

Department of
Information and Communication Technology (ICT)
Comilla University



Curriculum
For
Master of Science
Information and Communication Technology
Session: 2024-2025, 2025-2026, 2026-2027

1. Title of the academic Program:

M.Sc. (Engg.) In Information and Communication Technology

2. Name of the University:

Comilla University

3. Vision of the University:

Comilla University is committed to empowering society, advancing development, promoting human welfare and sustainable planet.

4. Mission of the University:

- 1 To educate a wide variety of students through effective teaching-learning to achieve academic excellence.
- 2 To create an ambience for creative and innovative academic exercise through high quality research.
- 3 To undertake actions regarding collaboration which entails opportunities for long-term interaction with academia and industry for producing competent graduate at workplace.
- 4 To develop human potential to its fullest extent so that intellectually capable and socially responsible leaders can emerge in a range of profession.

5. Name of the Program Offering Entity:

Department of Information and Communication Technology

6. Vision of the Program Offering Entity:

Establishment of quality academic culture in the department for the attainment of intended skills, knowledge and attitude in the field of Information and Communication Technology (ICT) so that the graduates can cater to the current and future needs of Information and Communication Technology (ICT) oriented industry and academia leading to the socio-economic development of Bangladesh.

7. Mission of the Program Offering Entity

In order to accomplish the vision, the department will

- Establish a unique learning environment to enable the students to face the challenges in the field of Information and Communication Engineering.
- Promote the establishment of centers of excellence in appropriate technological areas to enhance the spirit of innovation and creativity among faculty members and students.
- Provide ethical and value-based education by promoting activities addressing the socio-economic needs.
- Enable students to develop skills to solve complex technological problems and provide a framework for promoting collaborative and multidisciplinary activities.

8. Objectives of the Program Offering Entity:

- To demonstrate students through fundamentals and problem-solving skills to analyze, design and develop economically feasible solutions for technical and social problems.
- To prepare students for employment and advanced studies and provide them with significant experiences in contemporary development skills which will allow them to successfully adapt to evolving technologies throughout their professional careers.
- To teach students effective hard and soft skills that enables them to work with others effectively in their professional careers.
- To acknowledge students about research trends, higher education and entrepreneurial opportunities along with work ethically towards society.
- To develop cooperative research relationships within and outside the computer science discipline, as well as with industry, government, alumni, and local organizations.

9. Name of the Degree:

M.Sc. (Engg.) In Information and Communication Technology

10. Description of the program:

The M.Sc (Engg.) program courses in Information and Communication Technology shall extended over a period of one academic year and shall be divided into two semesters: first semester and second semester for project and three semesters: first semester, second semester and third semester for Thesis. One semester will extend for a period of 6 months. For the purpose of assessment, 100 marks will be assigned to 4/18 credits (4/18 contact hours/week) in a semester. A candidate for the M.Sc (Engg.) degree must complete all requirements for the degree within two academic years from the date of his/her first admission. A student shall be required to have attended at least 70% of the total number of lectures/tutorials/laboratory classes held to appear as a regular candidate at the semester final examinations.

11. Program Educational Objectives (PEOs):

The Program Educational Objective (PEO) of the Department of Information and Communication Technology (ICT) cater to the requirements of the stakeholders such as students, employers, alumni, faculty etc. The program educational objectives are as follows:

PEO1	Provide students with sound foundation in mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze the engineering problems and develop the solutions for real world ICT problems
PEO2	Conceptualize, Design, Implement, Test and Maintain software and hardware systems based on requirement specifications.
PEO3	Impart analytic and critical thinking skills to develop initiative and innovative ideas for research and development (R&D), industry and societal requirements.
PEO4	Inculcate professional and ethical attitude in students by providing effective communication skills, leadership skills and team work to challenge the contemporary issues to broader social context.
PEO5	Provide an academic environment that gives adequate opportunity to the students to cultivate lifelong skills needed for a successful professional career.

12. Program Learning Outcomes (PLO):

After completion of the B.Sc. Engineering degree in Information and Communication Technology (ICT) graduates will be able to

- PLO-1: Engineering Knowledge:** Utilize the basic knowledge of mathematics, science and engineering in Information and Communication Technology field.
- PLO-2: Problem Analysis:** Identify, formulate, research and analyze complex Information and Communication Engineering problems to achieve demonstrated conclusions using mathematical principles and engineering sciences.
- PLO-3: Design/Development of Solutions:** Design system components for complex Information and Communication Engineering problem that meet the requirement of public safety and offer solutions to the societal and environmental concerns.
- PLO-4: Investigation:** Conduct investigation to design and conduct experiments, analyze, synthesize and interpret the data pertaining to Information and Communication Engineering problems and arrive at valid conclusions.
- PLO-5: Modern Tool Uses:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools required for Information and Communication Engineering applications.

- PLO-6: The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
- PLO-7: Environment and Sustainability:** Examine the impact of Information and Communication Engineering solutions in global and environmental context and utilize the knowledge for sustainable development.
- PLO-8: Ethics:** Develop consciousness of professional, ethical and social responsibilities as experts in the field of Information and Communication Engineering.
- PLO-9: Individual Work and Teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.
- PLO-10: Communication:** Communicate effectively about complex Information and Communication Engineering activities with the engineering community and with society at large in both oral and written.
- PLO-11: Project Management and Finance:** Demonstrate knowledge and understanding of Information and Communication Engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.
- PLO-12: Life-Long Learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

13. Mapping mission of the university with PEOs:

	Mission 01	Mission 02	Mission 03	Mission 04
PEO1	✓			
PEO2			✓	
PEO3		✓		
PEO4				✓
PEO5				✓

14. Mapping PLO with PEO:

PLO	PEO1	PEO2	PEO3	PEO4	PEO5
PLO 1	✓				
PLO 2	✓				
PLO 3			✓		
PLO 4	✓				
PLO 5			✓		
PLO 6			✓		
PLO 7				✓	
PLO 8				✓	
PLO 9				✓	
PLO 10				✓	
PLO 11				✓	
PLO 12					✓

Course Schedule:

Course Type for M.Sc (Engg.) thesis group in Information and Communication Technology	Credits Distribution
Theoretical	20
Thesis	20
Board Viva-voce	02
Total	42

Course Type for M.Sc (Engg.) project in Information and Communication Technology	Credits Distribution
Theoretical	27
Sessional	05
Project	06
Board Viva-voce	02
Total	40

FIRST SEMESTER FOR THESIS GROUP

Course Code	Course Title	Class hours/week		Credit
		Theory	Lab	
ICT-1001	Advanced Wireless Communication	3.00	0.00	3.00
ICT-1003	Data Mining	3.00	0.00	3.00
ICT-1005	Wireless Sensor Networks	3.00	0.00	3.00
ICT-1007	Research Methodology	2.00	0.00	2.00
	Total			11.00

FIRST SEMESTER FOR PROJECT GROUP

Course Code	Course Title	Class hours/week		Credit
		Theory	Lab	
ICT-1001	Advanced Wireless Communication	3.00	0.00	3.00
ICT-1003	Data Mining	3.00	0.00	3.00
ICT-1005	Wireless Sensor Networks	3.00	0.00	3.00
ICT-xxxx	Optional I	3.00	0.00	3.00
ICT-xxxx	Optional II	3.00	0.00	3.00
ICT-1002	Advanced Wireless Communication Sessional	0.00	3.00	1.00

ICT-1004	Data Mining Sessional	0.00	3.00	1.00
ICT-1006	Wireless Sensor Networks Sessional	0.00	3.00	1.00
	Total			18.00
Optional Courses				
Course Code	Course Title	Class hours/week		Credit
ICT-1009	Information Theory & Coding	3.00	0.00	3.00
ICT-1011	Advanced Bio-informatics	3.00	0.00	3.00
ICT-1013	Cyber Physical System	3.00	0.00	3.00
ICT-1015	Multimedia Communication	3.00	0.00	3.00

