essential to achieving academic success. Students are required to follow the course timetable and adhere to faculty instructions to ensure they gain maximum benefit from the program’s interactive and experiential learning approach.

Program Structure

The PG Curricular Framework 2024, based on the National Education Policy (NEP) 2020, emphasizes a flexible, multidisciplinary, and research-driven approach to postgraduate education.

It is structured to cater to diverse academic and professional aspirations while maintaining global standards in higher education.

Level 6: First Year of PG (Two-Year PG Programmes - 3+2 Structure)

The **first year of a two-year PG program (Level 6)** serves as a **foundational stage**, focusing on **core disciplinary knowledge, skill development, and interdisciplinary exposure**. The curriculum comprises:

- **Discipline-Specific Core (DSC) Courses** – Fundamental courses providing in-depth knowledge of the subject.
- **Discipline-Specific Electives (DSE)** – Advanced electives allow students to specialize in emerging areas within their field.
- **Generic Electives (GE)** – Courses from other disciplines that broaden students' perspectives and foster interdisciplinary learning.

This stage ensures students gain a **strong theoretical base** while developing practical expertise through **labs, projects, and industry interactions**.

Level 6.5: Second Year of Two-Year PG / One-Year PG (Three Flexible Options)

The second year of the PG program (Level 6.5) or a one-year PG provides students with three academic pathways, allowing flexibility in their learning trajectories:

1. Coursework-Only Option – Focused on deep theoretical and practical knowledge through advanced courses and professional skill-building.
2. Coursework + Research Option – A blended approach incorporating coursework with a research component, enabling students to undertake short-term research projects along with structured learning.
3. Research-Only Option – Designed for students aiming for higher research, this track allows them to engage in an intensive research thesis, fostering innovation and scholarly contribution in their field.

This framework aligns with NEP 2020's vision of interdisciplinary learning, global competitiveness, and research-driven education, ensuring that PG programs equip students with the necessary expertise, innovation skills, and career readiness for academia, industry, or entrepreneurship.

Admission Requirements

Candidates must fulfill **one** of the following criteria:

I. Bachelor's Degree in Science:

A. Admission to a 2-Year PG Program (After a 3-Year B.Sc. Degree): Candidates who have completed a 3-year B.Sc. degree in the following disciplines are eligible for admission to the 2-year PG program:

- B.Sc. in Computer Science, Physics, Electronics, Mathematics, Statistics, or Operational Research
- B.Sc. (Three-Subject Scheme) in Physics, Mathematics, Electronics, Computer Science, or related disciplines

- B.A.Sc. (Applied Science) in Electronics/Instrumentation from the University of Delhi or an equivalent qualification from a recognized institution

B. Admission to a 1-Year PG Program (After a 4-Year B.Sc. Degree): Candidates who have completed a 4-year B.Sc. degree (as per the National Education Policy) in any of the above-mentioned disciplines are eligible for admission to the 1-year PG program.

Students must have the necessary background in **Mathematics, Physics, or Computer Science**, with at least **2 papers in Mathematics** and **1 paper in Computer Science**.

Minimum Marks Requirement:
A minimum of 50% marks for UR category and as per university norms for reserved categories in the qualifying degree is required.

II. Engineering Degree:

Candidates with a B.E./B.Tech. degree (10+2+4 scheme) in any discipline from the University of Delhi or an equivalent recognized university/institution can apply. A minimum of 50% marks for UR and other reservations as per university norms in the qualifying degree is required .

Admission Procedure
Admission to the program will be based on the candidate's performance in the Common University Entrance Test for Postgraduate (CUET-PG) /as per University norms. Candidates who meet the cutoff criteria set by the university will be shortlisted. Final selection will be based on cutoff and Interview marks.

Assessment & Grading Policy
The grade awarded to a student in any course is based on their performance in the End Semester Examination. The corresponding letter grades and grade points are listed in Table I.

Table 1: Grade points and description of performance

Letter Grade	**Grade Point (GPA/CGPA Scale 10)**	**Performance Description**
O (Outstanding)	10	91-100%
A+ (Excellent)	9	81-90%
A (Very Good)	8	71-80%
B+ (Good)	7	61-70%
B (Above Average)	6	51-60%
C (Average)	5	41-50%
D (Minimum Passing)	4	40%
F (Fail)	0	Below 40%
Ab (Absent)	0	Absent in Exam

For computing the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), only courses in which the student has secured a grade between *A* and *D* will be considered.

$$GPA = \frac{\Sigma(Number\ of\ Credits \times Grade\ Points)}{\Sigma Number\ of\ Credits}$$

The *F* Grade represents an unsatisfactory performance in a course. A student receiving an F Grade must repeat both theory and practical courses in which they failed.

Guidelines for the Award of 'I' (Incomplete) Grade

The *I* Grade may be awarded to a student who has not met all course requirements due to extraordinary circumstances, provided that:

- The student has attended at least 50% of the laboratory classes.
- The course coordinator is convinced about the circumstances and certifies the attendance record.
- The 'I' Grade must be converted into a proper grade within 10 days from the completion of the End Semester Examination.

Promotion to the Next Semester

A student will be promoted to the next semester only if they meet the following conditions:

1. **Practical Courses:** Must secure at least a ‘D’ Grade in all practical courses (no practical course can be carried over).
2. **Theory Courses:**
    - For a four-theory semester, the student must secure at least a ‘D’ Grade in two theory courses.
    - For a five-theory semester, the student must secure at least a ‘D’ Grade in three theory courses.

Repeating a Course and Additional Fees

- If a student needs to repeat a theory course from any semester, they must pay an additional examination fee for that semester/as per examination/University norms.
- The student must follow the syllabus prescribed for the fresh batch and appear for exams alongside regular students of that semester.

Attendance Requirement

- Attendance in all classes is mandatory.
- A student must maintain a minimum of 75% attendance in each subject to be eligible for the end-semester examination.
- If a student's attendance in any subject falls below 75%, they will not be allowed to appear for the examination in that subject.
- A student with poor attendance (below 75%) may be required to repeat the subject.
- Condonation of up to 25% may be granted on medical grounds or as per University norms, subject to approval.

Assessment of Student Performance and Examination Scheme

Each course carries 10 grade points, and the mode of evaluation is as follows:

For Theory Courses:

- Internal Assessment: 25% weightage
- End Semester Examination: 75% weightage

For Practical Courses:

- Continuous Evaluation during the Semester: 30% weightage
- End Semester Practical Examination/Viva-Voce: 70% weightage

Dissertation Writing Track in the Second Year of PG Programmes:

Semester III
The following four outcomes must be achieved by the end of III Semester:

- Research Problem identification
- Review of literature
- Research design formulation
- Commencement of experimentation, fieldwork, or similar tasks

Semester IV
The following three outcomes must be achieved by the end of IV Semester:

- Completion of experimentation/ fieldwork
- Submission of dissertation
- Research output in the form of any one of the following –
    - Prototype or product development/ patent
    - Any other scholastic work as recommended by the BRS and approved by the Research Council
    - Publication in a reputed Journals such as Scopus indexed journals or other similar quality journals
    - Book or Book Chapter in a publication by a reputed publisher

Academic Projects in the 2nd Year of PG Programmes

Semester III

The following four outcomes must be achieved by the end of III Semester:

- Research Problem identification
- Review of literature
- Research design formulation
- Commencement of experimentation, fieldwork, or similar tasks

Semester IV

The following three outcomes must be achieved by the end of IV Semester:

- Completion of the experimentation, fieldwork or similar task.
- Submission of project report
- Research output in the form of any one of the following –
    - Prototype or product development or patent
    - Any other scholastic work as recommended by the BRS and approved by the Research Council
    - Publication in a reputed Journals such as Scopus indexed journals or other similar quality journals
    - Draft policy formulation and submission to the concerned Ministry
    - Book or Book Chapter in a publication by a reputed publisher
    - Book translation (for Language departments)

Maximum Duration for Completion of the Program

If a student is unable to complete the coursework satisfactorily due to academic performance issues or unavoidable circumstances (such as medical reasons), they may choose to continue their studies by moderating their study plan in the subsequent semesters. To accommodate such cases, students may take a longer duration to fulfill the program requirements. Accordingly, the maximum duration allowed for completing all requirements of the MSc Informatics is 4 years from the date of admission.

Degree Requirements (3+2 scheme)

A degree will be awarded for the Two-year PG Programme (3+2) upon fulfilling the respective academic requirements for each program format:

1. Coursework-Based Program

- 10 Core Courses (Mandatory)
- 10 DSEs, or 06 DSEs+ 04 GEs
- Project Dissertation / Hands-on Training
- A total of 88 credits through successful course completion and assessments

2. Coursework + Research-Based Program

- 10 Core Courses (Mandatory)

- 08 DSEs, or 04 DSEs + 04 GEs
- Research Component:
    - A Research Project/Dissertation equivalent to the credit requirement
    - Submission of a research report/thesis evaluated by faculty
    - Participation in a seminar/presentation on research work
- A total of 88 credits, with coursework and research combined

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3. Research-Based Program

- 07 Core Courses
- 06 DSEs, or 04 DSEs + 02 GEs
- 02 Research Methods/ Tools/ Writing Courses
- Extensive Research Work:
    - Conduct original research under faculty supervision
    - Submission of a Research Thesis/Dissertation
    - Successful completion of research evaluations (seminars, progress reviews)
- A total of 88 credits, primarily research-focused

Degree Requirements (4+1 scheme)

A degree will be awarded for one year PG Programme after completion of the Four-Year UG Programme (4+1) upon fulfilling the respective academic requirements for each program format:

1. Coursework-Based Program

A student must successfully complete the following:

- 04 Core Courses (Mandatory)
- 06 DSEs, or 04 DSEs+ 02 GEs
- Project Dissertation / Hands-on Training
- A total of 44 credits through successful course completion and assessments

2. Coursework + Research-Based Program

- 04 Core Courses (Mandatory)
- 04 DSEs, or 02 DSEs + 02 GEs
- Research Component:
    - A Research Project/Dissertation equivalent to the credit requirement
    - Submission of a research report/thesis evaluated by faculty
    - Participation in a seminar/presentation on research work
- A total of 44 credits, with coursework and research combined

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3. Research-Based Program

- 01 Core Course
- 02 DSEs
- 02 Research Methods/ Tools/ Writing Courses
- Extensive Research Work:
    - Conduct original research under faculty supervision
    - Submission of a Research Thesis/Dissertation
    - Successful completion of research evaluations (seminars, progress reviews)
- A total of 44 credits, primarily research-focused

Revised Structure: Master of Science in Informatics (M.Sc. - Informatics)

M.Sc. Informatics – Two-Year PG Course Credit Scheme (3+2)

Structure-1 (Level 6.5): PG with Only Coursework

Semester	**Core Courses**		**Elective Courses**		**Skill-based/Hands-on**		**Research Methods**		**Dissertation/Project**		**Total Credits**
	No.	**Credits**	**No.**	**Credits**	**No.**	**Credits**	**No.**	**Credits**	**No.**	**Credits**	
I	3	12	2	8	1	2	-	-	-	-	22
II	3	12	2	8	1	2	-	-	-	-	22
III	2	8	3	12	1	2	-	-	-	-	22
IV	2	8	3	12	1	2	-	-	-	-	22
Total	10	40	10	40	4	8	-	-	-	-	**88**

Structure-2 (Level 6.5): PG with Coursework + Research

Semester	Core Courses		Elective Courses		Skill-based/Hands-on		Research Methods		Dissertation/Project		Total Credits
	No.	Credits	No.	Credits	No.	Credits	No.	Credits	No.	Credits	
I	3	12	2	8	1	2	-	-	-	-	22
II	3	12	2	8	1	2	-	-	-	-	22
III	2	8	2	8	-	-	-	-	1	6	22
IV	2	8	2	8	-	-	-	-	1	6	22
Total	10	40	8	32	2	4	-	-	2	12	**88**

Structure-3 (Level 6.5): PG with Research

Semester	Core Courses		Elective Courses		Skill-based/Hands-on		Research Methods		Dissertation/Project		Total Credits
	No.	Credits	No.	Credits	No.	Credits	No.	Credits	No.	Credits	
I	3	12	2	8	1	2	-	-	-	-	22
II	3	12	2	8	1	2	-	-	-	-	22
III	1	4	1	4	-	-	2	4	1	10	22
IV	-	-	1	4	-	-	1	2	1	16	22
Total	7	28	6	24	2	4	3	6	2	26	**88**

Table - II: List of Discipline Specific Electives	
Code	**Course Name**
ITDSE-01	Principles of Informatics & Digital Transformation
ITDSE-02	Programming Paradigms (C, C++)
ITDSE-03	Programming for Data Science (Python, R)
ITDSE-04	Digital Canvas: An Introduction to UI/UX Design
ITDSE-05	Mathematical foundations of computing
ITDSE-06	Computer organization and systems
ITDSE-07	Cyber Law, Data Protection & Privacy Regulations
ITDSE-08	AI-Driven Web & Mobile Application Development
ITDSE-09	Digital Image Processing
ITDSE-10	Blockchain Development & Smart Contracts
ITDSE-11	Digital electronics and Internet of Things (IoT)
ITDSE-12	Digital Forensics & Cyber Threat Intelligence
ITDSE-13	Explainable AI (XAI) & Model Interpretability
ITDSE-14	Software Engineering & Agile Development
ITDSE-15	Autonomous Systems & Robotics
ITDSE-16	NLP & Speech Processing
ITDSE-17	Deep Learning for Computer Vision
ITDSE-18	Digital Health Informatics
ITDSE-19	Cloud Computing & DevOps
ITDSE-20	Introduction to the Theory of Computation
ITDSE-21	Algorithms and Computation

Table III: List of General Electives	
Code	**Course Name**
ITGE01	Introduction to Computational Thinking & Problem Solving
ITGE02	Digital Humanities & Computational Social Sciences
ITGE03	Ethical AI & Bias Mitigation in Machine Learning
ITGE04	Ethical AI & Responsible Tech Development
ITGE05	Augmented Reality (AR) & Virtual Reality (VR)
ITGE06	Assistive Technologies & Digital Accessibility
ITGE07	Green Computing & Sustainable Technology
ITGE08	Advanced Robotics & Human-AI Collaboration
ITGE09	Social Network Analysis & Computational Propaganda
ITGE10	Cyber-Physical Systems & Smart Infrastructure
ITGE11	Future of Work: AI, Automation & Digital Labor
ITGE12	Introduction to Human-Computer Interaction
ITGE13	Research Methodology & Scientific Writing

Course Credit Scheme	
1st Year of PG for 2-year PG Programmes (3+2)	● Total credits = 44 ● Number of Discipline-Specific Core Papers = 06 ● Project (Dissertation) = Nil ● Number of Discipline-Specific Electives Papers = 04 ● Number of General Elective papers = 02 ● Skill-based course/ workshop/ Specialised laboratory/ Hands on Learning = 01
2nd Year of PG for Two-year PG Programme (3+2) or after completion of Four-Year UG Programme (4+1) with **only coursework**	● Total credits = 44 ● Number of Discipline-Specific Core Papers = 04 ● Project (Dissertation) = Nil ● Number of Discipline-Specific Electives Papers = 06 ● Number of General Elective papers = 02 ● Skill-based course/ workshop/ Specialised laboratory/ Hands on Learning = 01

2nd Year of PG for Two-year PG Programme (3+2) or after completion of Four-Year UG Programme (4+1) with **coursework + research**	• Total credits = 44 • Number of Discipline-Specific Core Papers = 04 • Project (Dissertation) = 01 • Number of Discipline-Specific Electives Papers = 04 • Number of General Elective papers = 02 • Skill-based course/ workshop/ Specialised laboratory/ Hands on Learning = Nil
2nd Year of PG for Two-year PG Programme (3+2) or after completion of Four-Year UG Programme (4+1) with **only Research**	• Total credits = 44 • Number of Discipline-Specific Core Papers = 01 • Project (Dissertation) = 01 • Number of Discipline-Specific Electives Papers = 02 • Number of General Elective papers = Nil • Skill-based course/ workshop/ Specialised laboratory/ Hands on Learning = Nil • Research Methods/ Tools/ Writing = 03

Selection of Discipline-Specific Electives and Generic Electives:

The selection of Discipline-Specific Electives and Generic Electives will be carried out through mutual consultation between students and the respective faculty members. However, students will have the flexibility to choose an elective from the available options. The list of Discipline-Specific Electives is provided in Table II, while the list of Generic Electives is provided in Table III.