SECOND SEMESTER FOR THESIS GROUP

Course Code	Course Title	Class hours/week		Credit
		Theory	Lab	
ICT-2001	Advanced IoT	3.00	0.00	3.00
ICT-2003	Advanced Machine Learning	3.00	0.00	3.00
ICT-2005	Advance Block Chain and Distributed System	3.00	0.00	3.00
ICT-2000	Viva-voce	0.00	0.00	2.00
ICT-3003	Proposal Defense	0.00	0.00	0.00
	Total			11.00

SECOND SEMESTER FOR PROJECT GROUP

Course Code	Course Title	Class hours/week		Credit
		Theory	Lab	
ICT-2001	Advanced IoT	3.00	0.00	3.00
ICT-2003	Advanced Machine Learning	3.00	0.00	3.00
ICT-2005	Advance Block Chain and Distributed System	3.00	0.00	3.00
ICT-xxxx	Optional Course	3.00	0.00	3.00
ICT-2015	Project	6.00	0.00	6.00
ICT-2002	Advanced IoT Sessional	0.00	3.00	1.00
ICT-2004	Advanced Machine Learning Sessional	0.00	3.00	1.00
ICT-2000	Viva-voce	0.00	0.00	2.00
	Total			22.00

Optional Courses

Course Code	Course Title	Class hours/week		Credit
ICT-2007	Management Information Systems (MIS)	3.00	0.00	3.00
ICT-2009	Random Variable and Stochastics	3.00	0.00	3.00
ICT-2011	Human Computer Interaction	3.00	0.00	3.00
ICT-2013	Statistical Signal Processing	3.00	0.00	3.00
ICT-2017	Emerging Topics in ICT	3.00	0.00	3.00

THIRD SEMESTER FOR THESIS GROUP

Course Code	Course Title	Class hours/week		Credit
		Theory	Lab	
ICT-3001	Thesis Work	10.00	0.00	10.00
ICT-3003	Proposal Defense	5.00	0.00	5.00
ICT-3005	Thesis Defense	5.00	0.00	5.00
		Total		20.00

BNQF Code: 06121001, Course Code: ICT-1001,

Course Title: Advanced Wireless Communication

Credit Hr.: 3.00, Contact Hr.: 3.00, Course Type: Core

Pre-requisites (if any): wireless communication

Rationale:

The course focuses on equipping students with in-depth knowledge of modern high-speed wireless systems, including both wired and wireless network architectures, and the design principles behind them. The course aims to develop essential industrial and commercial skills for professional development in this rapidly evolving field, while also preparing students for potential higher studies.

Course Objectives:

1. To provide a deep understanding of modern wireless communication systems,
2. To explore advanced techniques for improving performance and capacity, and
3. To prepare students for research or industry roles in this rapidly evolving field.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1 Understand the concepts of fading, multipath propagation, and interference in wireless channels.
- CLO2 Understand the architecture and protocols of cellular networks, including concepts like cell splitting, frequency reuse, and handover.
- CLO3 Design and analyze wireless communication systems based on performance requirements and QoS constraints.
- CLO4 Develop and apply multicarrier transmission techniques in wireless channel and apply different channel coding techniques.
- CLO5 Gain knowledge about network management, security, and emerging technologies like IoT and 5G.

Mapping Course Learning Outcomes (CLOs) with PLOs												
CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓											
CLO2	✓	✓										
CLO3			✓	✓								
CLO4			✓		✓							
CLO5						✓	✓					✓

Course Content and Mapping CLOs with the Teaching-Learning & Assessment Strategy				
Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1.	Preliminaries: Fading Channel Models, Digital Modulation Schemes and their comparative performance, Equalization and Diversity Techniques.	Lecture, Discussion	Class Test	CLO1
2.	Coding for Wireless Channels: Linear Block Codes,	Lecture,	Class Test	CLO2,

	Convolutional Codes, Concatenated Codes, Turbo Codes, Low Density Parity Check Code, Unequal Error Protection Codes, Joint Source and Channel Coding.	Discussion		CLO4
3.	Multicarrier Communication: Multicarrier Modulation, Data Transmission using Multiple Carriers (Non-overlapping sub channels), Multicarrier Modulation with Overlapping sub channels, Mitigation of subcarrier fading,	Lecture, Discussion	Class Test	CLO1, CLO3
4.	Discrete Implementation of Multicarrier, Challenges in Multi carrier system, OFDM-based Wireless Network overview, Implementations of Multicarrier in OFDM, MC-CDMA.	Lecture, Discussion	Assignment	CLO1, CLO3
5.	Wireless Networks and Topologies: Introduction, Wireless network topologies, Infrastructure network topology, Ad hoc network topology,	Lecture, Discussion	Quiz	CLO4
6.	Comparison of ad hoc and infrastructure network topologies, Cellular topology (the cellular concept, Cellular hierarchy, Cell fundamentals).	Lecture, Discussion	Exam	CLO4
7.	Review and makeup class form week 1 to 6 and Mid-semester exam.			
8.	Wireless Network Planning: Signal-to-interference ratio and calculation, Capacity expansion techniques, Architectural methods for capacity expansion.	Lecture, Discussion	Class Test	CLO2
9.	Cell splitting, Using directional antennas for cell sectoring, Lee's microcell method, Using overlaid cells, Using smart antennas	Lecture, Discussion	Class Test	CLO2
10.	Channel allocation techniques and capacity expansion(Fixed channel allocation (FCA), Dynamic channel allocation (DCA), Hybrid channel allocation (HCA),	Lecture, Discussion	Assignment	CLO3, CLO4
11.	Comparison of FCA, DCA and HCA) Migration to digital systems, Network planning for CDMA systems, Issues in CDMA network planning (managing the noise floor, cell breathing).	Lecture, Discussion	Class Test	CLO3
12.	Ad-hoc Wireless Networks: Applications and Limitations, Design Principles and Challenges, Protocol Layers, Cross-Layer Design, Network Capacity Limits, Energy-Constrained Networks.	Lecture, Discussion	Exam	CLO3, CLO5
13.	Emerging Technologies: 4G and Beyond(5G), IOT, LTE, Smart Grid, Wi-Fi, Li-Fi, Wireless Charging, V2X, M2M Communication, Heterogeneous small-scale network, Massive MIMO.	Lecture, Discussion	Exam	CLO5
14.	Review and makeup class form week 8 to 13 and Mid-semester exam.			

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment: Attendance, Class Test, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	SL	Category	Mark%
	1.	Attendance	5%
	2.	Class Test	5%
	3.	Assignment	5%
	4.	Presentation/Quiz	5%
	5.	Mid Semester Exam	20%

Make-up Procedures	6.	Final Semester Exam	60%
Repeat Course, Mid-Term Incomplete Exam, Final Term Incomplete Exam			
	Total:		100%

Learning Materials:

1. Wireless Communication: Andrea Goldsmith
2. Principles of Wireless Communication: T. S. Rappaport
3. Principles of Wireless Networks-A Unified Approach: Kaveh Pahlvan
4. OFDM-Based Broadband Wireless Networks: Design and Optimization: Hui Liu, Guoqing Li.
5. Channel Coding Techniques for Wireless Communications: K. Deerga Rao
6. Wireless communications and networking: Vijay K. Garg, (2nd edition): William Stallings.
7. Introduction to wireless and mobile systems (4th edition): Dharma Prakash Agrawal, Qing-An Zeng
8. CWNA, certified wireless network administrator official CWNA study guide: David D. Coleman, David D. Wesrcott
9. Wireless Communications Standard: Todor Cooklev.

BNQF Code: 06121003, Course Code: ICT-1003,

Course Title: Data Mining

Credit Hr.: 3.00, Contact Hr.: 3.00, Course Type: Core

Pre-requisites (if any): None

Rationale:

This course emphasizes on equipping individuals with the skills to extract valuable insights from vast amounts of data. This involves understanding the principles and techniques of data mining, including data preparation, model building, and the application of various algorithms like clustering, classification, and association rule mining. The course rationale also emphasizes the practical application of these skills to solve real-world problems and make informed decisions.

Course Objectives:

1. Learning how to clean, transform, and prepare data for analysis, including handling missing values, outliers, and data normalization.
2. Exploring techniques for identifying patterns, relationships, and trends in data using various algorithms, including classification, clustering, and association rule mining.

- Applying data mining techniques to real-world problems and developing solutions for various domains like business, science, and social sciences.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1 Learn fundamental concepts like data preprocessing, feature selection, different data mining tasks (classification, clustering, association rule mining)
- CLO2 Understand and learn various algorithms used in data mining, such as decision trees, neural networks, and clustering methods.
- CLO3 Analyze datasets, identify relevant features, and handle missing or noisy data.
- CLO4 Develop and design data warehousing, text mining and web mining techniques.
- CLO5 Apply data mining techniques to solve real-world problems across various domains.

Mapping Course Learning Outcomes (CLOs) with PLOs												
CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓											
CLO2	✓	✓										
CLO3		✓		✓	✓							
CLO4			✓		✓							
CLO5			✓			✓	✓					✓

Course Content and Mapping CLOs with the Teaching-Learning & Assessment Strategy				
Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1.	Introduction: Data Mining and its types, Application and Challenges, Data Mining Goals, Stages of the Data Mining Process.	Lecture, Discussion	Class Test	CLO1
2.	Data Analysis and Visualization: Data Mining Techniques, Representation Methods, Measures of Similarity and Dissimilarity, Statistical data description, Visualization using Plots and Diagrams.	Lecture, Discussion	Class Test	CLO2
3.	Data Preprocessing: Types of data and data set, Data cleaning, Selection,	Lecture, Discussion	Class Test	CLO3
4.	Data transformation, Data reduction, Discretization and linearization.	Lecture, Discussion	Assignment	CLO3
5.	Data Warehouse and OLAP: Data Warehouse and DBMS, OLAP and Multidimensional data analysis.	Lecture, Discussion	Quiz	CLO4
6.	Classification: Types of classification, Hunts algorithms for Decision trees classification, Validating a model, Bayesian classifier, Naïve Bayes Classifier,	Lecture, Discussion	Exam	CLO2
7.	Review and makeup class form week 1 to 6 and Mid-semester exam.			

8.	Rule-based classifier, Classification by back propagation, ANN, Support vector machine.	Lecture, Discussion	Class Test	CLO2, CLO5
9.	Cluster Analysis: Definition and types of Clusters, K-means algorithm, Agglomerative hierarchical clustering, DBSCAN algorithm	Lecture, Discussion	Class Test	CLO2, CLO4
10.	Density based clustering, Prototype based clustering, Scalable clustering algorithm, Clustering high dimensional data.	Lecture, Discussion	Assignment	CLO2, CLO4
11.	Text Mining: Extracting attributes (keywords), Structural approaches (parsing, soft parsing), Bayesian approach to classifying text.	Lecture, Discussion	Class Test	CLO2, CLO5
12.	Web Mining: Classifying web pages, Extracting knowledge from the web, Data Mining software and applications.	Lecture, Discussion	Exam	CLO4
13.	Complicated Data Mining: Graph-Based Clustering, Graph mining, Subgraph mining, Mining sequential pattern.	Lecture, Discussion	Exam	CLO4, CLO5
14.	Review and makeup class form week 8 to 13 and Mid-semester exam.			

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment: Attendance, Class Test, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	SL	Category	Mark%
	1.	Attendance	5%
	2.	Class Test	5%
	3.	Assignment	5%
	4.	Presentation/Quiz	5%
	5.	Mid Semester Exam	20%
Make-up Procedures	6.	Final Semester Exam	60%
Repeat Course, Mid-Term Incomplete Exam, Final Term Incomplete Exam			
	Total:		100%

Learning Materials:

- Introduction to Data Mining author: Vipin Kumar, 2nd edition
- Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Page- 94 Techniques (2nd Edition), Morgan Kaufmann, 2005.nd
- Data Mining and Data Warehousing - Bharat Bhushan Agarwal, Sumit Prakash Tayal - Mcgraw Hill, 2 edition
- Data Warehousing, Data Mining, and OLAP - Alex Berson and Stephen J. Smith- Mcgraw Hill
- Data Mining Concepts and Techniques: Jiawei Han and Micheline Kamber

BNQF Code: 06121005, Course Code: ICT-1005
Course Title: Wireless Sensor Networks
Credit Hr.: 3.00, Contact Hr.: 3.00, Course Type: Core
Pre-requisites (if any): None

Rationale

Wireless Sensor Networks (WSNs) are pivotal in enabling smart environments by allowing seamless sensing, data processing and wireless communication. This course is essential for postgraduate ICT students to understand the foundational architecture, protocols, challenges and applications of WSNs. As sensor-based systems become increasingly integrated into healthcare, agriculture, industry and environmental monitoring, students must be prepared to develop and deploy secure, energy-efficient and scalable WSN solutions.

Course Objective

The objective of this course is to equip students with theoretical and practical knowledge of Wireless Sensor Networks. It focuses on the design principles, communication protocols, data handling, power efficiency and security issues in WSNs. Students will also explore modern WSN applications and engage in project-based learning to develop practical solutions using contemporary tools.

Course Learning Outcomes (CLOs)

Upon successful completion of the course, students will be able to:

- CLO1 Explain the basic concepts, architecture and applications of Wireless Sensor Networks.
- CLO2 Analyze WSN protocols including MAC, routing and transport layer protocols.
- CLO3 Design efficient sensor network solutions considering energy, scalability and security constraints.
- CLO4 Apply simulation tools or programming environments to implement and test sensor network solutions.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓											
CLO2		✓		✓								
CLO3			✓									
CLO4					✓							

Course Content and Mapping CLOs with the Teaching-Learning & Assessment Strategy

Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1	Introduction to Wireless Sensor Networks, Applications & Characteristics	Lecture, Discussion, Real-world case examples	Short quiz, Class participation	CLO1
2	Network Architecture: Node	Interactive lecture,	In-class MCQ quiz,	CLO1

Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
	structure, WSN architecture, Design issues	Diagram analysis, Group Q&A	Concept map submission	
3	Wireless Communication Basics & Challenges in WSN	Lecture with visual demos, Peer explanation	Written problem-solving tasks	CLO1
4	MAC Protocols for WSN: Contention-based and Schedule-based	Lecture, Protocol comparison through examples	Homework on MAC protocol types and efficiency	CLO2
5	Routing Protocols: Flat, Hierarchical, Location-based	Case-based learning, Protocol mapping activity	Mid-level analytical assignment	CLO2
6	Transport Protocols: Congestion control, Reliability	Interactive lecture, Scenario discussion	Concept-based questions and oral presentation	CLO2
7	Mid Term Exam Preparation	Revision sessions, Self-assessment, Practice problems	—	—
8	Mid Term Examination			CLO1, CLO2
9	Energy Efficiency in WSN: Sources of energy loss, Optimization methods	Simulation walkthrough, Group activity	Design review of an energy-aware network scenario	CLO3
10	Scalability and Mobility Issues in WSN	Lecture, Real-world examples, Discussion	Case study evaluation	CLO3
11	Security in WSN: Threats, Cryptographic techniques	Problem-solving session, Paper reading & discussion	Quiz and mini-essay on security protocol trade-offs	CLO3
12-13	Sensor Deployment and Coverage Strategies	Group brainstorming, Algorithm exploration	Group task on coverage planning and optimization	CLO3
14	Project Implementation: Use of programming environment for a WSN problem	Lecture with visual demos	Mini-project presentation	CLO4
15	Final Exam Preparation and Feedback Collection	Problem-solving, Student reflection, Q&A	Feedback survey, CLO achievement reflection	CLO1–CLO4
16	Final Examination			CLO1–CLO4