Instructional Framework and Faculty Involvement:
The faculty of the department is primarily responsible for conducting lectures for courses as outlined in the syllabus. Tutorials are managed by the respective registering units under the overall supervision of the department. Additionally, as needed, faculty members from industry, other departments, and constituent colleges may also be involved in delivering lectures and conducting practical sessions within the department. Each semester will consist of 90 instructional days, excluding examination days.

M.Sc. Informatics - Course Wise Content Details

First Semester

ITC101: Artificial Intelligence: Principles and Techniques

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course introduces the fundamental principles of Artificial Intelligence. Introduce search algorithms, knowledge representation, machine learning techniques, and AI-driven decision-making.

Course Learning Outcomes (CLOs):

- CLO1: Understand the core principles of AI and its real-world applications.
- CLO2: Learn various search techniques (uninformed, heuristic, adversarial).
- CLO3: Apply knowledge representation and reasoning for problem-solving.
- CLO4: Understand machine learning basics and AI-based decision systems.
- CLO5: Discuss AI's ethical implications and societal impact.

Course Contents:

- UNIT I: Introduction to AI, problem-solving strategies, and heuristic search techniques.
- UNIT II: Knowledge representation, logic-based AI, probabilistic graphical models, and reasoning methods.
- UNIT III: Machine learning techniques: supervised, unsupervised, and reinforcement learning.
- UNIT IV: AI applications in robotics, expert systems, natural language processing (NLP).
- UNIT V: Ethical considerations, explainable AI, AI safety, and industry applications.
- The course includes tutorials/case studies/hands-on/interactive learning exercises to enhance practical understanding and application.

Recommended Readings:

1. Stuart Russell & Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 3rd Edition.
2. Elaine Rich, "Artificial Intelligence", McGraw-Hill.
3. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann.

ITC102: Operating Systems

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course covers operating system principles, including process scheduling, memory management, file systems, distributed systems, and security mechanisms.

Course Learning Outcomes:

- CLO1: Understand the fundamental structure of operating systems.
- CLO2: Learn process scheduling and resource management techniques.
- CLO3: Gain insights into memory management, virtual memory, and paging.
- CLO4: Explore file system architectures and I/O device management.
- CLO5: Study distributed computing, virtualization, and OS security.

Course Contents:

- UNIT I: Introduction to OS, types of OS, system calls, process scheduling.
- UNIT II: Interprocess communication, synchronization, deadlock detection/prevention.
- UNIT III: Memory management (paging, segmentation, virtual memory, MMU).
- UNIT IV: File systems, disk scheduling, security models, and access control policies.
- UNIT V: Virtualization, containerization (Docker, Kubernetes), cloud-based OS, and distributed OS models.
- The course includes tutorials/case studies/hands-on/interactive learning exercises to enhance practical understanding and application.

Recommended Readings:

1. Abraham Silberschatz, "Operating System Concepts", Wiley, 10th Edition.
2. William Stallings, "Operating Systems: Internals and Design Principles", Pearson.
3. Andrew S. Tanenbaum, "Modern Operating Systems", Pearson.

ITC103: Data Science & Big Data Analytics

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course focuses on data science techniques, statistical modeling, machine learning for big data, and scalable analytics frameworks.

Course Learning Outcomes:

- CLO1: Understand the core concepts of data science and its applications.
- CLO2: Learn data wrangling techniques for structured and unstructured datasets.
- CLO3: Apply statistical and machine learning models to solve real-world problems.
- CLO4: Develop data visualization techniques to communicate insights effectively.

Course Contents:

- UNIT I: Introduction to Data Science, Understanding structured, semi-structured, and unstructured data, Overview of data-driven decision-making and business intelligence.
- UNIT II: Data collection, handling missing values, and cleaning techniques, Feature selection, scaling, encoding, and transformation, Handling categorical and numerical data. Exploratory Data Analysis (EDA) and statistical summary.
- UNIT III: Descriptive statistics: mean, median, mode, variance, and standard deviation, Probability distributions (normal, binomial, Poisson), Hypothesis testing, confidence intervals, and p-values, correlation and regression analysis.
- UNIT IV: Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop**,** Hadoop Distributed File System.
- UNIT V: Importance of data visualization in decision-making, Data visualization tools: Matplotlib, Seaborn, Plotly, Tableau, Time-series visualization and dashboards, Communicating insights through effective reporting.
- The course includes tutorials/case studies/hands-on/interactive learning exercises to enhance practical understanding and application.

Recommended Readings:

1. Joel Grus, "Data Science from Scratch", O'Reilly.
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly.
3. Tom White, "Hadoop: The Definitive Guide", O'Reilly.
4. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

ITL106: Computational Data Science Lab

Marks: 100 | Duration: 30 Hrs

Course Objectives:

The lab focuses on practical implementation of data science techniques, software programming, and handling real-world datasets for analytics.

Course Learning Outcomes:

- CLO1: Implement Python-based data science workflows.
- CLO2: Use Jupyter, Pandas, NumPy, and SciPy for data analysis.
- CLO3: Work with machine learning models (scikit-learn, TensorFlow, PyTorch).
- CLO4: Implement big data processing in Spark and Hadoop.
- CLO5: Perform data visualization and storytelling (Tableau, Power BI, Matplotlib).

Course Activities:

- Lab 1: Introduction to Python for Data Science.
- Lab 2: Exploratory Data Analysis and Visualization.
- Lab 3: Implementation of Exploratory Data Analysis.

- Lab 4: Big Data Analytics.
- Lab 5: Cloud-based Data Science Solutions.

Recommended Readings:

1. Wes McKinney, "Python for Data Analysis", O'Reilly.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly.

Second Semester

ITC201: Advanced Data Structures

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course provides a comprehensive understanding of data structures, focusing on efficient data organization, manipulation, and retrieval techniques. Students will learn fundamental and advanced data structures, their implementations, and their applications in problem-solving and algorithm development.

Course Learning Outcomes:

- CLO1: Understand the concepts, operations, and importance of data structures in computer science.
- CLO2: Analyze and implement linear data structures such as arrays, linked lists, stacks, and queues.
- CLO3: Apply non-linear data structures like trees and graphs for various applications.
- CLO4: Implement sorting, searching, and hashing algorithms for data optimization.
- CLO5: Evaluate time and space complexities of different data structures and algorithms.

Course Contents:

- UNIT I: Introduction to Data Structures & Algorithm Analysis, Abstract Data Types (ADTs), Recursive Algorithms and Applications
- UNIT II: Linear Data Structures, Arrays: Static and Dynamic Arrays, Multi-dimensional Arrays, Linked Lists: Singly, Doubly, and Circular Linked Lists, Stacks: Implementation using Arrays and Linked Lists, Applications (Expression Evaluation, Backtracking), Queues: Implementation of Circular Queue, Deque, Priority Queue
- UNIT III: Non-Linear Data Structures, Trees: Binary Trees, Binary Search Trees (BST), AVL Trees, Heap Trees, B-Trees, Graph Theory: Representation (Adjacency Matrix & List), BFS, DFS, Graph Algorithms: Dijkstra's Shortest Path, Floyd-Warshall, Kruskal's and Prim's Algorithm
- UNIT IV: Sorting Algorithms: Bubble Sort, Selection Sort, Merge Sort, Quick Sort, Heap Sort, Searching Algorithms: Linear Search, Binary Search, Hashing: Hash Functions, Collision Resolution Techniques (Chaining, Open Addressing)
- UNIT V: Advanced Data Structures & Applications, Prefix Trees, Suffix Trees, Tries, Applications in Databases, AI, and Web Technologies
- The course includes tutorials/case studies/hands-on/interactive learning exercises to enhance practical understanding and application.

Recommended Readings:

1. Data Structures and Algorithm Analysis in C – Mark Allen Weiss, Pearson.
2. Data Structures and Algorithms Made Easy – Narasimha Karumanchi, CareerMonk Publications.
3. Introduction to Algorithms – Cormen, Leiserson, Rivest, and Stein (CLRS), MIT Press.

4. Data Structures and Algorithms in Java – Robert Lafore, Pearson.
5. The Algorithm Design Manual – Steven S. Skiena, Springer.

ITC202: Computer Networks and Communication

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course provides a comprehensive understanding of computer networks, communication protocols, and network security. It covers network architectures, data transmission techniques, networking models, and emerging network technologies such as 5G, SDN, and IoT.

Course Learning Outcomes:

- CLO1: Understand fundamental networking concepts, architectures, and protocols.
- CLO2: Learn the OSI and TCP/IP models and how data transmission occurs across networks.
- CLO3: Gain knowledge of wired and wireless networking technologies.
- CLO4: Understand network security principles and how to protect networked systems.
- CLO5: Explore advanced networking technologies like Software-Defined Networking (SDN), Cloud Networking, and IoT communication.

Course Contents:

- UNIT I: Introduction to Computer Networks, Overview of Networking and Communication, Types of Networks: LAN, WAN, MAN, PAN, Network Models: OSI Model, TCP/IP Model, Data Transmission Techniques: Serial vs Parallel, Synchronous vs Asynchronous
- UNIT II: Network Protocols and Layered Architecture, Physical Layer: Data Encoding, Modulation, Multiplexing, Data Link Layer: Error Detection & Correction, MAC Protocols (CSMA/CD, CSMA/CA), Ethernet, Network Layer: IP Addressing, Subnetting, Routing Algorithms (Distance Vector, Link-State), Transport Layer: TCP vs UDP, Flow Control, Congestion Control
- UNIT III: Wireless and Mobile Networking, Wireless Technologies: Wi-Fi, Bluetooth, RFID, NFC, Cellular Networks: 4G LTE, 5G, Mobile IP, IoT and Edge Computing Communication, Cloud Networking and SDN
- UNIT IV: Emerging Trends and Network Applications, Future of Networking: AI in Networking, Quantum Networks, Network Simulation and Performance Evaluation, Software-Defined Networking (SDN) and Network Function Virtualization (NFV)
- Hands-on with Tools: Wireshark, Cisco Packet Tracer, Mininet

Recommended Readings:

1. Computer Networking: A Top-Down Approach – Kurose & Ross, Pearson.
2. Data and Computer Communications – William Stallings, Pearson.
3. Computer Networks – Andrew S. Tanenbaum, Pearson.
4. TCP/IP Protocol Suite – Behrouz A. Forouzan, McGraw-Hill.
5. Network Security Essentials – William Stallings, Pearson.

ITC203: Database Management & NoSQL Technologies

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course provides a comprehensive understanding of database management systems (DBMS), relational database design, and an introduction to NoSQL technologies. It covers data modeling, query optimization, transaction management, and scalability in modern database applications. Students will also explore emerging NoSQL paradigms for handling big data and real-time applications.

Course Learning Outcomes:

- CLO1: Understand fundamental database concepts, architectures, and storage mechanisms.
- CLO2: Learn Relational Database Management Systems (RDBMS) and the SQL language for data manipulation.
- CLO3: Design efficient data models, schemas, and normalization techniques.
- CLO4: Gain insights into transaction management, concurrency control, and database security.
- CLO5: Explore NoSQL databases (Key-Value, Document, Columnar, and Graph DBs) and their applications in big data and distributed computing.

Course Contents:

- UNIT I: Introduction to Database Systems, Overview of Database Architectures, Types of Databases: Relational, Hierarchical, Object-Oriented, and NoSQL, Data Independence and Data Models (Conceptual, Logical, Physical), Entity-Relationship (ER) Modeling and Relational Model
- UNIT II: SQL and RDBMS, SQL Queries: DDL, DML, DCL, and TCL, Constraints, Views, Joins, Triggers, and Stored Procedures, Normalization (1NF, 2NF, 3NF, BCNF, 4NF, 5NF), Indexing and Query Optimization
- UNIT III: Transaction Management and Database Security, ACID Properties and Concurrency Control, Deadlock Detection and Prevention, Backup and Recovery Mechanisms, Role-Based Access Control (RBAC) and Database Security Models
- UNIT IV: Introduction to NoSQL Databases, Differences between RDBMS and NoSQL, Types of NoSQL Databases: Key-Value Stores, Document Stores, Columnar Stores, Graph Databases, CAP Theorem and BASE vs ACID Properties
- UNIT V: NoSQL Applications and Big Data Integration, Scalability and Distributed Databases, NoSQL Data Modeling Techniques, Querying NoSQL Databases using MongoDB, Integration of NoSQL with Big Data Technologies.
- The course includes tutorials/case studies/hands-on/interactive learning exercises to enhance practical understanding and application.

Recommended Readings:

1. Database System Concepts – Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw-Hill.

2. Fundamentals of Database Systems – Ramez Elmasri and Shamkant B. Navathe, Pearson.
3. SQL: The Complete Reference – James Groff and Paul Weinberg, McGraw-Hill.
4. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence – Pramod J. Sadalage and Martin Fowler, Addison-Wesley.
5. MongoDB: The Definitive Guide – Kristina Chodorow, O'Reilly.