Course Evaluation Process and Mark Distributions

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment: Class Test, Assignment, Presentation Summative: Mid-Term and Final Term Exams	1.	Attendance:	10%
	2.	Mid Term	
		a. Class Test	5%
		b. Assignment/ Presentation	5%
Make-up Procedures		c. Exam	20%
	Repeat Course, Mid-Term Incomplete Exam, Final Term Incomplete Exam	3.	Final Term
		Total:	100%

Learning Materials

Textbooks:

- Kazem Sohraby, Daniel Minoli, and Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley, 2007.
- Holger Karl and Andreas Willig, *Protocols and Architectures for Wireless Sensor Networks*, Wiley, 2005.

Reference Books:

- Feng Zhao and Leonidas Guibas, *Wireless Sensor Networks: An Information Processing Approach*, Morgan Kaufmann, 2004.

BNQF Code: 06121007, Course Code: ICT-1007

Course Title: Research Methodology

Credit Hr.: 2.00, Contact Hr.: 2.00, Course Type: Core

Pre-requisites (if any): None

Rationale

In today's knowledge-driven society, the ability to conduct high-quality research is essential for academic, scientific, and professional success. This course equips postgraduate students with the fundamental principles and practical tools of research methodology required to undertake independent research in the field of Information and Communication Technology. It provides an understanding of research design, data collection, statistical analysis, technical writing, and ethical considerations—laying a solid foundation for thesis work, publication, and lifelong inquiry.

Course Objective

The objective of this course is to develop the students' understanding of the principles and practices of research in ICT. It aims to familiarize students with research philosophies, methodologies, and ethical norms. This course also enables them to formulate research problems, conduct literature reviews, design experiments, evaluate results, write high-quality technical papers, research reports and theses, use modern tools for referencing, plagiarism checking and data analysis.

Course Learning Outcomes (CLOs)

Upon successful completion of this course, students will be able to:

- CLO1 Explain the key concepts, types, and ethics of scientific research.
- CLO2 Design and apply appropriate research methodology and data collection techniques.
- CLO3 Analyze and interpret research data using modern tools.
- CLO4 Develop structured research proposals and write technical reports or academic papers effectively.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓					✓		✓				✓
CLO2		✓		✓						✓		
CLO3			✓				✓				✓	
CLO4				✓	✓				✓			

Course Content and Mapping CLOs with the Teaching-Learning & Assessment Strategy

Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1	Introduction to Research: Definition, Objectives, Significance, and Ethics in Research	Lecture, Case Discussions, Interactive Q&A	In-class quiz, Participation	CLO1
2	Types of Research: Qualitative, Quantitative, Mixed Methods	Group Discussion, Comparative Analysis, Examples	Short written assignment	CLO1
3	Literature Review Techniques and Tools (Google Scholar, Scopus, Mendeley)	Hands-on Demo, Literature Mapping Activity	Literature mapping exercise	CLO1
4	Formulating Research Problems and Hypotheses	Workshop, Brainstorming, Mini-Projects	Problem Statement Submission	CLO1, CLO2
5	Research Design: Experimental, Survey, Case Study	Lecture with Real-life Examples, Group Case Study	Case Analysis Report	CLO2
6	Data Collection Methods: Sampling, Questionnaire, Interviews	Field-based Examples, Mock Interview/Survey Practice	Questionnaire Design & Submission	CLO2
7-8	Mid Term Examination			CLO1, CLO2
9	Data Analysis Techniques: Descriptive and Inferential Statistics	Software-based Demo (SPSS/Excel), Practice Worksheets	Data Analysis Assignment	CLO3
10	Use of Research Tools	Lecture Sessions	Tool-based Analysis	CLO3
11	Interpretation of Results and Validation	Group Discussion, Research Paper Review	Short Analytical Report	CLO3
12	Research Proposal Structure and Writing Guidelines	Interactive Lecture, Real Proposal Samples	Draft Proposal Submission	CLO4
13	Academic Writing and Referencing Techniques	Hands-on Practice, Plagiarism Check Practice	Referencing & Plagiarism Quiz	CLO4
14	Technical Report and Journal Article Writing	Guided Writing Practice, Peer Review	Final Proposal/Report Submission	CLO4
16	Final Term Exam (Contd.) & Course Feedback			CLO1–CLO4

Course Evaluation Process and Mark Distributions

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment: Class Test, Assignment, Presentation Summative: Mid-Term and Final Term Exams	1.	Attendance:	10%
	2.	Mid Term	
		a. Class Test	5%
		b. Assignment/ Presentation	5%
Make-up Procedures	c. Exam	20%	
	Repeat Course, Mid-Term Incomplete Exam, Final Term Incomplete Exam	3. Final Term	60%
Total:		100%	

Learning Material

Textbooks:

- C. R. Kothari, *Research Methodology: Methods and Techniques*, New Age International Publishers.

Reference Books:

- Dawson, Catherine. *Practical Research Methods*, How To Books Ltd.

BNQF Code: 06121015, Course Code: ICT-1015

Course Title: Multimedia Communication

Credit Hr.: 3.00, Contact Hr.: 3.00, Course Type: Core

Pre-requisites (if any): None

Rationale

With the increasing demand for rich media services across networks, understanding the theory and practice of multimedia communication is crucial for advanced-level learners. This course equips students with the knowledge and skills to understand multimedia data types, compression techniques, communication protocols, and multimedia networking. It lays the foundation for developing and analyzing modern multimedia systems including VoIP, video conferencing, and streaming platforms.

Course Objective

To provide students with a thorough understanding of the principles, technologies, and standards of multimedia communication, enabling them to design, analyze, and implement efficient multimedia systems and protocols for real-world applications.

Course Learning Outcomes (CLOs)

Upon successful completion of the course, students will be able to:

- CLO1 Explain fundamental concepts of multimedia communication systems including data types, formats, and standards.
- CLO2 Apply various compression and encoding techniques for audio, image, and video data.
- CLO3 Analyze multimedia transmission protocols and network performance metrics.
- CLO4 Design and evaluate basic multimedia communication applications or simulations.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓											
CLO2		✓										
CLO3				✓								
CLO4					✓							

Course Content and Mapping CLOs with the Teaching-Learning & Assessment Strategy

Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1	Introduction to Multimedia Systems and Applications	Lecture, Real-life Examples	Quiz, Participation	CLO1
2	Multimedia Data Types: Text, Image, Audio, Video	Demonstrations, Group Discussions	In-class short test	CLO1
3	Color Models, Video Formats, and Digitization	Visual Demos, Video Analysis	Homework assignment	CLO1
4	Audio and Speech Coding: PCM, ADPCM, MP3	Analytical Problem Solving, Audio Tool Demos	Practical assessment	CLO2
5	Image Compression: JPEG, PNG	Tutorial-based Lecture, MATLAB Practice	In-class short test	CLO2
6	Video Compression Standards: MPEG-1, MPEG-4, H.264	Simulation-based Teaching, Case Studies	In-class short test	CLO2
7-8	Mid Term Examination			CLO1, CLO2
9	Multimedia Networking: RTP, RTSP, SIP	Interactive Lecture, Protocol Analysis	In-class short test	CLO3
10	Quality of Service (QoS), Traffic Shaping, Buffering	Real-world Examples, Diagrams	Short analysis quiz	CLO3
11	Streaming Techniques: Live vs. On-Demand	Lecture, Hands-on Demo	In-class discussion, MCQ	CLO3
12	Multimedia Communication over Wireless Networks	Group Discussion, Research Paper Review	Group presentation	CLO3
13-14	System Design: VoIP, Video Conferencing Architecture	Design Thinking, Tool Demo	In-class short test	CLO4
15-16	Final Examination			CLO1–CLO4