ITL206: Data Management & Optimization Lab

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This lab focuses on practical implementation of data management techniques, database optimization strategies, and handling large-scale structured and unstructured datasets. Students will gain hands-on experience in SQL and NoSQL database performance tuning, indexing, query optimization, and data processing techniques for big data environments.

Course Learning Outcomes:

- CLO1: Implement database management techniques for handling structured and unstructured data.
- CLO2: Apply SQL and NoSQL query optimization techniques to improve database performance.
- CLO3: Work with data indexing, partitioning, and sharding for large-scale databases.
- CLO4: Use ETL (Extract, Transform, Load) pipelines for efficient data processing.
- CLO5: Optimize data storage and retrieval techniques using advanced tools.

Tools & Technologies Used:

- Relational Databases: MySQL, PostgreSQL, SQLite
- NoSQL Databases: MongoDB, Cassandra
- Big Data Frameworks: Apache Hadoop, Apache Spark
- Performance Monitoring Tools: MySQL Workbench, pgAdmin, MongoDB Atlas

Recommended Readings:

1. Database System Concepts – Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw-Hill.
2. SQL Performance Explained – Markus Winand, Redgate.
3. High-Performance MySQL – Baron Schwartz, O'Reilly.
4. MongoDB Performance Tuning – Guy Harrison, O'Reilly.
5. Optimizing SQL Queries for Faster Execution – Ian Robinson, Packt.

Third Semester

ITC301: Cybersecurity Risk Management & Compliance

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course provides a comprehensive understanding of cybersecurity risk management, governance frameworks, and compliance regulations. Students will learn to identify, assess, and mitigate security risks, ensuring organizations meet industry security standards and regulatory requirements. The course also covers cyber risk assessment methodologies, security policies, compliance laws (GDPR, ISO 27001, NIST, etc.), and cybersecurity frameworks for effective risk management.

Course Learning Outcomes:

- CLO1: Understand cybersecurity risk management principles, strategies, and threat mitigation techniques.
- CLO2: Learn industry-recognized security frameworks and compliance regulations.
- CLO3: Conduct cyber risk assessments and vulnerability analysis using modern tools and methodologies.
- CLO4: Develop and implement security policies, incident response plans, and disaster recovery strategies.
- CLO5: Analyze real-world case studies of cybersecurity breaches and regulatory non-compliance.

Course Contents:

- UNIT I: Introduction to Cybersecurity Risk Management, Fundamentals of Risk, Threats, and Vulnerabilities, Types of Cybersecurity Risks (Data Breaches, Insider Threats, Ransomware, Zero-Day Exploits), Risk Management Lifecycle: Identification, Assessment, Mitigation, Monitoring, Cyber Risk Quantification Techniques
- UNIT II: Cybersecurity Compliance and Regulatory Standards, Overview of Information Security Compliance, ISO 27001: Information Security Management System (ISMS), GDPR (General Data Protection Regulation) and Data Privacy Laws, NIST Cybersecurity Framework (Identify, Protect, Detect, Respond, Recover), SOC 2, HIPAA, PCI-DSS: Industry-Specific Compliance
- UNIT III: Risk Assessment, Governance, and Security Policies, Cyber Risk Assessment Methodologies (Qualitative vs Quantitative Risk Analysis), Network Security and Cryptography, Encryption Techniques: Symmetric (AES, DES), Asymmetric (RSA, ECC), Firewall, IDS, IPS, VPN, and Network Access Control (NAC), Secure Communication Protocols: SSL/TLS, IPSec, HTTPS
- UNIT IV: Threat Intelligence, Incident Handling, and Digital Forensics, Intrusion Detection and Prevention Systems (IDS/IPS), Incident Response Frameworks (SANS, NIST Incident Handling Guide), Digital Forensics & Evidence Handling
- UNIT V: Emerging Trends in Cyber Risk and Compliance, Cloud Security and Compliance Challenges, Zero Trust Security Model, AI & Machine Learning in Cybersecurity Risk Analysis, Future of Cybersecurity Regulation and Policy

- The course includes tutorials/case studies/hands-on/interactive learning exercises to enhance practical understanding and application.

Recommended Readings:

1. Cybersecurity and Cyber Risk Management – David Sutton, BCS Learning & Development.
2. Information Security Risk Management for ISO 27001/ISO 27002 – Alan Calder, IT Governance Publishing.
3. Cybersecurity Risk Management: Mastering the Fundamentals – Evan Wheeler, Elsevier.
4. GDPR Compliance and Data Protection – Ardi Kolah, Kogan Page.
5. The NIST Cybersecurity Framework: A Comprehensive Guide – Alan Friedman, Wiley.

ITC302: Advanced Topics in Machine Learning and AI
Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course provides an in-depth understanding of advanced machine learning techniques and artificial intelligence methodologies. It covers deep learning architectures, generative AI models, reinforcement learning, explainable AI (XAI), and federated learning. Students will explore cutting-edge AI research trends, optimization strategies, and applications in real-world scenarios such as healthcare, finance, and autonomous systems.

Course Learning Outcomes:

- CLO1: Understand advanced machine learning algorithms and deep learning architectures.
- CLO2: Explore reinforcement learning models and decision-making AI systems.
- CLO3: Learn about trustworthy AI applications.
- CLO4: Gain expertise in generative models such as GANs, VAEs, and transformers.
- CLO5: Analyze real-world AI applications and emerging AI trends (federated learning, edge AI, quantum AI).

Course Contents:

- UNIT I: Machine Learning Fundamentals, Supervised and unsupervised learning, Overview of classification (Logistic Regression, Decision Trees, k-NN), Ensemble Learning: Boosting (AdaBoost, Gradient Boosting, XGBoost), Bagging, Evaluation metrics (precision, recall, F1-score, confusion matrix).
- UNIT II: Clustering techniques (K-Means, Hierarchical, DBSCAN), Anomaly Detection & Outlier Analysis, Unsupervised Learning: Autoencoders, Dimensionality Reduction Techniques: PCA, t-SNE, UMAP
- UNIT III: Deep Learning Architectures, Convolutional Neural Networks (CNNs): ResNet, DenseNet, EfficientNet, Recurrent Neural Networks (RNNs) and LSTMs, Optimization Techniques: Adam, RMSprop, L-BFGS, Dropout, Batch Normalization.

- UNIT IV: Reinforcement Learning (RL) and Decision-Making AI, Introduction of Semi-Supervised and Reinforcement Learning, Markov Decision Processes (MDPs) and Q-Learning, Applications of RL: Robotics, Game AI, Finance
- UNIT V: Introduction of XAI, Emerging Trends in AI, Introduction to Federated Learning and Privacy-Preserving AI, Introduction to Edge AI and AI in IoT Systems, Introduction to Quantum Machine Learning, Introduction to Autonomous AI Systems (Self-Driving Cars, AI in Healthcare, Smart Cities).
- The course incorporates tutorials/case studies/hands-on exercises/interactive learning methods to enhance practical understanding and application.

Recommended Readings:

1. Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press.
2. Reinforcement Learning: An Introduction – Richard S. Sutton, Andrew G. Barto, MIT Press.
3. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron, O'Reilly.
4. Interpretable Machine Learning – Christoph Molnar, Leanpub.
5. AI Ethics – Mark Coeckelbergh, MIT Press.

ITL306: Machine Learning & Data Analytics Lab

Marks: 100 | Duration: 30Hrs

Course Objectives:

This lab provides hands-on experience in implementing machine learning models, data preprocessing techniques, feature engineering, and advanced analytics. Students will work with real-world datasets, apply deep learning algorithms, and perform predictive modeling cloud-based ML platforms.

Course Learning Outcomes:

- CLO1: Implement machine learning algorithms for supervised and unsupervised learning tasks.
- CLO2: Perform data preprocessing, feature selection, and dimensionality reduction.
- CLO3: Work with deep learning models (CNNs, RNNs, Transformers) and optimization techniques.
- CLO4: Apply big data analytics techniques using Apache Spark and cloud-based ML platforms.
- CLO5: Conduct model evaluation, tuning, and interpretability analysis using XAI.

Course Activities:

- Module 1: Data Preprocessing & Feature Engineering
- Module 2: Supervised and Unsupervised Machine Learning
- Module 3: Deep Learning & Neural Networks
- Module 4: Model Evaluation & Explainability

Tools & Technologies Used:

- Programming Languages: Python (Scikit-learn, TensorFlow, PyTorch), R
- Big Data Frameworks: Apache Spark MLlib, Hadoop
- Cloud AI Tools: AWS SageMaker, Google Vertex AI
- Visualization & Model Interpretation: Seaborn, Matplotlib, SHAP, LIME

Recommended Readings:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron, O'Reilly.
2. Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer.
3. Deep Learning for Computer Vision – Rajalingappaa Shanmugamani, Packt.
4. Mastering Apache Spark 3 – Mike Frampton, Packt.
5. Interpretable Machine Learning – Christoph Molnar, Leanpub.

Fourth Semester

ITC401: Information System Design and Management

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course focuses on the principles, methodologies, and best practices of software engineering and information system design. It covers software development life cycle (SDLC), system modeling, software architecture, project management, and quality assurance. The course also emphasizes agile methodologies, DevOps practices, and modern software engineering tools for managing large-scale software systems.

Course Learning Outcomes:

- CLO1: Understand the fundamental concepts of software engineering and information systems.
- CLO2: Learn different Software Development Life Cycle (SDLC) models and system design approaches.
- CLO3: Apply software modeling techniques (UML, ER Diagrams, DFDs) for system analysis and design.
- CLO4: Gain knowledge of software architecture, design patterns, and best practices.
- CLO5: Implement software project management strategies including Agile, Scrum, and DevOps.
- CLO6: Understand software testing, validation, and quality assurance methods for building robust systems.

Course Contents:

- UNIT I: Information Systems in Business and Strategy, Role of Information Systems in Organizations and Global Business, E-Business and Digital Collaboration, Information Systems and Business Strategy, Ethical and Social Issues in Information Systems
- UNIT II: IT Infrastructure and Emerging Technologies, IT Infrastructure Components and Cloud Computing, Foundations of Business Intelligence: Databases and Information Management, Telecommunications, Internet, and Wireless Technologies
- UNIT III: Cybersecurity and Risk Management, Cybersecurity: Securing Information Systems, IT Governance and Regulatory Compliance, Risk Management and Disaster Recovery Planning, Cyber Threat Mitigation
- UNIT IV: Enterprise Applications and E-Commerce, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM), E-Commerce Models: Digital Markets and Digital Goods, Managing Knowledge and Enhancing Decision Making, Business Intelligence and Big Data Analytics
- UNIT V: Building and Managing Information Systems, Systems Development Life Cycle (SDLC) and Agile Development, Information System Project Management, Managing IT in Global Organizations, Emerging Trends in Digital Transformation Information System Project Management, Managing IT in Global Organizations, IT Governance and Regulatory Compliance

- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Management Information Systems: Managing the Digital Firm – Kenneth C. Laudon, Jane P. Laudon, Pearson.
2.
3. Enterprise Architecture as Strategy – Jeanne W. Ross, Peter Weill, David C. Robertson, Harvard Business Review Press.
4.
5. Information Systems: A Manager's Guide to Harnessing Technology – John Gallaugher, Flat World Knowledge.
6.
7. IT Governance: How Top Performers Manage IT Decision Rights for Superior Results – Peter Weill, Jeanne W. Ross, Harvard Business Press.

ITC402: Quantum Computing Fundamentals

Marks: 100 | Duration: 60 Hrs

Course Objectives:

This course provides an introduction to quantum computing principles, quantum mechanics, and quantum algorithms. It covers quantum gates, quantum circuits, quantum cryptography, and quantum machine learning. The course also explores the potential applications of quantum computing in cryptography, optimization, artificial intelligence, and complex problem-solving.

Course Learning Outcomes:

- CLO1: Understand the fundamental principles of quantum mechanics and their application to computing.
- CLO2: Learn quantum bit (qubit) representation, quantum gates, and quantum circuits.
- CLO3: Explore quantum algorithms (Shor's algorithm, Grover's search algorithm) and their advantages over classical algorithms.
- CLO4: Gain insights into quantum cryptography, quantum error correction, and quantum supremacy.
- CLO5: Analyze the emerging applications of quantum computing in AI, finance, drug discovery, and optimization problems.

Course Contents:

- UNIT I: Introduction to Quantum Computing and Quantum Mechanics, Overview of Classical vs Quantum Computing, Postulates of Quantum Mechanics (Superposition, Entanglement, Measurement), Qubits and Quantum States (Bloch Sphere Representation), Quantum Operators and Quantum Gates (Pauli, Hadamard, CNOT, Toffoli, Swap)
- UNIT II: Quantum Circuits and Quantum Algorithms, Quantum Circuit Model and Quantum Logic Gates, Quantum Parallelism and Quantum Measurement, Shor's

Algorithm for Integer Factorization (Breaking RSA Cryptography), Grover's Algorithm for Unstructured Search

- UNIT III: Quantum Information, Quantum Key Distribution (QKD) (BB84 Protocol), Quantum Entanglement and Teleportation, Quantum Error Correction Codes (Shor Code, Surface Code), Cryptography, Challenges in Quantum Cryptography
- UNIT IV: Quantum Hardware and Computing Platforms, Quantum Cloud Platforms (IBM Quantum Experience Qiskit, Google Sycamore, D-Wave), Scalability and Noise Challenges in Quantum Computing, Current and Future Quantum Processors
- UNIT V: Emerging Applications of Quantum Computing, Quantum Machine Learning (QML) and Variational Quantum Algorithms, Quantum Computing in AI
- The course incorporates tutorials/case studies/hands-on exercises/interactive learning methods to enhance practical understanding and application.

Recommended Readings:

1. Quantum Computation and Quantum Information – Michael A. Nielsen & Isaac L. Chuang, Cambridge University Press.
2. Quantum Computing: A Gentle Introduction – Eleanor Rieffel & Wolfgang Polak, MIT Press.
3. Quantum Algorithms via Linear Algebra – Richard J. Lipton & Kenneth W. Regan, MIT Press.
4. Quantum Computing for Computer Scientists – Noson S. Yanofsky & Mirco A. Mannucci, Cambridge University Press.
5. Quantum Machine Learning: What Quantum Computing Means to Data Mining – Peter Wittek, Elsevier.

ITL406: Web Applications & Services Lab

Marks: 100 | Duration: 30 Hrs

Course Objectives:

This lab provides hands-on experience in designing, developing, and deploying web applications and services. Students will work with front-end, back-end, and full-stack development frameworks, build RESTful APIs, microservices, and cloud-integrated web applications, and learn modern DevOps practices for scalable deployment.

Course Learning Outcomes:

- CLO1: Develop responsive web applications using HTML, CSS, JavaScript, and modern frameworks.
- CLO2: Implement backend development using Python (Django/Flask) or Node.js (Express.js).
- CLO3: Design and integrate RESTful and GraphQL APIs for web applications.
- CLO4: Work with databases (SQL or NoSQL) for dynamic web applications.
- CLO5: Deploy and manage web applications on cloud platforms (AWS, Azure, GCP, Firebase).

- CLO6: Understand security best practices for web applications (OWASP guidelines, authentication, and authorization).

Course Activities:
Module 1: Front-End Web Development
Module 2: Backend Development & Database Integration
Module 3: Web Services and APIs
Module 4: DevOps & Deployment
Module 5: Advanced Topics & Security

Tools & Technologies Used:

- Front-End: HTML5, CSS3, JavaScript, React.js, Angular, Vue.js
- Back-End: Node.js (Express.js), Python (Django, Flask), FastAPI
- Databases: MySQL, PostgreSQL, MongoDB, Firebase
- APIs: RESTful, GraphQL
- DevOps & Deployment: Docker, Kubernetes, AWS, Azure, Firebase Hosting
- Security: OWASP Top 10, OAuth2, JWT, CSRF Protection

Recommended Readings:

1. Eloquent JavaScript – Marijn Haverbeke, No Starch Press.
2. You Don't Know JS – Kyle Simpson, O'Reilly.
3. Flask Web Development – Miguel Grinberg, O'Reilly.
4. Node.js Design Patterns – Mario Casciaro, Packt.
5. Web Security for Developers – Malcolm McDonald, No Starch Press.

Masters of Science in Informatics – M.Sc. (Informatics)
Discipline Specific Elective Courses

ITDSE-01: Principles of Informatics & Digital Transformation
Marks: 100 | Duration: 60 Hrs

Course Objectives:

1. Introduce fundamental concepts of informatics and its role in the digital era.
2. Explore the impact of digital transformation on industries and organizations.
3. Understand data-driven decision-making and emerging technologies.
4. Discuss ethical, legal, and societal aspects of digital transformation.

Course Learning Outcomes:

1. Understand key informatics concepts and digital transformation principles.
2. Analyze the role of digital technologies in modern enterprises.
3. Apply informatics methods to solve real-world problems.
4. Evaluate ethical and legal challenges in digitalization.

Course Contents:

- UNIT I: Fundamentals of Informatics, Definition, scope, and interdisciplinary nature of informatics, Evolution and significance of informatics in various domains, Role of informatics in scientific research, healthcare, business, and education
- UNIT II: Digital Transformation & Emerging Technologies, Digital transformation: definition, key drivers, and impact on industries, Role of cloud computing in digital transformation, Internet of Things (IoT): architecture, communication models, and applications, Case studies of digital transformation in healthcare, finance, and manufacturing
- UNIT III: Big Data, Analytics & Decision Making, Overview of big data: data sources, structured vs. unstructured data, Data collection, storage, and processing techniques, Data visualization tools and techniques for decision-making, Predictive analytics and AI-driven insights for business intelligence
- UNIT IV: AI, Automation & Cybersecurity, Role of artificial intelligence and automation in modern computing, Applications of AI in business, healthcare, and governance, Cybersecurity challenges in the digital age: threats, risks, and mitigation strategies, Privacy concerns and frameworks for securing personal and organizational data
- UNIT V: Ethical & Legal Aspects of Informatics, Ethical challenges in informatics: bias in AI, digital rights, and misinformation, Global data protection regulations (GDPR, CCPA) and their implications, AI ethics, accountability, and transparency in automated decision-making, Future trends and responsible innovation in informatics
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Laudon & Laudon, *Management Information Systems*.
2. McAfee & Brynjolfsson, *Machine, Platform, Crowd*.
3. Porter & Heppelmann, *How Smart, Connected Products Are Transforming Companies*.
4. Articles and case studies from IEEE, ACM, and Harvard Business Review.

ITDSE-02: Programming Paradigms (C, C++)
Marks: 100 | Duration: 60 Hrs

Course Objectives:

1. Introduce fundamental programming paradigms with C and C++.
2. Develop problem-solving skills through structured and object-oriented programming.
3. Understand memory management, data structures, and algorithms.
4. Prepare students for system programming and software development.

Course Learning Outcomes:

1. Implement structured programming concepts using C.
2. Develop object-oriented solutions using C++.
3. Utilize efficient data structures and algorithms.
4. Optimize memory usage and system resources in programming.

Course Contents:

- UNIT I: Introduction to Programming Paradigms and C Basics, Overview of programming paradigms: Imperative, Procedural, Object-Oriented. Basics of C programming: Variables, data types, operators, and expressions, Control structures: Loops and decision-making statements, Functions and modular programming in C
- UNIT II: Pointers, Memory Management, Understanding pointers and dynamic memory allocation (malloc, calloc, free), Arrays and pointer arithmetic, Linked lists, stacks, and queues, File handling in C
- UNIT III: Introduction to Object-Oriented Programming, Basics of C++: Syntax, classes, and objects, Constructors and destructors, Inheritance: Single, multiple, and hierarchical inheritance, Polymorphism: Function overloading and operator overloading
- UNIT IV: Standard Template Library (STL) and Advanced C++ Concepts, Overview of STL: Vectors, lists, maps, and iterators, Function templates and class templates, Exception handling in C++
- UNIT V: Advanced Programming and System-Level Features, Memory management techniques in C++ (new, delete, smart pointers), Multi-threading concepts (basics of thread creation and synchronization), Performance optimization techniques
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Kernighan & Ritchie, *The C Programming Language*.

2. Stroustrup, *The C++ Programming Language*.
3. Deitel & Deitel, *C++ How to Program*.
4. Robert Lafore, *Object-Oriented Programming in C++*.

ITDSE-03: Programming for Data Science (Python, R)
Marks: 100 | Duration: 60 Hrs

Course Objectives:

1. Introduce Python and R for data science applications.
2. Develop skills for data manipulation, visualization, and statistical analysis.
3. Apply machine learning techniques using Python and R libraries.
4. Prepare students for data-driven decision-making in real-world applications.

Course Learning Outcomes:

1. Implement data handling and processing techniques using Python and R.
2. Perform exploratory data analysis and visualization.
3. Apply machine learning models for classification and regression tasks.
4. Utilize Python and R for real-world data science applications.

Course Contents:

- UNIT I:Overview of Python or R, Setting up Jupyter Notebook, RStudio, and IDEs, Variables, data types, and control structures, Functions and scripting in Python and R
- UNIT II: Data Manipulation and Handling, Working with structured and unstructured data, Data manipulation using Pandas, NumPy (Python) or dplyr, tidyr (R), Handling missing data, filtering, grouping, and summarizing, String operations and regular expressions
- UNIT III: Data Visualization and Statistical Analysis, Data visualization using Matplotlib, Seaborn (Python) and ggplot2 (R), Descriptive statistics and exploratory data analysis (EDA), Probability distributions, hypothesis testing, and regression analysis, Correlation and statistical inference
- UNIT IV: Machine Learning Fundamentals in Python or R, Introduction to machine learning concepts, Supervised learning: Linear Regression, Decision Trees, SVM, Unsupervised learning: K-Means, PCA, Clustering techniques, Implementation using Scikit-learn (Python) and caret (R)
- UNIT V: Working with Databases and Real-World Applications, SQL and NoSQL database integration with Python and R, Web scraping and data acquisition from APIs
- The course incorporates tutorials/case studies/hands-on exercises/interactive learning methods to enhance practical understanding and application.

Recommended Readings:

1. Wes McKinney, *Python for Data Analysis*.
2. Hadley Wickham & Garrett Grolemund, *R for Data Science*.

3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*.
4. Trevor Hastie, Robert Tibshirani, *The Elements of Statistical Learning*.

ITDSE-04: Digital Canvas: An Introduction to UI/UX Design
Marks: 100 | Duration: 60 Hrs

Course Objectives

- To introduce fundamental principles of User Interface (UI) and User Experience (UX) design.
- To develop an understanding of user-centered design methodologies.
- To provide hands-on experience with wireframing, prototyping, and usability testing.
- To explore modern tools and techniques used in UI/UX design.

Course Learning Outcomes:

1. Explain key UI/UX principles and design methodologies.
2. Conduct user research and usability testing.
3. Develop wireframes, prototypes, and interactive designs.
4. Apply cognitive psychology and accessibility considerations in UI/UX.
5. Utilize modern UI/UX tools like Figma, Adobe XD, or Sketch.

Course Contents

- UNIT I: Introduction to UI/UX Design & User-Centered Design, Definition and importance of UI/UX design, Difference between UI and UX, Principles of user-centered design, Overview of the design thinking process
- UNIT II: User Research & Analysis, Understanding user personas and their importance, Conducting user research: Surveys, interviews, and observations, Analyzing user behavior and journey mapping, Competitive analysis in UI/UX design
- UNIT III: Wireframing & Prototyping, Introduction to wireframes: Low-fidelity vs. high-fidelity wireframes, Prototyping tools and techniques (Figma, Adobe XD, Sketch), Creating interactive prototypes, Usability testing methods: A/B testing and heuristic evaluation
- UNIT IV: Visual & Interaction Design, Fundamentals of color theory, typography, and layout design, Design patterns, consistency, and usability principles, Responsive vs. adaptive design approaches, Microinteractions and animations in UI design
- UNIT V: Usability Testing & Accessibility, UX heuristics and cognitive load reduction techniques, Accessibility guidelines (WCAG compliance), Usability testing strategies and user feedback analysis, Iterative design improvements based on testing outcomes
- The course incorporates tutorials/case studies/hands-on exercises/interactive learning methods to enhance practical understanding and application.

Recommended Readings

1. Norman, D. A. *The Design of Everyday Things*. Basic Books.

2. Krug, S. *Don't Make Me Think: A Common Sense Approach to Web Usability*. New Riders.
3. Garrett, J. J. *The Elements of User Experience*. New Riders.
4. Interaction Design Foundation articles and research papers.

ITDSE-05: Mathematical Foundations of Computing
Marks: 100 | Duration: 60 Hrs

Course Objectives

- To introduce mathematical concepts fundamental to computing and algorithm design.
- To develop logical reasoning and problem-solving skills for computer science applications.
- To provide a foundation in discrete mathematics, probability, and graph theory.
- To explore mathematical modeling techniques used in machine learning and AI.

Course Learning Outcomes (CLOs)

1. Apply set theory, logic, and proof techniques in computing problems.
2. Understand graph theory, combinatorics, and probability in algorithm design.
3. Analyze and solve computational problems using mathematical models.
4. Use linear algebra and matrix operations in applications like data science.

Course Contents

- UNIT I: Set Theory & Combinatorics, Relations, functions, and their properties, Cardinality of sets and countability, Permutations, combinations, and the binomial theorem, Inclusion-exclusion principle and pigeonhole principle
- UNIT II: Graph Theory & Applications, Graph representation: Adjacency matrix and adjacency list, Graph traversals: BFS and DFS, Trees, spanning trees, and minimum spanning tree algorithms, Connectivity, network flows, and applications in computing
- UNIT III: Probability & Statistics, Bayes' theorem and conditional probability, Random variables and probability distributions, Expectation, variance, and standard deviation, Regression and correlation techniques in data analysis
- UNIT IV: Linear Algebra for Computing, Matrices, determinants, and their properties, Vector spaces and linear transformations, Eigenvalues, eigenvectors, and diagonalization, Singular Value Decomposition (SVD) and applications
- UNIT V: Applications in Computing & Machine Learning, Graph theory in social networks and web analytics, Probability and statistics in data science, Linear algebra in graphics and image processing, Applications of eigenvalues and eigenvectors in machine learning
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings

1. Rosen, K. H. *Discrete Mathematics and Its Applications*. McGraw-Hill.
2. Cormen, T. H., Leiserson, C. E., Rivest, R. L. *Introduction to Algorithms*. MIT Press.
3. Grimaldi, R. P. *Discrete and Combinatorial Mathematics*. Pearson.
4. Strang, G. *Linear Algebra and Its Applications*. Brooks Cole.

ITDSE-06: Computer Organization and Systems
Marks: 100 | Duration: 60 Hrs

Course Objectives

- To introduce fundamental principles of computer architecture and system organization.
- To explore hardware-software interactions and system performance considerations.
- To analyze the structure of processors, memory, and input/output systems.
- To provide insights into parallel computing and modern computing architectures.

Course Learning Outcomes:

1. Understand the workings of digital logic circuits and computer organization.
2. Describe instruction set architectures (ISA) and assembly language programming.
3. Analyze memory hierarchy, caching, and performance optimization techniques.
4. Explore modern processor designs, parallel computing, and cloud computing infrastructures.

Course Contents

- UNIT I: Digital Logic & Computer Organization, Boolean algebra, logic gates, and combinational circuits, Sequential circuits: Flip-flops, registers, and counters, Number systems, arithmetic operations, and ALU design, Introduction to computer organization and Von Neumann architecture
- UNIT II: Instruction Set Architecture (ISA) & Assembly Language, Machine instructions, addressing modes, and instruction formats, Assembly language programming and instruction execution cycle, RISC vs. CISC architectures, Control unit design: Hardwired and microprogrammed control
- UNIT III: Memory Hierarchy & Performance Optimization, Memory organization and types: RAM, ROM, cache memory, Cache mapping techniques and replacement policies, Virtual memory, paging, and segmentation, Performance optimization techniques: Pipelining and instruction-level parallelism
- UNIT IV: Modern Processor Architectures & Parallel Computing, Multi-core and superscalar architectures, Thread-level parallelism and GPU computing, Instruction scheduling, out-of-order execution, and branch prediction, Introduction to vector processing and SIMD architectures
- UNIT V: Advanced Computing & Cloud Infrastructures, Introduction to distributed computing and cloud architectures, Virtualization techniques and containerization (Docker, Kubernetes), High-performance computing (HPC) and data centers, Trends in computing: Edge computing, IoT, and AI-driven hardware
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings

1. Stallings, W. *Computer Organization and Architecture: Designing for Performance*. Pearson.
2. Patterson, D. A., Hennessy, J. L. *Computer Organization and Design: The Hardware/Software Interface*. Morgan Kaufmann.
3. Tanenbaum, A. S., Austin, T. *Structured Computer Organization*. Pearson.
4. Mano, M. M., Kime, C. R. *Logic and Computer Design Fundamentals*. Pearson.

ITDSE-07: Cyber Law, Data Protection & Privacy Regulations
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To understand legal frameworks for cybersecurity and data protection.
- To explore privacy regulations across different jurisdictions.
- To analyze case studies on cybercrime, intellectual property, and compliance issues.

Course Learning Outcomes:

1. Explain cyber laws and compliance requirements.
2. Analyze case laws on cybersecurity breaches and data protection.
3. Assess the impact of global privacy regulations like GDPR and CCPA.
4. Develop strategies for ethical and legal data handling.