Course Evaluation Process and Mark Distributions

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment:	1.	Attendance:	10%

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Class Test, Assignment, Presentation Summative: Mid-Term and Final Term Exams Make-up Procedures	2.	Mid Term	
		a. Class Test	5%
		b. Assignment/ Presentation	5%
	c. Exam	20%	
Repeat Course, Mid-Term Incomplete Exam, Final Term Incomplete Exam	3.	Final Term	60%
		Total:	

Learning Materials

Textbooks:

- *Fundamentals of Multimedia* by Ze-Nian Li and Mark S. Drew, Pearson Education.
- *Multimedia Communications: Applications, Networks, Protocols and Standards* by Fred Halsall, Pearson.

Reference Books:

- *Multimedia Systems* by Ralf Steinmetz and Klara Nahrstedt.
- *Digital Video Processing* by A. Murat Tekalp.

BNQF Code: 06121011, Course Code: ICT-1011

Course Title: Advanced Bio-informatics

Credit Hr.: 3.00, Contact Hr.: 3.00, Course Type: Core

Pre-requisites (if any): None

Rationale

Bioinformatics has evolved as an essential interdisciplinary field combining biology, computer science, and statistics to analyze biological data. The rapid growth in biological databases and high-throughput technologies like next-generation sequencing demands skilled professionals who can interpret complex data efficiently. This course aims to equip students with theoretical foundations and hands-on experience in computational approaches for biological data analysis, enabling them to contribute to areas like genomics, proteomics, and personalized medicine.

Course Objective

The objective of this course is to provide students with an in-depth understanding of advanced bioinformatics techniques, tools, and algorithms for biological sequence and structure analysis. The course will develop the computational skills needed for modeling, analyzing, and interpreting complex biological data, enabling students to solve real-world biological problems.

Course Learning Outcomes (CLOs)

Upon successful completion of the course, students will be able to:

- CLO1 Explain the advanced principles and techniques used in bioinformatics for biological data analysis.
- CLO2 Apply algorithms and tools for sequence alignment, genome annotation, and structural bioinformatics.
- CLO3 Analyze high-throughput omics data using computational tools and statistical models.
- CLO4 Design and develop bioinformatics pipelines or solutions to address biological research questions.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓	✓										
CLO2			✓									
CLO3				✓								
CLO4					✓							

Course Content and Mapping CLOs with the Teaching-Learning & Assessment Strategy

Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1	Introduction to Advanced Bioinformatics	Lecture	In-class quiz/Class Test	CLO1
2	Sequence Alignment Algorithms: Smith-Waterman, BLAST, FASTA	Lecture	Assignment on alignment implementation	CLO2
3	Genome Annotation: Gene Prediction Techniques	Lecture	In-class quiz/Class Test	CLO2
4	Protein Structure Prediction and Modeling	Lecture	In-class quiz/Class Test	CLO2
5	Structural Bioinformatics: Docking, Molecular Dynamics	Case Studies, Lecture	In-class quiz/Class Test	CLO2, CLO3
6	Phylogenetic Tree Construction and Comparative Genomics	Lecture	In-class quiz/Class Test	CLO2
7-8	Mid Term Examination			CLO1, CLO2
9	Microarray and RNA-Seq Data Analysis	Lecture	In-class quiz/Class Test	CLO3
10	Proteomics Data Analysis (Mass Spectrometry and Tools)	Lecture, Case Discussion	In-class quiz/Class Test/Assignment	CLO3
11	Machine Learning in Bioinformatics	Lecture	In-class quiz/Class Test	CLO3
12	Biological Databases and Data Mining	Lecture	In-class quiz/Class Test	CLO1
13-14	Designing Bioinformatics Pipelines	Lecture	In-class quiz/Class Test	CLO4
15-16	Final Examination			CLO1–CLO4

Course Evaluation Process and Mark Distributions

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment:	1.	Attendance:	10%

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Class Test, Assignment, Presentation Summative: Mid-Term and Final Term Exams Make-up Procedures	2.	Mid Term	
		a. Class Test	5%
		b. Assignment/ Presentation	5%
	c. Exam	20%	
Repeat Course, Mid-Term Incomplete Exam, Final Term Incomplete Exam	3.	Final Term	60%
		Total:	

Learning Materials

Textbooks:

- Baxevanis, A. D., & Ouellette, B. F. (Eds.). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd ed.). Wiley-Interscience.
- Lesk, A. M. *Introduction to Bioinformatics* (4th ed.). Oxford University Press.

Reference Books:

- Mount, D. W. *Bioinformatics: Sequence and Genome Analysis* (2nd ed.). Cold Spring Harbor Laboratory Press.
- Pevsner, J. *Bioinformatics and Functional Genomics* (3rd ed.). Wiley-Blackwell.

BNQF Code: 06121002, Course Code: ICT-1002
Course Title: Advanced Wireless Communication Sessional
Credit Hr.: 1.00, Contact Hr.: 3.00, Course Type: Core
Pre-requisites (if any): Wireless Communication Sessional

Rationale

Laboratory-based learning is crucial in wireless communication, as it bridges theoretical knowledge with real-world implementation. This course provides hands-on experience with simulation tools, hardware platforms, and case studies in wireless communication systems. Students will develop practical skills in channel modeling, modulation techniques, MIMO systems, and performance analysis of advanced wireless technologies such as 4G, 5G, and beyond. By engaging in experiments, projects, and case studies, learners will strengthen their problem-solving, analytical, and research capabilities in modern wireless communication.

Course Objectives:

The objective of this course is to provide students with advanced practical exposure to wireless communication systems. It aims to train students in the design, simulation, and evaluation of wireless systems, and to prepare them for solving real-world challenges in wireless networks through projects and case studies.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: **Analyze** the performance of various digital modulation and coding schemes over different wireless channel models (AWGN, Rayleigh, Rician).
- CLO2: **Design and simulate** a complete Orthogonal Frequency-Division Multiplexing (OFDM) communication system and evaluate its key performance metrics.
- CLO3: **Evaluate** the performance benefits of Multiple-Input Multiple-Output (MIMO) systems, including diversity gain and spatial multiplexing gain, in comparison to single-antenna systems.
- CLO4: **Utilize** modern simulation tools and/or Software-Defined Radio (SDR) hardware to build and test a functional wireless communication link as part of a course project.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓	✓			✓							
CLO2	✓		✓	✓	✓							
CLO3	✓	✓		✓	✓							
CLO4			✓	✓	✓			✓				