Course Contents:

- UNIT I: Introduction to Cyber Law & Ethics, Overview of cyber law and its importance, Cybercrimes: Types, legal definitions, and penalties, Ethical considerations in cyberspace, Intellectual property rights (IPR) in the digital domain
- UNIT II: Data Protection & Privacy Laws, General Data Protection Regulation (GDPR) principles and compliance, California Consumer Privacy Act (CCPA) and its impact, India's Digital Personal Data Protection Act (DPDPA) and global privacy regulations, Cross-border data transfer and jurisdictional challenges
- UNIT III: Digital Evidence & Cyber Forensics, Fundamentals of digital forensics and investigation techniques, Collection, preservation, and admissibility of digital evidence, Cybercrime investigation procedures, Role of law enforcement and regulatory bodies
- UNIT IV: Cybersecurity Frameworks & Compliance, Overview of cybersecurity policies and standards (ISO 27001, NIST), Risk management and legal responsibilities in cybersecurity, Compliance requirements for businesses and organizations, Legal aspects of blockchain, artificial intelligence, and emerging technologies
- UNIT V: Case Studies & Emerging Trends, Case studies on major cybersecurity breaches and legal actions, Role of cyber law in digital transformation and e-governance, Future trends: AI ethics, quantum computing security, and global policy developments
- The course incorporates tutorials/case studies/hands-on exercises/interactive learning methods to enhance practical understanding and application.

Recommended Readings:

1. Solove, D. J. *Understanding Privacy*. Harvard University Press.
2. Kerr, O. S. *Computer Crime Law*. West Academic.
3. Global and national cybersecurity policies and regulations.

ITDSE-08: AI-Driven Web & Mobile Application Development
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To integrate AI capabilities in web and mobile applications.
- To develop intelligent applications using modern frameworks.
- To explore real-time applications of AI-driven automation.

Course Learning Outcomes:

1. Design AI-enhanced user experiences for web and mobile apps.
2. Develop applications using AI APIs and frameworks.
3. Implement natural language processing and computer vision in applications.
4. Optimize AI models for performance in mobile and web environments.

Course Contents:

- UNIT I: Introduction to AI-Driven Applications, Overview of AI integration in web and mobile applications, AI in UI/UX: personalization, adaptive interfaces, and behavior-driven design, Conversational AI: chatbots, virtual assistants, and voice-based interactions, AI-powered automation in applications
- UNIT II: Machine Learning for Web & Mobile Applications, Supervised vs. unsupervised learning for application development, Model training, optimization, and deployment strategies, Frameworks for AI integration: TensorFlow.js, TensorFlow Lite, PyTorch Mobile, Cloud-based AI services: Google AI, AWS AI, Azure Cognitive Services
- UNIT III: AI-Enabled Web Development, AI-powered search and recommendation systems (collaborative and content-based filtering), NLP applications: sentiment analysis, automatic translation, and text summarization, Automated UI generation, adaptive A/B testing, and heatmap analysis, AI-enhanced cybersecurity: fraud detection, anomaly detection, and automated threat response
- UNIT IV: Mobile AI & Edge Computing, On-device AI processing vs. cloud-based AI inference, AI model compression techniques (quantization, pruning, knowledge distillation), Real-time image and speech processing for mobile applications, Edge computing frameworks: TensorFlow Lite, Core ML, MediaPipe, OpenVINO
- UNIT V: AI Applications, Deployment & Future Trends, AI in gaming, healthcare, e-commerce, and financial applications, Ethical considerations: bias mitigation, privacy, and security in AI applications, Case studies of AI-powered web and mobile applications, Future trends in AI-driven app development: generative AI, federated learning, and multimodal AI

- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Russell, S., Norvig, P. *Artificial Intelligence: A Modern Approach*. Pearson.
2. Flach, P. *Machine Learning: The Art and Science of Algorithms That Make Sense of Data*. Cambridge University Press.
3. TensorFlow, PyTorch, and AI-driven development documentation.

ITDSE-09: Digital Image Processing
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce fundamental concepts of digital image processing and computer vision.
- To explore image enhancement, restoration, and compression techniques.
- To implement image analysis, segmentation, and object detection.
- To apply deep learning techniques for image classification and recognition.

Course Learning Outcomes:

- Understand the fundamental principles of image processing.
- Implement image enhancement, filtering, and restoration techniques.
- Apply edge detection, segmentation, and object tracking.
- Develop computer vision applications using OpenCV and deep learning frameworks.

Course Contents:

- UNIT I: Introduction to Digital Image Processing, Basics of digital images, color models, and formats, Image sampling, quantization, and resolution
- UNIT II: Image Enhancement & Filtering, Spatial and frequency domain techniques, Histogram equalization, contrast stretching, Smoothing, sharpening, and noise reduction
- UNIT III: Image Segmentation & Feature Extraction, Edge detection (Sobel, Canny, Laplacian), Thresholding and region-based segmentation, Feature descriptors (SIFT, SURF, ORB)
- UNIT IV: Object Detection & Deep Learning for Images, Convolutional Neural Networks (CNNs), Image classification and object detection, Face recognition and real-time video analysis
- UNIT V: Image Compression & Applications, Lossless vs lossy compression (JPEG, PNG, GIF), Video compression (MPEG, H.264), Applications in medical imaging, biometrics, and remote sensing
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Gonzalez, R. C., Woods, R. E. *Digital Image Processing*. Pearson.

2. Szeliski, R. *Computer Vision: Algorithms and Applications*. Springer.
3. Goodfellow, I., Bengio, Y., Courville, A. *Deep Learning*. MIT Press.
4. OpenCV and TensorFlow documentation for image processing and computer vision.

ITDSE-10: Blockchain Development & Smart Contracts
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce blockchain technology and its applications.
- To explore the architecture of distributed ledgers and consensus mechanisms.
- To develop and deploy smart contracts on Ethereum and other blockchain platforms.
- To analyze security, privacy, and scalability challenges in blockchain.

Course Learning Outcomes:

- Explain blockchain fundamentals, consensus mechanisms, and cryptographic principles.
- Develop smart contracts using Solidity and deploy them on Ethereum.
- Implement decentralized applications (DApps) using Web3.js and IPFS.
- Analyze scalability, security, and governance challenges in blockchain.

Course Contents:

- UNIT I: Introduction to Blockchain Technology, Fundamentals of blockchain and distributed ledgers, Cryptographic techniques: hashing, digital signatures, and encryption, Consensus mechanisms (Proof-of-Work, Proof-of-Stake, Byzantine Fault Tolerance)
- UNIT II: Smart Contracts & Solidity Programming, Writing and deploying smart contracts on Ethereum, Solidity programming language: variables, functions, and events, Security vulnerabilities in smart contracts (reentrancy, overflow, etc.)
- UNIT III: Decentralized Applications (DApps) Development, Web3.js integration with smart contracts, Interacting with Ethereum blockchain using Metamask, Storing data on IPFS and other decentralized storage solutions
- UNIT IV: Blockchain Security, Privacy, and Scalability, Privacy-enhancing technologies (zk-SNARKs, Ring Signatures), Layer-2 scaling solutions (Sidechains, State Channels, Rollups), Governance models and enterprise blockchain solutions (Hyperledger, Corda)
- UNIT V: Real-World Applications of Blockchain, Cryptocurrencies and DeFi (Decentralized Finance), NFT (Non-Fungible Tokens) and digital asset tokenization, Blockchain for supply chain, healthcare, and identity management
- The course incorporates tutorials/case studies/hands-on exercises/interactive learning methods to enhance practical understanding and application.

Recommended Readings:

1. Nakamoto, S. *Bitcoin: A Peer-to-Peer Electronic Cash System* (Whitepaper).
2. Antonopoulos, A. M. *Mastering Blockchain*. O'Reilly Media.
3. Dannen, C. *Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners*. Apress.
4. Ethereum, Hyperledger, and Web3.js documentation.

ITDSE-11: Digital Electronics and Internet of Things (IoT)
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the fundamentals of digital electronics and embedded systems.
- To explore the architecture and working of microcontrollers and IoT devices.
- To develop IoT applications using sensors, actuators, and communication protocols.
- To analyze security challenges and cloud integration in IoT networks.

Course Learning Outcomes:

- Understand digital circuits, logic gates, and microcontroller programming.
- Design and implement IoT applications using sensors and wireless communication.
- Analyze IoT protocols like MQTT, CoAP, and LoRaWAN.
- Evaluate IoT security threats and cloud-based IoT integration.

Course Contents:

- UNIT I: Introduction to Digital Electronics, Number systems, Boolean algebra, and logic gates, Combinational and sequential circuits, Flip-flops, multiplexers, demultiplexers, and memory elements
- UNIT II: Microcontrollers & Embedded Systems, Overview of 8051, AVR, ARM, and ESP32 microcontrollers, Embedded programming in C/C++ and Python, Introduction to real-time operating systems (RTOS)
- UNIT III: Introduction to IoT Architecture, Components of IoT: sensors, actuators, edge devices, IoT communication models and data flow, IoT cloud platforms: AWS IoT, Google Cloud IoT, Azure IoT
- UNIT IV: IoT Protocols and Communication, Wireless communication: Bluetooth, Zigbee, LoRaWAN, Message Queuing Telemetry Transport (MQTT), CoAP, and HTTP, Edge computing and fog computing in IoT
- UNIT V: IoT Security and Applications, Security challenges in IoT networks, Encryption and authentication in IoT devices, Case studies: smart homes, healthcare, and industrial IoT
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Tocci, R. J., Widmer, N. S. *Digital Systems: Principles and Applications*. Pearson.
2. Floyd, T. L. *Digital Fundamentals*. Pearson.
3. Pujol, F. *IoT Security Issues: Threats, Risks, and Countermeasures*. Springer.
4. Al-Fuqaha, A., Guizani, M. *Internet of Things: Architectures, Protocols, and Standards*. Wiley.

ITDSE-12: Digital Forensics & Cyber Threat Intelligence
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the fundamentals of digital forensics and cyber threat intelligence.
- To explore cybercrime investigation techniques and forensic tools.
- To analyze malware, network intrusions, and threat detection strategies.
- To develop expertise in incident response and legal aspects of digital evidence.

Course Learning Outcomes:

- Explain digital forensic principles and forensic investigation methodologies.
- Analyze malware, logs, and digital footprints for cyber threat intelligence.
- Apply forensic tools like Autopsy, FTK, Wireshark, and Volatility.
- Understand legal frameworks, privacy regulations, and cyber laws.

Course Contents:

- UNIT I: Introduction to Digital Forensics, Basics of digital evidence and forensic investigation process, Types of cybercrimes: hacking, phishing, ransomware, identity theft, Forensic tools and lab setup
- UNIT II: Computer and Network Forensics, Disk imaging, file system analysis, and data recovery, Log analysis and intrusion detection, Network packet analysis using Wireshark
- UNIT III: Malware Analysis & Cyber Threat Intelligence, Static and dynamic malware analysis, Reverse engineering of malware, Threat intelligence frameworks (MITRE ATT&CK, OpenCTI)
- UNIT IV: Incident Response & Cybercrime Investigation, Handling security incidents and forensic reporting, Cloud forensics and IoT forensics, Blockchain forensics and cryptocurrency tracking
- UNIT V: Legal Aspects & Compliance, Digital evidence handling and chain of custody, Cyber laws: GDPR, CCPA, IT Act, 2000, Ethical hacking and forensic challenges
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Casey, E. *Digital Forensics and Cyber Crime*. Elsevier.
2. Nelson, B., Phillips, A., Steuart, C. *Guide to Computer Forensics and Investigations*. Cengage Learning.
3. Easttom, C. *Computer Security Fundamentals*. Pearson.
4. MITRE ATT&CK and NIST Cybersecurity Framework documentation.

ITDSE-13: Explainable AI (XAI) & Model Interpretability
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the fundamentals of XAI and the need for model interpretability.
- To explore techniques for interpreting ML and deep learning models.
- To analyze trade-offs between accuracy and interpretability in AI models.
- To develop explainable AI models for critical applications like healthcare and finance.

Course Learning Outcomes:

- Understand the importance of XAI and ethical AI principles.
- Apply feature importance, rule-based explanations, and visualization methods.
- Implement post-hoc explainability techniques like SHAP, LIME, and counterfactual explanations.
- Design AI models that are transparent, fair, and interpretable.

Course Contents:

- UNIT I: Introduction to Explainable AI, Importance of model interpretability, Black-box vs white-box models, Ethical considerations in AI decision-making
- UNIT II: Model Interpretability Techniques, Feature importance and decision trees, Partial dependence plots (PDPs) and accumulated local effects (ALE), Counterfactual explanations
- UNIT III: Post-hoc Explainability Methods, Local Interpretable Model-agnostic Explanations (LIME), SHapley Additive exPlanations (SHAP), Integrated Gradients and Saliency Maps for Deep Learning
- UNIT IV: Fairness, Bias, and Trust in AI, Bias detection and mitigation in AI models, Regulatory frameworks for explainability (GDPR, AI Ethics Guidelines), Case studies in healthcare, finance, and law enforcement
- UNIT V: XAI in Real-World Applications, Explainability for NLP models (Transformer-based models like BERT), Explainability in computer vision (CNN visualization techniques), Tools and frameworks for XAI: IBM AI Explainability 360, Google What-If Tool
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Molnar, C. *Interpretable Machine Learning*.
2. Doshi-Velez, F., Kim, B. *Towards A Rigorous Science of Interpretable Machine Learning*.
3. Burkart, N., Huber, M. F. *A Survey on Explainability of Supervised Machine Learning*.
4. Google AI, IBM AI Explainability 360, and OpenAI documentation on model interpretability.

ITDSE-14: Software Engineering & Agile Development
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce software engineering principles and best practices.
- To explore agile methodologies, DevOps, and continuous integration (CI/CD).
- To develop scalable and maintainable software architectures.
- To analyze quality assurance, testing, and software project management.

Course Learning Outcomes:

- Understand SDLC models.
- Apply agile methodologies like Scrum and Kanban for software development.
- Develop and deploy software using CI/CD pipelines and DevOps practices.
- Implement software testing strategies, version control, and documentation.

Course Contents:

- UNIT I: Software Engineering Fundamentals, Software development life cycle (Waterfall, Agile, DevOps), Requirement analysis and software design principles, Object-oriented design and UML diagrams
- UNIT II: Agile Software Development, Agile principles and methodologies (Scrum, Kanban, XP), Sprint planning, backlog grooming, and stand-up meetings, Agile documentation and project tracking tools (JIRA, Trello)

- UNIT III: DevOps and CI/CD, Version control using Git and GitHub, Continuous Integration/Continuous Deployment (Jenkins, GitHub Actions), Containerization and orchestration (Docker, Kubernetes)
- UNIT IV: Software Testing and Quality Assurance, Unit testing, integration testing, system testing, Automated testing frameworks (JUnit, Selenium), Software maintenance and debugging strategies
- UNIT V: Software Project Management & Security, Risk management in software engineering, Secure coding practices and compliance, Case studies on software failures and best practices
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Sommerville, I. *Software Engineering*. Pearson.
2. Pressman, R. S. *Software Engineering: A Practitioner's Approach*. McGraw-Hill.
3. Beck, K. *Extreme Programming Explained: Embrace Change*. Addison-Wesley.
4. Atlassian and Microsoft documentation on Agile and DevOps methodologies.

ITDSE-15: Autonomous Systems & Robotics
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the fundamentals of autonomous systems and robotics.
- To explore robot perception, motion planning, and control.
- To analyze AI-based decision-making and reinforcement learning for robotics.
- To develop applications in self-driving vehicles, drones, and industrial automation.

Course Learning Outcomes:

- Understand robotic kinematics, dynamics, and control systems.
- Implement sensor fusion techniques for robot perception.
- Apply motion planning and navigation algorithms.
- Develop AI-driven autonomous systems using deep learning and reinforcement learning.

Course Contents:

- UNIT I: Introduction to Autonomous Systems & Robotics, Types of robots (industrial, mobile, humanoid, swarm), Components: actuators, sensors, microcontrollers, Overview of robotic operating systems (ROS)
- UNIT II: Perception and Sensor Fusion, Vision-based sensing (cameras, LiDAR, depth sensors), IMU and GPS-based localization, Sensor fusion using Kalman filters
- UNIT III: Motion Planning & Navigation, Path planning algorithms (A*, Dijkstra, RRT), Simultaneous Localization and Mapping (SLAM), Obstacle avoidance and real-time decision-making
- UNIT IV: AI & Reinforcement Learning for Robotics, Deep learning for robotic perception, Reinforcement learning for control (DQN, PPO, A3C), Applications in self-driving cars, drones, and robotic arms

- UNIT V: Autonomous Systems Applications & Ethics, Self-driving vehicles and industrial automation, Ethics and safety considerations in robotics, Case studies: Boston Dynamics, Tesla Autopilot
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Siciliano, B., Khatib, O. *Springer Handbook of Robotics*. Springer.
2. Thrun, S., Burgard, W., Fox, D. *Probabilistic Robotics*. MIT Press.
3. Sutton, R. S., Barto, A. G. *Reinforcement Learning: An Introduction*. MIT Press.
4. ROS and OpenAI Gym documentation for robotic simulation.

ITDSE-16: NLP & Speech Processing
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the fundamentals of Natural Language Processing (NLP) and Speech Processing.
- To explore language modeling, text representation, and deep learning techniques for NLP.
- To analyze speech synthesis, recognition, and conversational AI.
- To develop applications in chatbots, machine translation, and voice assistants.

Course Learning Outcomes:

- Understand tokenization, word embeddings, and syntactic parsing.
- Apply transformer-based models like BERT, GPT for NLP tasks.
- Implement speech recognition and text-to-speech (TTS) systems.
- Develop real-world NLP applications in healthcare, finance, and customer support.

Course Contents:

- UNIT I: Introduction to NLP & Speech Processing, Basics of linguistics: syntax, semantics, and pragmatics, Overview of speech processing and phonetics, Applications of NLP in industry
- UNIT II: Text Representation & Language Modeling, Bag-of-Words, TF-IDF, and word embeddings (Word2Vec, GloVe), N-grams, statistical language models, Transformer architectures (BERT, GPT)
- UNIT III: Deep Learning for NLP, Sequence-to-sequence models (RNN, LSTM, GRU), Attention mechanisms and transformer-based NLP, Sentiment analysis, named entity recognition (NER)
- UNIT IV: Speech Recognition & Synthesis, Automatic Speech Recognition (ASR) techniques, Text-to-Speech (TTS) and speech synthesis, Speech enhancement and noise reduction
- UNIT V: Conversational AI & NLP Applications, Chatbot and virtual assistant development, Machine translation (Google Translate, DeepL), Ethical challenges in NLP (bias, misinformation)

- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Jurafsky, D., Martin, J. H. *Speech and Language Processing*. Pearson.
2. Goldberg, Y. *Neural Network Methods for Natural Language Processing*. Morgan & Claypool.
3. Vaswani, A. et al. *Attention Is All You Need* (Transformer Paper).
4. Hugging Face and TensorFlow documentation on NLP models.

ITDSE-17: Deep Learning for Computer Vision
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the fundamentals of deep learning for computer vision.
- To explore CNNs and modern deep learning architectures.
- To analyze object detection, segmentation, and image generation techniques.
- To develop real-world applications in autonomous systems, healthcare, and biometrics.

Course Learning Outcomes:

- Understand CNN architectures and their applications in vision tasks.
- Implement transfer learning and fine-tuning for image classification.
- Apply object detection (YOLO, Faster R-CNN) and image segmentation (U-Net, Mask R-CNN).
- Develop computer vision applications using TensorFlow, PyTorch, and OpenCV.

Course Contents:

- UNIT I: Introduction to Deep Learning for Computer Vision, Fundamentals of image processing and feature extraction, Overview of neural networks and deep learning, Evolution of CNNs for vision tasks
- UNIT II: Convolutional Neural Networks & Feature Learning, Convolution, pooling, and activation functions, Architectures: AlexNet, VGG, ResNet, DenseNet, Transfer learning and fine-tuning for vision tasks
- UNIT III: Object Detection & Image Segmentation, Object detection models: YOLO, SSD, Faster R-CNN, Image segmentation: U-Net, Mask R-CNN, Applications in medical imaging and autonomous systems
- UNIT IV: Generative Models & Advanced Techniques, Generative Adversarial Networks (GANs) for image synthesis, Variational Autoencoders (VAEs), Image super-resolution and style transfer
- UNIT V: Computer Vision Applications & Deployment, Face recognition and biometrics, AI-powered video analytics, Deployment of vision models on edge devices (TensorFlow Lite, NVIDIA Jetson)
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Goodfellow, I., Bengio, Y., Courville, A. *Deep Learning*. MIT Press.

2. Chollet, F. *Deep Learning with Python*. Manning Publications.
3. Szeliski, R. *Computer Vision: Algorithms and Applications*. Springer.
4. TensorFlow, PyTorch, and OpenCV documentation for deep learning models.

ITDSE-18: Digital Health Informatics
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce digital health informatics and healthcare data analytics.
- To explore electronic health records (EHR), medical imaging, and telemedicine.
- To analyze AI-driven diagnostics, predictive modeling, and wearable health monitoring.
- To understand privacy, security, and ethical considerations in digital health.

Course Learning Outcomes:

- Understand health informatics concepts, standards, and interoperability.
- Apply machine learning techniques to healthcare data.
- Implement AI-powered diagnostics and decision-support systems.
- Evaluate privacy, security, and compliance challenges in health informatics.

Course Contents:

- UNIT I: Introduction to Digital Health Informatics, Overview of healthcare data and health informatics, Electronic Health Records (EHR) and interoperability (HL7, FHIR), Telemedicine and mobile health (mHealth)
- UNIT II: AI & Machine Learning in Healthcare, Predictive modeling for disease progression, AI-driven diagnostics and clinical decision support systems, Personalized medicine and genomics
- UNIT III: Medical Imaging & AI, Deep learning applications in radiology and pathology, AI-based medical image segmentation and classification, Case studies: AI for cancer detection, retinal disease screening
- UNIT IV: Wearable & IoT-based Healthcare Systems, Smart health monitoring devices (smartwatches, biosensors), IoT-based real-time patient monitoring, Data processing and analytics in wearable health tech
- UNIT V: Privacy, Security, and Ethical Issues in Digital Health, HIPAA, GDPR, and data protection regulations, Cybersecurity threats in healthcare systems, Ethical challenges in AI-driven healthcare
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Shortliffe, E. H., Cimino, J. J. *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*. Springer.
2. Patel, V. L., Kannampallil, T. G., Kaufman, D. R. *Cognitive Informatics for Biomedicine*. Springer.
3. Dey, N., Ashour, A. S., Borra, S. *Big Data Analytics for Intelligent Healthcare Management*. Elsevier.
4. WHO, HIMSS, and NIST guidelines on digital health and informatics.

ITDSE-19: Cloud Computing & DevOps

Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce cloud computing fundamentals and architecture.
- To explore virtualization, containerization, and cloud service models (IaaS, PaaS, SaaS).
- To develop expertise in DevOps practices, CI/CD, and infrastructure automation.
- To analyze cloud security, monitoring, and cost optimization strategies.

Course Learning Outcomes:

- Understand cloud computing models, providers, and deployment strategies.
- Implement containerized applications using Docker and Kubernetes.
- Apply CI/CD pipelines, infrastructure as code (IaC), and DevOps best practices.
- Evaluate cloud security risks, compliance, and scalability considerations.

Course Contents:

- UNIT I: Introduction to Cloud Computing, Fundamentals of cloud computing and its evolution, Cloud service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Cloud deployment models: Public, Private, Hybrid, and Multi-cloud, Overview of major cloud providers: AWS, Azure, Google Cloud
- UNIT II: Virtualization & Containerization, Hypervisors, Virtual Machines (VMs), and resource allocation, Docker fundamentals, Container orchestration with Kubernetes, Serverless computing and Function-as-a-Service (FaaS)
- UNIT III: Principles of DevOps and agile software development, Continuous Integration/Continuous Deployment (CI/CD) pipelines, Automation tools: Jenkins, GitHub Actions, GitLab CI/CD, Infrastructure as Code (IaC) using Terraform and Ansible
- UNIT IV: Cloud Monitoring, Scaling & Cost Optimization, Cloud resource scaling: Auto-scaling and load balancing, Cloud monitoring tools: Prometheus, Grafana, AWS CloudWatch, Cost management strategies and resource allocation optimization, Cloud security best practices
- UNIT V: Advanced Cloud Technologies & Case Studies, Edge computing and its role in cloud ecosystems, AI and Machine Learning integration in cloud services, Case studies on cloud adoption in enterprises, Future trends: Quantum cloud computing and cloud sustainability
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Erl, T. *Cloud Computing: Concepts, Technology & Architecture*. Pearson.
2. Hüttermann, M. *DevOps for Developers*. Apress.
3. Burns, B. *Kubernetes: Up & Running*. O'Reilly Media.
4. AWS, Azure, and Google Cloud documentation on cloud computing and DevOps.

ITDSE-20: Introduction to the Theory of Computation
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce formal models of computation and automata theory.
- To explore computability, complexity classes, and Turing machines.
- To analyze decidability, NP-completeness, and P vs NP problem.
- To develop a mathematical foundation for algorithmic analysis.

Course Learning Outcomes:

- Understand finite automata, regular languages, and context-free grammars.
- Apply Turing machines and computational complexity theories.
- Analyze problems related to decidability and intractability.
- Solve computational problems using formal models of computation.

Course Contents:

- UNIT I: Introduction to Automata Theory, Deterministic and Non-Deterministic Finite Automata (DFA, NFA), Regular expressions and their equivalence to finite automata, Pumping lemma for regular languages, Applications of automata in lexical analysis and text processing
- UNIT II: Context-Free Grammars & Pushdown Automata incorporating Chomsky hierarchy of languages, Context-Free Grammars (CFG) and their properties, Pushdown Automata (PDA) and their equivalence to CFG, Parsing algorithms and applications in programming languages and compilers
- UNIT III: Turing Machines & Computability incorporating Definition and components of a Turing Machine, Universal computation and the Church-Turing thesis, Decidability, undecidability, and the Halting problem, Gödel's incompleteness theorem and implications for computation
- UNIT IV: Complexity Theory & NP-Completeness incorporating Time complexity analysis and Big-O notation, Complexity classes: P, NP, NP-hard, and NP-complete, Polynomial-time reductions and Cook's theorem, Introduction to approximation algorithms
- UNIT V: Advanced Topics in Computation Theory incorporating Quantum computing and post-classical computation models, Applications of computational theory in artificial intelligence and cryptography, Complexity theory in modern computing: P vs NP problem, Open problems and future research directions in theoretical computer science
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Hopcroft, J. E., Motwani, R., Ullman, J. D. *Introduction to Automata Theory, Languages, and Computation*. Pearson.
2. Sipser, M. *Introduction to the Theory of Computation*. Cengage Learning.
3. Arora, S., Barak, B. *Computational Complexity: A Modern Approach*. Cambridge University Press.
4. Goldreich, O. *Computational Complexity: A Conceptual Perspective*. MIT Press.

ITDSE-21: Algorithms and Compution

Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce algorithms and probabilistic techniques in computing.
- To explore Monte Carlo, Las Vegas, and Markov chain-based algorithms.
- To analyze probabilistic data structures and hashing techniques.
- To develop efficient algorithms for large-scale data analysis.

Course Learning Outcomes:

- Understand randomized techniques for algorithm optimization.
- Apply probabilistic methods to computational problems.
- Analyze Markov chains, stochastic processes, and Bayesian inference.
- Implement randomized algorithms for real-world applications.

Course Contents:

- UNIT I: Introduction to Algorithms incorporating Deterministic vs. randomized algorithms, Monte Carlo, Las Vegas, Random number generation and pseudo-randomness, Probabilistic analysis of algorithms
- UNIT II: Markov chains and their applications incorporating Random walks and applications in graph theory, Bayesian inference and probabilistic reasoning, Basics of queuing theory: M/M/1 and M/G/1 queues
- UNIT III: Randomized Data Structures & Hashing incorporating Bloom filters and probabilistic data structures, Universal hashing and hash tables, Skip lists and treaps, Randomized search trees
- UNIT IV: Graph Theory incorporating Randomized min-cut and shortest path algorithms, PageRank algorithm and web search ranking, Applications of randomization in graph processing
- UNIT V: Applications of Algorithms in Computing, Cryptographic protocols and zero-knowledge proofs, Quantum computing and probabilistic approaches, Randomized algorithms in machine learning and AI, Real-world applications in big data processing and optimization
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Motwani, R., Raghavan, P. *Randomized Algorithms*. Cambridge University Press.
2. Mitzenmacher, M., Upfal, E. *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*. Cambridge University Press.
3. Vazirani, V. *Approximation Algorithms*. Springer.
4. Cormen, T. H., Leiserson, C. E., Rivest, R. L., Stein, C. *Introduction to Algorithms*. MIT Press.

Masters of Science in Informatics – M.Sc. (Informatics)
General Elective Courses

ITGE01: Introduction to Computational Thinking & Problem Solving
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the principles of computational thinking and structured problem-solving.
- To develop algorithmic thinking and logical reasoning skills.
- To explore basic programming concepts and applications in various domains.
- To analyze problem decomposition, pattern recognition, and abstraction techniques.