Week	Topics Covered	Mapped CLO(s)
Week 1	Introduction to the Lab & Tools: Course overview, safety guidelines, assessment policies and introduction to MATLAB/Simulink for wireless communication simulation.	CLO1, CLO2, CLO3, CLO4
Week 2	Digital Modulation Performance: Simulation of BPSK, QPSK, and 16-QAM, Generation of Bit Error Rate (BER) vs. E_b/N_0 curves.	CLO1
Week 3	Wireless Channel Modeling: Simulating communication over Additive White Gaussian Noise (AWGN), Rayleigh and Rician fading channels.	CLO1
Week 4	Channel Coding for Error Control: Implementation of Linear Block Codes (e.g., Hamming code), performance analysis of coding gain in AWGN and fading channels.	CLO2
Week 5	Class Test 1	
Week 6	OFDM System Simulation (Part 1): Design and implementation of an OFDM transmitter using IFFT, implementation of Cyclic Prefix (CP) insertion.	CLO2
Week 7	OFDM System Simulation (Part 2): Design of an OFDM receiver (CP removal, FFT), performance analysis of BER for an end-to-end OFDM link.	CLO2
Week 8	MIMO Systems (Diversity): Introduction to MIMO concepts, simulating a 2x1 system with Alamouti's Space-Time Block Code (STBC) to achieve diversity gain.	CLO3
Week 9	MIMO Systems (Spatial Multiplexing): Simulating a 2x2 MIMO system using Zero-Forcing (ZF) or MMSE detector, analyzing the capacity improvement (spatial multiplexing gain).	CLO3
Week 10	Class Test 2	
Week 11	Wireless Network Performance Evaluation: Delay, Throughput, and BER Analysis.	CLO2
Week 12	Case Study: IoT and Wireless Sensor Networks Applications.	CLO3, CLO4
Week 13	Cognitive Radio and Dynamic Spectrum Access: Simulation of Spectrum Sensing	CLO4
Week 14	Project Presentations / Case Studies Review / Course Recap	CLO1–CLO4

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	1	Class participation and activity	14	10%
	2	Assignments/Report and Presentation	1	10%
	3	Midterm examination(Lab)	2	20%
	4	Final examination (Viva, Lab)	1	60%
	Total			

Learning Materials:

1. Rappaport, T. S. *Wireless Communications: Principles and Practice (2nd ed.)*. Pearson.
2. Goldsmith, A. *Wireless Communications*. Cambridge University Press.
3. IEEE Xplore Digital Library (Wireless Communication Journals)

BNQF Code: 06121004, Course Code: ICT-1004,

Course Title: Data Mining Sessional

Credit Hr.: 1.00, Contact Hr.: 3.00, Course Type: Core

Pre-requisites (if any): None

Rationale:

Data Mining, as a practical discipline, equips students with the ability to analyze, interpret, and transform raw data into valuable insights for decision-making. This course is designed to complement theoretical coursework by providing hands-on experience with algorithms, tools, and real-world datasets. Through practical implementation, students will learn how to apply classification, clustering, association rule mining, and other techniques to solve real problems.

Course Objectives:

1. Provide practical exposure to the implementation of data mining algorithms such as classification, clustering, association rule mining, and regression.
2. Strengthen students' ability to preprocess, clean, and transform datasets for effective mining.
3. Develop critical thinking and problem-solving skills by applying data mining techniques to real-world datasets and case studies.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1 Implement and compare various data mining algorithms for classification, clustering, and association.
- CLO2 Preprocess and prepare datasets through cleaning, transformation, and normalization techniques.
- CLO3 Analyze and interpret results obtained from mining experiments, drawing meaningful insights.
- CLO4 Design and execute small-scale projects that apply data mining to real-world problems.
- CLO5 Critically evaluate performance metrics of different mining approaches (e.g., accuracy, precision, recall, F1-score).

Mapping Course Learning Outcomes (CLOs) with PLOs												
CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓				✓							
CLO2		✓		✓	✓							
CLO3		✓		✓						✓		
CLO4			✓						✓		✓	
CLO5				✓	✓							✓

Course Content and Mapping CLOs with the Teaching-Learning& Assessment Strategy				
Week	Contents	Teaching-Learning Strategy	Assessment Strategy	CLO
1.	Introduction to the lab, tools, and datasets, Installing and configuring software	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO2
2.	Data cleaning: handling missing values, noise, and outliers Data transformation: normalization, standardization, discretization	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO2
3.	Feature selection and dimensionality reduction (e.g., PCA), Exploratory Data Analysis (EDA) using visualization tools	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO2, CLO3
4.	Implementing Naïve Bayes classifier, Comparing classification accuracy on sample datasets	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO3
5.	Implementing k-Nearest Neighbors (k-NN), Comparing classification accuracy on sample datasets	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO3
6.	Implementing ID3 / C4.5 / CART decision tree classifiers, Visualization of decision trees, Performance evaluation (accuracy, confusion matrix)	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO3, CLO5
7.	Review and makeup class from week 1 to 6 and Mid-semester Lab performance.			
8.	Implementing Support Vector Machines (SVM), Logistic Regression for binary classification, Case study: Email spam classification / sentiment analysis	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO3, CLO5
9.	Implementing Logistic Regression for binary classification, Case study: Email spam classification / sentiment analysis	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO3, CLO4
10.	Implementing k-Means clustering, Visualization of clusters	Lecture,	Assignment,	CLO2,

	on 2D datasets, Evaluating clustering with silhouette score	Discussion, Lab Assignment	Lab Performance	CLO4
11.	Implementing Hierarchical clustering (Agglomerative, Divisive), Case study: Document clustering / customer segmentation	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO2, CLO5
12.	Implementing Apriori algorithm in WEKA / Python, Generating frequent item sets and association rules	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO1, CLO3
13.	Mini Project: Students select a dataset of choice (healthcare, finance, education, etc.), Apply preprocessing + one classification + one clustering method	Lecture, Discussion, Lab Assignment	Assignment, Lab Performance	CLO4, CLO5
14.	Review and makeup class from week 8 to 13 and Mid-semester lab performance.			

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Exam Continuous Assessment: Attendance, Lab Test, Assignment, Lab works Summative: Mid Semester Lab Exam and Final Semester Exam	SL	Category	Mark%
	1.	Attendance	5%
	2.	Lab Test	5%
	3.	Assignment	5%
	4.	Lab performance	5%
	5.	Mid Semester Lab Exam	20%
Make-up Procedures	6.	Final Semester Exam	60%
	Total:		100%

Learning Materials:

- Introduction to Data Mining author: Vipin Kumar, 2nd edition
- Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Page- 94 Techniques (2nd Edition), Morgan Kaufmann, 2005.nd
- Data Mining and Data Warehousing - Bharat Bhushan Agarwal, Sumit Prakash Tayal - Mcgraw Hill, 2 edition
- Data Warehousing, Data Mining, and OLAP - Alex Berson and Stephen J. Smith- Mcgraw Hill
- Data Mining Concepts and Techniques: Jiawei Han and Micheline Kamber

BNQF Code: 06121006, Course Code: ICT-1006
Course Title: Advanced Wireless Sensor Networks Sessional
Credit Hr.: 1.00, Contact Hr.: 3.00, Course Type: Core
Pre-requisites (if any): Wireless Sensor Networks Sessional

Rationale

Wireless Sensor Networks (WSNs) are an essential component of modern communication and computing systems, with applications in smart cities, healthcare, military, disaster management, and environmental monitoring. This lab-based course provides hands-on experience in WSN design, simulation, deployment, and performance evaluation. It bridges theoretical foundations with practical implementations using simulation tools and experimental testbeds. Students will gain skills in routing, energy management, security, and real-world sensor network applications.