Course Learning Outcomes:

- Understand computational thinking concepts and their applications.
- Apply problem-solving strategies using algorithms and programming.
- Implement basic coding techniques in Python and pseudocode.
- Analyze real-world problems using computational models.

Course Contents:

- UNIT I: Fundamentals of Computational Thinking – Decomposition, pattern recognition, abstraction, and algorithms, Problem-solving strategies and heuristic approaches, Examples of computational thinking in science, business, and social sciences
- UNIT II: Algorithmic Thinking & Pseudocode – Steps of algorithm design and optimization, Flowcharts, decision trees, and recursion, Sorting and searching algorithms
- UNIT III: Introduction to Programming & Logic – Variables, loops, functions, and control structures, Debugging and error handling, Algorithmic efficiency and complexity analysis
- UNIT IV: Computational Models & Real-World Applications – Graph theory, game theory, and network analysis, Applications in bioinformatics, cryptography, and finance, Computational thinking for AI and automation
- UNIT V: Future of Computational Thinking & AI Integration – Role of computation in emerging technologies, Ethics and societal impact of automation, Case studies and project-based learning
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Wing, J. M. *Computational Thinking*. ACM Journal.
2. Lee, J., Lodi, A. *Computational Thinking in Education: Foundations and Research Perspectives*. Springer.
3. Python documentation and introductory programming resources.
4. Grok Learning and Code.org materials on computational problem-solving.

ITGE02: Digital Humanities & Computational Social Sciences
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the interdisciplinary field of digital humanities and computational social sciences.
- To explore data-driven approaches to analyzing cultural, historical, and social phenomena.
- To develop text analysis, network science, and visualization techniques.
- To examine ethical considerations in digital research methodologies.

Course Learning Outcomes:
- Understand how computational tools are applied in humanities and social sciences.
- Analyze large-scale text, media, and social network datasets.
- Apply machine learning, NLP, and data visualization techniques.
- Evaluate ethical and privacy concerns in digital humanities research.

Course Contents:
- UNIT I: Introduction to Digital Humanities & Computational Social Sciences – Overview of digital humanities and computational methodologies, Historical, cultural, and political applications of data science, Tools for digital research
- UNIT II: Text Mining & Sentiment Analysis – NLP for humanities research, Topic modeling and stylometry (author identification), Sentiment analysis in social media and political discourse
- UNIT III: Social Network Analysis & Computational Sociology – Graph theory and network visualization, Case studies on misinformation, polarization, and online behavior, Ethical challenges in digital social science research
- UNIT IV: Big Data, AI, and Ethics in Humanities – Digital archives and knowledge representation, AI-generated literature and automated translation, Privacy, surveillance, and digital rights in cultural studies
- UNIT V: Future of Computational Humanities & Social Sciences – Interactive storytelling and augmented reality in digital humanities, Case studies in history, linguistics, and media studies, Project-based learning using computational tools for social impact
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:
1. Berry, D. M. *Understanding Digital Humanities*. Palgrave Macmillan.
2. Moretti, F. *Distant Reading*. Verso Books.
3. Lazer, D., Pentland, A., et al. *Computational Social Science*. Science Journal.
4. Stanford NLP and Gephi documentation for text and network analysis.

ITGE03: Ethical AI & Bias Mitigation in Machine Learning
Marks: 100 | Duration: 60 Hrs

Course Objectives:
- To introduce the ethical challenges and societal impact of AI and machine learning.
- To explore bias detection and fairness-enhancing techniques in AI systems.
- To analyze AI governance frameworks and regulatory policies.
- To develop strategies for building fair, transparent, and accountable AI models.

Course Learning Outcomes:

- Understand bias sources in AI models and their consequences.
- Apply mathematical fairness metrics and debiasing techniques.
- Implement XAI methods for transparency and interpretability.
- Evaluate ethical AI frameworks and regulatory policies.

Course Contents:

- UNIT I: Introduction to AI Ethics & Bias – Ethical considerations in AI development, Case studies: AI discrimination in hiring, healthcare, and policing, Legal and societal impact of biased AI
- UNIT II: Fairness, Accountability & Transparency in AI – Fairness metrics: demographic parity, equal opportunity, individual fairness, Interpretability techniques (LIME, SHAP, counterfactual explanations), Transparency challenges in deep learning models
- UNIT III: Bias Mitigation Techniques in Machine Learning – Pre-processing, in-processing, and post-processing bias mitigation, Algorithmic fairness techniques (reweighing, adversarial debiasing), Differential privacy and federated learning for ethical AI
- UNIT IV: AI Regulation, Governance, and Compliance – Global AI regulations: GDPR, CCPA, IEEE AI Ethics Guidelines, AI auditing frameworks and model risk management, Explainability and accountability in AI decision-making
- UNIT V: Ethical AI in Practice & Future Trends – Human-in-the-loop AI and ethical decision support systems, AI for social good: fairness in healthcare, finance, and law, The future of ethical AI and bias-free machine learning
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Binns, R. *Fairness in Machine Learning: Lessons from Political Philosophy*. ACM.
2. O'Neil, C. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown Publishing.
3. Russell, S., Norvig, P. *Artificial Intelligence: A Modern Approach*. Pearson.
4. IBM AI Fairness 360, Google AI Ethics, and EU AI Act documentation.

ITGE04: Ethical AI & Responsible Tech Development
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce ethical considerations in AI and emerging technologies.
- To explore the societal impact of AI, automation, and digital transformation.
- To analyze bias, transparency, and accountability in AI systems.
- To develop frameworks for responsible AI governance and technology ethics.

Course Learning Outcomes:

- Understand ethical challenges in AI and responsible tech innovation.
- Analyze bias, fairness, and transparency issues in machine learning models.
- Apply ethical frameworks and regulations for responsible AI governance.

- Develop AI solutions with human-centered, fair, and inclusive design principles.

Course Contents:

- UNIT I: Introduction to AI Ethics & Responsible Tech Development – Ethical dilemmas in AI and automation, Societal risks of AI, automation, and decision-making algorithms, Case studies on ethical AI failures (e.g., facial recognition bias, hiring AI discrimination)
- UNIT II: Bias, Fairness & Transparency in AI – Algorithmic bias and fairness metrics, Interpretability and explainable AI (XAI) techniques, Trustworthy AI: transparency, reliability, and user accountability
- UNIT III: Regulatory Frameworks & AI Governance – Ethical AI policies: IEEE AI Ethics Guidelines, EU AI Act, and OECD AI Principles, Privacy laws and compliance (GDPR, CCPA, HIPAA), AI auditing, risk management, and accountability
- UNIT IV: Human-Centered AI & Inclusive Technology – Ethical design principles for AI systems, Digital inclusion, accessibility, and fairness in AI, The role of stakeholders in AI-driven decision-making
- UNIT V: Future of Responsible Tech Development – AI for social good and sustainability, Emerging trends in ethical AI, automation, and human-AI collaboration, Case studies: ethical AI in healthcare, education, and governance
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. O'Neil, C. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown Publishing.
2. Binns, R. *Fairness in Machine Learning: Lessons from Political Philosophy*. ACM.
3. Russell, S. *Human Compatible: Artificial Intelligence and the Problem of Control*. Penguin Random House.
4. IEEE AI Ethics, EU AI Act, and IBM AI Fairness 360 documentation.

ITGE05: Augmented Reality (AR) & Virtual Reality (VR)
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce fundamentals of Augmented Reality (AR) and Virtual Reality (VR).
- To explore hardware and software development for immersive experiences.
- To analyze applications of AR/VR in gaming, education, healthcare, and industrial training.
- To develop interactive AR/VR applications using Unity, Unreal Engine, and WebXR.

Course Learning Outcomes:

- Understand the core principles of AR/VR systems and immersive environments.
- Develop interactive 3D applications using Unity, Unreal Engine, and WebXR.
- Implement gesture recognition, spatial computing, and mixed reality interactions.
- Evaluate usability, accessibility, and ethical considerations in AR/VR design.

Course Contents:

- UNIT I: Introduction to AR/VR Technologies – Differences between AR, VR, and Mixed Reality (MR), Components of immersive environments: hardware, software, sensors, Applications in gaming, healthcare, education, and enterprise
- UNIT II: AR/VR Development Frameworks – Development tools: Unity, Unreal Engine, ARKit, ARCore, Web-based AR/VR (A-Frame, WebXR), 3D modeling, rendering, and physics engines
- UNIT III: User Interaction & HCI in AR/VR – Gesture recognition and spatial computing, Eye-tracking and haptic feedback, Designing intuitive and immersive experiences
- UNIT IV: Advanced AR/VR Applications & Future Trends – AI-driven AR/VR experiences (computer vision, real-time object recognition), 5G, cloud gaming, and VR streaming, Ethical concerns: privacy, security, and accessibility in AR/VR
- UNIT V: AR/VR in Industry & Research – Industrial training and simulation (healthcare, automotive, military), Augmented reality for smart cities and digital twins, The future of metaverse and AR/VR social platforms
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Craig, A. B. *Understanding Augmented Reality: Concepts and Applications*. Elsevier.
2. Burdea, G., Coiffet, P. *Virtual Reality Technology*. Wiley.
3. Sherman, W. R., Craig, A. B. *Understanding Virtual Reality: Interface, Application, and Design*. Morgan Kaufmann.
4. Unity, Unreal Engine, and WebXR documentation on AR/VR development.

ITGE06: Assistive Technologies & Digital Accessibility
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce assistive technologies and their role in accessibility.
- To explore universal design principles for digital accessibility.
- To analyze AI-driven assistive technologies for individuals with disabilities.
- To develop inclusive technologies that enhance digital equity.

Course Learning Outcomes:

- Understand the importance of assistive technologies for digital accessibility.
- Apply universal design principles in web and mobile applications.
- Implement AI-powered accessibility tools for visually and hearing-impaired users.
- Evaluate compliance with accessibility laws and standards (WCAG, ADA, Section 508).

Course Contents:

- UNIT I: Introduction to Assistive Technologies & Accessibility – Definition and types of assistive technologies, Accessibility barriers and digital inclusion, Case studies on inclusive technology design
- UNIT II: Universal Design Principles & Accessibility Guidelines – Web Content Accessibility Guidelines (WCAG), Accessible web and mobile UI/UX design, Best practices for inclusive digital experiences

- UNIT III: AI & Machine Learning for Accessibility – AI-powered screen readers and speech-to-text applications, Computer vision-based assistive solutions (e.g., Seeing AI, Google Lens), NLP-based conversational AI for accessibility (voice assistants, chatbots)
- UNIT IV: Wearable & Smart Assistive Devices – Smart prosthetics, brain-computer interfaces (BCIs), AR/VR-based assistive tools for cognitive disabilities, Eye-tracking and gesture-based control interfaces
- UNIT V: Challenges & Future Trends in Digital Accessibility – Ethical issues in assistive tech development, Emerging innovations in smart accessibility devices, The role of AI and IoT in next-gen accessibility solutions
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Cooper, M., Sloan, D., Kelly, B. *Digital Accessibility: Enabling Inclusion & Usability*. Springer.
2. Mace, R. *Universal Design Handbook*. McGraw-Hill.
3. Treviranus, J. *Inclusive Design for a Digital World: Designing with Accessibility in Mind*. Apress.
4. W3C, WebAIM, and WCAG documentation on accessibility standards.

ITGE07: Green Computing & Sustainable Technology
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the principles of green computing and sustainable technology.
- To explore energy-efficient computing practices and eco-friendly IT solutions.
- To analyze sustainability challenges in hardware, software, and data centers.
- To develop strategies for reducing carbon footprints in technology use.

Course Learning Outcomes:

- Understand energy-efficient computing architectures and hardware design.
- Implement sustainable software development practices.
- Analyze the environmental impact of cloud computing and data centers.
- Develop green IT policies for organizations and industries.

Course Contents:

- UNIT I: Introduction to Green Computing & Sustainable IT – Definition and need for sustainable computing, Environmental impact of technology production and usage, Principles of energy-efficient computing
- UNIT II: Sustainable Hardware & Infrastructure – Energy-efficient processors, memory, and power management, E-waste management and recycling strategies, Green data centers and energy optimization
- UNIT III: Sustainable Software Engineering – Eco-friendly coding practices, Power-aware computing and load balancing, Sustainable lifecycle management for IT products

- UNIT IV: Cloud Computing & Sustainability – Environmental challenges in cloud and edge computing, Energy-efficient virtualization and containerization, Carbon-neutral data storage and processing
- UNIT V: Green IT Policies & Future Trends – Corporate sustainability initiatives, Policy frameworks and global regulations (e.g., Green IT, ESG compliance), Emerging trends: biodegradable electronics, carbon-aware computing
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Murugesan, S. *Harnessing Green IT: Principles and Practices*. Wiley.
2. Hanks, K. *Sustainable IT Playbook for Technology Leaders*. O'Reilly.
3. Patterson, D. A. *The Datacenter as a Computer: An Introduction to the Design of Warehouse-Scale Machines*. Morgan & Claypool.
4. Reports from the UN, IEEE, and corporate sustainability policies on green IT.

ITGE08: Advanced Robotics & Human-AI Collaboration
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce robotics principles, automation, and human-robot interaction.
- To explore robotic system design, control, and real-world applications.
- To analyze collaborative robotics and its role in industries and society.
- To develop strategies for ethical and safe human-robot collaboration.

Course Learning Outcomes:

- Understand fundamental robotics concepts and control mechanisms.
- Implement robotic motion planning and kinematics.
- Analyze the impact of collaborative robots (cobots) in industrial and service sectors.
- Evaluate ethical and safety considerations in human-robot interaction.

Course Contents:

- UNIT I: Introduction to Robotics & Automation – Basic components of robotic systems, Actuators, sensors, and robotic controllers, Role of automation in industries and everyday life
- UNIT II: Kinematics, Motion Planning & Control – Forward and inverse kinematics, Robotic path planning and obstacle avoidance, Control algorithms for robotic arms and mobile robots
- UNIT III: Human-Robot Interaction & Collaborative Robotics – Role of cobots in manufacturing, healthcare, and services, Safety and ergonomic considerations in human-robot collaboration, Social and emotional aspects of human-robot interaction
- UNIT IV: Industrial & Service Robotics Applications – Robotics in logistics, healthcare, agriculture, and defense, Exoskeletons, wearable robotics, and prosthetics, Autonomous systems in transportation and smart cities
- UNIT V: Ethical, Legal, and Safety Aspects in Robotics – Workplace automation and labor market effects, Safety regulations and compliance for robotics, Future trends: swarm robotics, soft robotics, and biomimetic robots

- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Siciliano, B., Khatib, O. *Springer Handbook of Robotics*. Springer.
2. Craig, J. *Introduction to Robotics: Mechanics and Control*. Pearson.
3. Brynjolfsson, E., McAfee, A. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. Norton.
4. Reports from IEEE Robotics and Automation Society, ISO Robotics Safety Standards.

ITGE09: Social Network Analysis & Computational Propaganda
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce social network analysis (SNA) and its applications.
- To explore the impact of digital networks on public opinion and misinformation.
- To analyze computational propaganda techniques and social media manipulation.
- To develop methods for detecting and mitigating information disorder in online spaces.

Course Learning Outcomes:

- Understand social network structures, metrics, and algorithms.
- Analyze social media influence, virality, and misinformation dynamics.
- Implement graph-based techniques for network visualization and community detection.
- Evaluate ethical, legal, and regulatory challenges in digital communication.

Course Contents:

- UNIT I: Introduction to Social Network Analysis– Basics of graph theory and network structures, Centrality, clustering, and small-world networks, Applications of SNA in sociology, politics, and business
- UNIT II: Computational Propaganda & Social Media Manipulation – Misinformation, disinformation, and fake news, Automated bots, trolls, and coordinated inauthentic behavior, Influence campaigns and algorithmic amplification
- UNIT III: Network Visualization & Community Detection – Tools for analyzing social graphs (Gephi, NetworkX), Detection of echo chambers and filter bubbles, Case studies on viral trends and online movements
- UNIT IV: AI & Algorithmic Bias in Social Media – Role of recommendation algorithms in shaping opinions, Personalization, surveillance, and privacy concerns, Ethical considerations in digital influence and persuasion
- UNIT V: Regulation, Policy & Future of Digital Communication – Government and corporate responses to online misinformation, Media literacy and digital resilience initiatives, Future trends in networked communication and online governance
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Watts, D. J. *Six Degrees: The Science of a Connected Age*. W.W. Norton & Company.

2. Tufekci, Z. *Twitter and Tear Gas: The Power and Fragility of Networked Protest*. Yale University Press.
3. Ferrara, E., Varol, O., et al. *The Rise of Social Bots*. Communications of the ACM.
4. Reports from the Oxford Internet Institute, Pew Research Center, and Global Disinformation Index.

ITGE10: Cyber-Physical Systems & Smart Infrastructure
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the concept of Cyber-Physical Systems (CPS) and their role in modern infrastructure.
- To explore integrated hardware-software systems for monitoring and automation.
- To analyze connectivity, security, and resilience in smart infrastructure.
- To evaluate the impact of digital transformation on urban planning and industries.

Course Learning Outcomes:

- Understand CPS architecture and applications.
- Implement communication protocols and interoperability frameworks in smart systems.
- Analyze security challenges and reliability considerations in CPS.
- Evaluate smart infrastructure applications in transportation, energy, and healthcare.

Course Contents:

- UNIT I: Introduction to Cyber-Physical Systems – Definition and characteristics of CPS, Integration of physical and digital systems, CPS in industrial automation, healthcare, and urban planning
- UNIT II: Smart Infrastructure & Connected Systems – Smart cities, intelligent transportation, and energy grids, IoT and sensor networks in infrastructure management, Case studies: smart buildings, water management, and disaster resilience
- UNIT III: Security & Privacy in Cyber-Physical Systems – Threats and vulnerabilities in CPS, Security frameworks and risk management, Compliance with regulations and ethical considerations
- UNIT IV: Communication & Interoperability in CPS – Wireless networks and industrial communication protocols, Edge computing and real-time decision-making, System integration challenges and standardization efforts
- UNIT V: Sustainability & Future Trends in CPS – Role of CPS in environmental sustainability, Digital twins and predictive analytics for infrastructure, Future trends: autonomous transportation, adaptive infrastructure
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Baheti, R., Gill, H. *Cyber-Physical Systems*. IEEE.
2. Rajkumar, R., Lee, I., et al. *Cyber-Physical Systems: The Next Computing Revolution*. ACM.
3. Zanero, S. *Security in Cyber-Physical Systems*. Springer.
4. Reports from Smart Cities Council, NIST CPS Framework, and IEEE standards.

ITGE11: Future of Work: AI, Automation & Digital Labor
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To examine the impact of technological advancements on employment and workforce dynamics.
- To explore automation, remote work, and digital labor trends.
- To analyze the role of digital platforms in the gig economy and global workforce.
- To evaluate the ethical, social, and economic implications of technological shifts.

Course Learning Outcomes:

- Understand the transformation of labor markets in the digital age.
- Analyze the impact of automation on different industries and job roles.
- Evaluate strategies for workforce adaptation and skill development.
- Examine global labor policies and regulations in the digital economy.

Course Contents:

- UNIT I: Introduction to the Future of Work – Historical perspectives on technological disruption, Changing nature of employment and digital workspaces, Workforce digitalization and emerging job roles
- UNIT II: Automation & Workforce Transformation – Industrial automation and robotics in manufacturing, Service automation and the rise of digital assistants, Ethical concerns: job displacement vs job augmentation
- UNIT III: Gig Economy & Digital Labor Platforms – Online freelancing, remote work, and global talent pools, Labor rights and fair compensation in digital work, Platform governance and worker protections
- UNIT IV: Workplace Culture & Skills for the Future – Hybrid work models and organizational shifts, Digital literacy and lifelong learning, Reskilling and upskilling strategies for workers
- UNIT V: Policy, Ethics & Societal Impact – Economic policies and labor market regulations, Universal basic income and alternative employment models, Future outlook: balancing technological progress with workforce inclusion
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Brynjolfsson, E., McAfee, A. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. Norton.
2. Ford, M. *The Rise of the Robots: Technology and the Threat of Mass Unemployment*. Basic Books.
3. Srnicek, N. *Platform Capitalism*. Polity Press.
4. Reports from the World Economic Forum, International Labour Organization, and McKinsey Global Institute on the future of work.

ITGE12: Introduction to Human-Computer Interaction (HCI)
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce fundamental concepts of Human-Computer Interaction.
- To explore usability principles, interaction design, and user experience.
- To analyze cognitive, social, and ergonomic aspects of system design.
- To develop an understanding of evaluation methods for interactive systems.

Course Learning Outcomes:

- Understand HCI principles and user-centered design methodologies.
- Apply usability testing and UX evaluation techniques.
- Develop effective interaction designs for various platforms.
- Analyze accessibility, inclusivity, and emerging trends in HCI.

Course Contents:

- UNIT I: Introduction to Human-Computer Interaction – Evolution and importance of HCI, Interaction paradigms (command-based, graphical, multimodal interfaces), User experience (UX) and usability principles
- UNIT II: Designing Interactive Systems – User-centered design (UCD) and participatory design, Affordances, mental models, and feedback mechanisms, Interface design patterns and heuristics
- UNIT III: Cognitive & Social Aspects of HCI – Cognitive load, attention, and perception in interaction, Social computing and collaborative technologies, Ethics and privacy concerns in interaction design
- UNIT IV: Usability Testing & UX Evaluation – Usability heuristics (Nielsen's principles), A/B testing and user studies, Eye-tracking and biometric feedback in usability research
- UNIT V: Emerging Trends & Future of HCI – Augmented reality (AR), virtual reality (VR), and mixed reality (MR), Conversational interfaces (voice assistants, chatbots), Accessibility and inclusive design for diverse users
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Norman, D. *The Design of Everyday Things*. Basic Books.
2. Shneiderman, B., Plaisant, C. *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Pearson.
3. Rogers, Y., Sharp, H., Preece, J. *Interaction Design: Beyond Human-Computer Interaction*. Wiley.
4. Research papers from ACM SIGCHI and IEEE on emerging HCI trends.

ITGE13: Research Methodology & Scientific Writing
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce fundamental principles of research methodology.
- To explore qualitative and quantitative research techniques.
- To develop skills for scientific writing, academic publishing, and research ethics.

- To analyze data interpretation, literature review, and citation management.

Course Learning Outcomes:

- Understand different research methods and approaches.
- Conduct systematic literature reviews and critical analyses.
- Develop effective scientific writing and publication strategies.
- Apply ethical considerations and best practices in research.

Course Contents:

- UNIT I: Introduction to Research Methodology – Definition and scope of research, Types of research (exploratory, descriptive, analytical, experimental), Research process and problem formulation
- UNIT II: Qualitative & Quantitative Research Methods – Data collection techniques (surveys, interviews, case studies), Statistical methods, hypothesis testing, and inferential analysis, Mixed-method research and triangulation techniques
- UNIT III: Scientific Writing & Literature Review – Structuring research papers, reports, and theses, Writing effective abstracts, introductions, and conclusions, Managing references with citation tools (Mendeley, Zotero, EndNote)
- UNIT IV: Publication & Ethical Considerations – Journal selection, peer review process, and impact factors, Plagiarism, authorship ethics, and academic integrity, Research funding, proposals, and grant writing
- UNIT V: Data Interpretation & Visualization – Statistical analysis and data representation, Using software tools for data analysis (SPSS, R, Python), Best practices in presenting findings through tables, charts, and infographics
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Creswell, J. W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage.
2. Kothari, C. R. *Research Methodology: Methods and Techniques*. New Age International.
3. Day, R. A. *How to Write and Publish a Scientific Paper*. Cambridge University Press.
4. Publications from Springer, IEEE, and Elsevier on academic writing and research methods.

Masters of Science in Informatics – M.Sc. (Informatics)
Research Methods/ Tools/Writing

ITR01: Advanced Research Methodology of Informatics
Marks: 100 | Duration: 60 Hrs

Course Objectives:
- To introduce various qualitative and quantitative data collection methods.
- To explore sampling techniques, survey design, and interview methodologies.
- To analyze ethical considerations and challenges in data collection.
- To develop skills for data acquisition, preprocessing, and management.

Course Learning Outcomes:
- Understand primary and secondary data collection techniques.
- Design and conduct surveys, interviews, and observational studies.
- Apply data validation, cleaning, and preprocessing methods.
- Evaluate ethical considerations and data security best practices.

Course Contents:
- UNIT I: Introduction to Data Collection – Importance of data collection in research, Difference between primary and secondary data, Reliability, validity, and biases in data collection
- UNIT II: Qualitative Data Collection Methods – Interviews (structured, semi-structured, unstructured), Focus groups and ethnographic studies, Case studies and document analysis
- UNIT III: Quantitative Data Collection Techniques – Surveys and questionnaire design, Experiments and observational research, Sampling methods (probability and non-probability sampling)
- UNIT IV: Data Management & Preprocessing – Data validation and cleaning techniques, Handling missing data and outliers, Ethical considerations in data collection
- UNIT V: Technological Tools for Data Collection – Online survey tools (Google Forms, Qualtrics, SurveyMonkey), Mobile data collection and IoT-based sensors, Data repositories and open-access databases
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Creswell, J. W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage.
2. Babbie, E. *The Practice of Social Research*. Cengage Learning.
3. Fowler, F. J. *Survey Research Methods*. Sage.
4. Reports and guidelines from UNESCO, WHO, and Data.gov on ethical data collection.

ITR02: Tools for Research
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To introduce the importance of citation management in research.
- To explore different citation styles and formatting techniques.
- To provide hands-on training on reference management tools.
- To develop skills for avoiding plagiarism and ensuring academic integrity.

Course Learning Outcomes:

- Understand the role of citations and proper attribution in research.
- Apply various citation styles (APA, IEEE, MLA, Chicago, etc.).
- Use reference management software (Zotero, EndNote, Mendeley, BibTeX).
- Evaluate ethical considerations and plagiarism detection techniques.

Course Contents:

- UNIT I: Introduction to Citation Management – Purpose of citations in research, Direct and indirect citations, Citation styles and their applications (APA, IEEE, MLA, Chicago)
- UNIT II: Reference Management Tools – Overview of citation software (Zotero, Mendeley, EndNote, BibTeX), Automating citation generation and bibliography creation, Integrating citation tools with MS Word, LaTeX, and Google Docs
- UNIT III: Plagiarism Detection & Academic Integrity – Understanding plagiarism (types and consequences), Tools for plagiarism detection (Turnitin, iThenticate, Grammarly), Ethical guidelines for referencing and attribution
- UNIT IV: Managing and Organizing References – Creating and maintaining a reference library, Importing and exporting references, Collaboration and cloud-based reference sharing
- UNIT V: Advanced Citation Practices & Open Access Publishing – Digital Object Identifiers (DOI) and ORCID for researcher identification, Open-access journals and research repositories, Copyright and fair use policies
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Lipson, C. *Cite Right: A Quick Guide to Citation Styles*. University of Chicago Press.
2. Neville, C. *The Complete Guide to Referencing and Avoiding Plagiarism*. Open University Press.
3. Weller, M. *The Digital Scholar: How Technology Is Transforming Scholarly Practice*. Bloomsbury Academic.
4. Manuals of major citation styles (APA, IEEE, MLA, Chicago) and online resources from Purdue OWL and Elsevier.

ITR03: Techniques of research writing
Marks: 100 | Duration: 60 Hrs

Course Objectives:

- To develop academic writing skills for research papers, reports, and dissertations.
- To explore structuring and formatting techniques for scientific writing.
- To analyze common writing challenges and strategies for improving clarity.
- To provide hands-on training on writing tools and editing software.

Course Learning Outcomes:

- Understand the structure and components of academic research writing.
- Develop clear, concise, and well-structured research documents.
- Apply writing techniques for abstracts, introductions, and discussions.
- Use writing and editing tools (Grammarly, LaTeX, MS Word, Overleaf).

Course Contents:

- UNIT I: Introduction to Research Writing – Importance of clarity and coherence in research writing, Types of academic writing (journal articles, conference papers, dissertations), Writing styles and conventions
- UNIT II: Structuring a Research Paper or Thesis – Title, abstract, and keywords, Introduction, literature review, methodology, results, discussion, conclusion, References and appendices
- UNIT III: Academic Writing Best Practices – Sentence structure, grammar, and punctuation, Avoiding redundancy and ambiguity, Writing for different audiences (academic, industry, policymakers)
- UNIT IV: Research Writing Tools & Technologies – Reference managers (Zotero, EndNote), Writing platforms (MS Word, LaTeX, Overleaf), AI-assisted writing tools (Grammarly, Hemingway Editor)
- UNIT V: Publishing & Presenting Research – Preparing research papers for journals and conferences, Writing grant proposals and research funding applications, Oral and poster presentations
- The course includes tutorials/case studies/hands-on exercises to enhance practical understanding and application.

Recommended Readings:

1. Booth, W. C., Colomb, G. G., Williams, J. M. *The Craft of Research*. University of Chicago Press.
2. Day, R. A. *How to Write and Publish a Scientific Paper*. Cambridge University Press.
3. Alley, M. *The Craft of Scientific Writing*. Springer.
4. Resources from Nature, Elsevier, and IEEE Author Guidelines on research writing best practices.