Course Objectives:

The main objective of this course is to equip students with practical knowledge and skills to design, simulate, and analyze wireless sensor networks. Students will learn to implement routing protocols, evaluate network performance, and explore applications of WSNs through projects and case studies.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: **Demonstrate** practical understanding of wireless sensor network architecture, protocols, and applications.
- CLO2: **Apply** simulation tools (e.g., NS-3, MATLAB, Cooja/Contiki) for WSN design and performance analysis.
- CLO3: **Analyze** network performance with respect to energy efficiency, latency, throughput, and reliability.
- CLO4: **Design** project-based solutions or case studies addressing real-world WSN challenges.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓				✓							
CLO2	✓		✓		✓							
CLO3		✓		✓	✓			✓				
CLO4		✓			✓							

Week	Topics Covered	Mapped CLO(s)
Week 1	Introduction to WSNs, Simulation Tools Setup (NS-3, MATLAB, Cooja)	CLO1
Week 2	Sensor Node Architecture and Energy Models	CLO1
Week 3	Simulation of Node Deployment Strategies (Random vs. Controlled)	CLO2
Week 4	Medium Access Control (MAC) Protocols for WSNs	CLO1-CLO2
Week 5	Class Test 1	CLO1-CLO2

Week 6	Routing Protocols: LEACH, PEGASIS, and Energy-Aware Routing	CLO2-CLO3
Week 7	Data Aggregation and Fusion in WSNs	CLO2-CLO3
Week 8	Fault Tolerance and Reliability in WSNs	CLO3
Week 9	Security Issues in WSNs: Key Management, Intrusion Detection	CLO3
Week 10	ClassTest 2	CLO2-CLO3
Week 11	Performance Evaluation: Energy Efficiency, Latency, Throughput	CLO3
Week 12	IoT Integration: WSNs for Smart Cities and Healthcare Applications	CLO4
Week 13	Project Development (Simulation/Case Study Implementation)	CLO4
Week 14	Project Presentations / Case Studies Review / Course Recap	CLO4

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	1	Class participation and activity	14	10%
	2	Assignments/Report and Presentation	1	10%
	3	Midterm examination (Lab)	2	20%
	4	Final examination (Viva, Lab)	1	60%
	Total			

Learning Materials:

1. Holger Karl & Andreas Willig. *Protocols and Architectures for Wireless Sensor Networks*. Wiley.
2. Feng Zhao & Leonidas Guibas. *Wireless Sensor Networks: An Information Processing Approach*. Morgan Kaufmann.
3. Walteneus Dargie & Christian Poellabauer. *Fundamentals of Wireless Sensor Networks: Theory and Practice*. Wiley.

Course Code: ICT 2001 (0714 02), **Course Title:** Advanced Internet of Things

Credit Hr.: 3.00, **Contact Hr.:** 3.00, **Course Type:** Core Engineering Course

Pre-requisites (if any): None

Rationale

The Internet of Things (IoT) is revolutionizing modern industries by connecting physical devices with intelligent systems. This course equips MS in ICT students with essential knowledge of IoT architectures, communication protocols, enabling technologies, and real-world applications. It emphasizes both theoretical

foundations and practical skills, including cloud integration, embedded systems, and system management using SDN and NFV. By completing this course, students will be prepared to design, develop, and manage IoT solutions that drive innovation and digital transformation across various sectors.

Course Objectives:

1. CO1: Understand the fundamental concepts, architecture, and communication models of IoT systems
2. CO2: Analyze enabling technologies and protocols used in IoT, including wireless sensor networks, cloud computing, big data analytics, and embedded systems
3. CO3: Explore domain-specific IoT applications across various sectors such as home automation, smart cities, energy, agriculture, industry, and healthcare
4. CO4: Design and manage IoT platforms and devices using development tools, cloud platforms, and system management technologies

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: Understand the architecture, characteristics, and communication models of IoT systems
- CLO2: Identify and compare key enabling technologies and protocols used in IoT environments
- CLO3: Analyze and evaluate domain-specific IoT applications in areas like smart cities, agriculture, etc.
- CLO4: Design and develop IoT-based systems using physical devices, software platforms, and cloud services
- CLO5: Apply system management and integration concepts using SDN/NFV and cloud services for IoT systems

Mapping Course Learning Outcomes(CLOs) with PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	√	√										
CLO2	√		√									
CLO3		√			√							
CLO4			√	√	√							
CLO5				√	√							

Contents

Introduction to Internet of Things: Definition & Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies.
IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, Embedded Systems, IoT 1st Year, IoT Year-2, IoT Year-3, IoT Year-4, IoT Year- 5.
Domain Specific IoTs I: Home Automation, Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors, Cities- Smart Parking, Smart Lighting, Structural Health Monitoring, Surveillance, EnvironmentWeather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection.

Domain Specific IoTs II: Energy- Smart Grids, Renewable Energy Systems, Prognostics, Retail- Inventory Management, Smart Payments, Smart Vending Machines, Logistics- Route Generation & Scheduling, Shipment Monitoring, Remote Vehicle Diagnostics, Agriculture- Smart Irrigation, Green House Control, Industry- Machine Diagnosis & Prognosis, Indoor Air Quality Monitoring, Health & Lifestyle, Wearable Electronics.

IoT and M2M: Introduction to M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT System Management with NETCONF-YANG, Need for IoT Systems Management, Network Operator Requirements, NETCONF, YANG.

IoT Platforms Design Methodology: Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Year Specification, Functional View Specification, Operational View Specification, Device & Component Integration, Case Study on IoT System for Weather Monitoring, IoT Physical Devices & Endpoints, Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, pc Duino, Beagle Bone Black, Cubieboard.

IoT Physical Servers & Cloud Offerings: Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT, Xively Cloud for IoT, Django Architecture, Starting Development with Django, Amazon Web Services for IoT, Amazon EC2, Amazon Auto Scaling, Amazon S3, Amazon RDS, Amazon Dynamo DB, Amazon Kinesis, Amazon SQS, Amazon EMR, Sky Net IoT Messaging Platform.

Week	Topics Covered	Mapped CLO(s)
Week 1	Introduction to IoT: Definition, Characteristics, IoT Evolution	CLO1
Week 2	Physical and Logical Design of IoT; Things in IoT	CLO1
Week 3	IoT Communication: Protocols, Communication Models, and APIs	CLO1
Week 4	IoT Enabling Technologies I: Wireless Sensor Networks, Embedded Systems	CLO2
Week 5	IoT Enabling Technologies II: Cloud Computing, Big Data Analytics, Communication Protocols	CLO2
Week 6	Evolution of IoT (Year 1 to Year 5); Summary of Enabling Trends	CLO2
Week 7	Domain-Specific IoT I: Smart Homes – Lighting, Appliances, Intrusion & Gas Detection	CLO3
Week 8	Domain-Specific IoT II: Smart Cities – Parking, Structural Health, Surveillance, Environment & Pollution Monitoring	CLO3
Week 9	Domain-Specific IoT III: Agriculture, Industry, Energy, Health & Wearables	CLO3
Week 10	IoT Platform Design I: Process, Domain, Information, and Service Specifications	CLO4
Week 11	IoT Platform Design II: Functional & Operational Views; Device and Component Integration	CLO4
Week 12	IoT Devices and Cloud Platforms: Raspberry Pi, pcDuino, BeagleBone, Cubieboard; WAMP, Xively, Django; AWS Services (EC2, S3, RDS, etc.)	CLO4
Week 13	IoT and M2M Communication: M2M vs IoT; SDN, NFV; Introduction to Network Virtualization	CLO5
Week 14	IoT System Management: NETCONF, YANG, and Network Operator Requirements	CLO5

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)

Exam Continuous Assessment: Attendance, Class Test, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	1	Class participation and activity	28	5%
	2	Class test	1	5%
	3	Assignments/Report and Presentation	1	10%
	4	Midterm examination	2	20%
	5	Final examination	1	40%
	Total			

Learning Materials:

1. Internet of Things: A Hands-On Approach
Arshdeep Bahga, VPT edition1, 2014.
2. Designing for Emerging - UX for Genomics, Robotics, and the Internet of Things Technologies, 2014.
3. Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014
4. Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013
5. CunoPfister, Getting Started with the Internet of Things, O’Reilly Media, 2011, ISBN: 978-1-4493-9357-1
6. Designing for Emerging - UX for Genomics, Robotics, and the Internet of Things Technologies, 2014 by Jonathan Follett, O’Reilly
7. From Machine-to-Machine to the Internet of Things – Jan Holler
8. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – David Hanes

Course Code: ICT 2003 (0714 02), **Course Title:** Advanced Machine Learning

Credit Hr.: 3.00, **Contact Hr.:** 3.00, **Course Type:** Core Engineering Course

Pre-requisites (if any): None

Rationale

Advanced Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to introduce machine learning, and the algorithmic paradigms it offers, in a principled way. The course provides a theoretical account of the fundamentals underlying machine learning and the mathematical derivations that transform these principles into practical algorithms.

Course Objectives:

1. CO1: Introduce the foundational concepts of machine learning, including supervised and unsupervised learning, loss functions, and generalization theory.
2. CO2: Develop the ability to apply kernel and Bayesian methods for modeling complex data patterns

and uncertainty.

3. CO3: Explore and implement ensemble techniques such as bagging, boosting, and random forests to enhance prediction accuracy.
4. CO4: Provide in-depth understanding of deep feedforward neural networks, focusing on model design, optimization, and regularization.
5. CO5: Enable students to model dependencies using structured probabilistic approaches and apply approximate inference techniques for deep learning problems.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: Understand the core principles of supervised and unsupervised learning, loss functions, and generalization theory
- CLO2: Apply kernel methods and Bayesian techniques for building machine learning models on complex datasets
- CLO3: Analyze and implement ensemble methods to improve model performance and generalization
- CLO4: Design and train deep feed-forward neural networks using modern optimization and regularization techniques
- CLO5: Evaluate structured probabilistic models and apply inference techniques for deep learning applications

Mapping Course Learning Outcomes(CLOs) with PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	√	√										
CLO2	√		√									
CLO3		√			√							
CLO4			√	√	√							
CLO5		√		√	√							

Contents

Introduction: Supervised/Unsupervised Learning; Loss functions and generalization; Probability Theory (Conditional probability, The Law of Total Probability and Bayes' rule, Expectations, mean vectors and covariance matrices, Continuous random variables, Distributions of sums of independent random variables) ; Elements of Computational Learning Theory.

Kernel Methods: Dual Representations; Constructing Kernels; Radial Basis Function Networks (Nadaraya-Watson model); Gaussian Processes (Linear regression revisited, Gaussian processes for regression, Learning the hyperparameters, Automatic relevance determination, Gaussian processes for classification, Laplace approximation).

Bayesian Methods for Using Prior Knowledge and Data: Bayesian inference; Bayesian Belief Networks and Graphical models; Gaussian Processes (Gaussian derivatives and integrals; Multivariate normal densities; Bivariate normal densities).

Ensemble Learning: Bagging; Boosting; Random Forest.

Deep Feed forward Network: Gradient-based learning; Hidden units; Architectural design; Back propagation algorithms; Parameter norm penalties; Dataset augmentation; Early stopping.

Structured Probabilistic models for Deep Learning: Challenges of unstructured modeling; Learning about dependencies; Inference and approximate inference; Sampling from graphical models.

Week	Topics Covered	Mapped CLO(s)
Week 1	Introduction to Machine Learning: Supervised vs Unsupervised Learning, Key Applications	CLO1
Week 2	Loss Functions and Generalization: Bias-Variance Trade-off, Overfitting, Regularization	CLO1
Week 3	Probability Theory Refresher: Conditional Probability, Bayes' Rule, Expectation, Mean/Covariance, Random Variables	CLO1
Week 4	Computational Learning Theory: PAC Learning, Generalization Bounds, VC Dimension	CLO1
Week 5	Kernel Methods I: Dual Representations, Kernel Construction	CLO2
Week 6	Kernel Methods II: RBF Networks, Gaussian Processes (Regression, Hyperparameters, Classification)	CLO2
Week 7	Bayesian Methods: Bayesian Inference, Belief Networks, Graphical Models	CLO2
Week 8	Ensemble Learning I: Bagging and Boosting Theory and Algorithms	CLO3
Week 9	Ensemble Learning II: Random Forests, Practical Implementation	CLO3
Week 10	Deep Feedforward Networks I: Gradient-Based Learning, Hidden Units, Architectural Design	CLO4
Week 11	Deep Feedforward Networks II: Backpropagation, Regularization Techniques (L1/L2, Early Stopping, Dropout)	CLO4
Week 12	Structured Probabilistic Models I: Unstructured Modeling Challenges, Dependency Learning	CLO5
Week 13	Structured Probabilistic Models II: Approximate Inference Techniques, Graphical Model Sampling	CLO5
Week 14	Project Presentations / Case Studies Review / Course Recap	CLO1–CLO5 (All)

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Class Test, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	1	Class participation and activity	28	5%
	2	Class test	1	5%
	3	Assignments/Report and Presentation	1	10%
	4	Midterm examination	2	20%
	5	Final examination	1	40%
	Total			

Learning Materials:

1. Pattern Classification (2nd ed.) Richard O. Duda, Peter E. Hart and David G. Stork September 3, 1997
2. Deep Learning, by Ian Goodfellow
3. Pattern Recognition and Machine Learning by Christopher M. Bishop
4. Introduction to Machine Learning by Alex Smola and S.V.N. Vishwanathan
5. Hands-on machine learning with scikit-learn, keras, and tensorflow 3rd edition
6. Machine Learning (2nd Edition) - Tom Mitchell (McGraw Hill)

Course Code: ICT 2005 (0714 02), **Course Title:** Advanced Block Chain and Distributed System

Credit Hr.: 3.00, **Contact Hr.:** 3.00, **Course Type:** Core Engineering Course

Pre-requisites (if any): None

Rationale

Blockchain and distributed systems form the foundation of decentralized computing, secure financial platforms, and scalable consensus protocols. This course equips students with a deep understanding of cryptography, blockchain architecture, distributed consensus, and real-world implementations like Bitcoin and Ethereum. It emphasizes both theoretical principles and practical skills for building secure and high-performance decentralized applications (DApps).

Course Objectives:

1. CO1: Develop a strong understanding of applied cryptographic techniques and their role in securing blockchain systems.
2. CO2: Analyze the structure, mechanisms, and security challenges of blockchain protocols such as Bitcoin and Ethereum.
3. CO3: Explore foundational concepts and impossibility results in distributed systems relevant to blockchain consensus.
4. CO4: Apply smart contract development and blockchain programming using platforms like Ethereum and Solidity.
5. CO5: Evaluate performance improvement strategies in blockchain systems and their practical impact on scalability and security.
6. CO6: Understand the intersection of blockchain technology with financial instruments and decentralized finance (DeFi) applications.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

CLO1: Understand cryptographic primitives like hash functions, Merkle trees, and elliptic curve

- cryptography used in blockchains
- CLO2: Analyze consensus protocols, blockchain architecture, and key attack models including double-spend and eclipse attacks
- CLO3: Apply distributed system concepts like Lamport clocks and Byzantine fault tolerance to evaluate blockchain design
- CLO4: Develop smart contracts using Solidity and implement core Ethereum blockchain features
- CLO5: Assess and propose blockchain performance enhancements using DAGs, Bloom filters, and compact blocks
- CLO6 Interpret financial concepts such as derivatives and futures in the context of blockchain and DApps

Mapping Course Learning Outcomes(CLOs) with PLOs												
CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	√											
CLO2	√	√		√								
CLO3	√	√	√	√								
CLO4	√		√	√	√							
CLO5	√	√			√							
CLO6	√											

Contents

Applied Cryptography: Definition of security, Hash functions, Merkle trees, Public/private key crypto using elliptical curves.

Blockchains: Nakamoto consensus, Details of Bitcoin: transactions, blocks, P2P networking, Ethics, Doublespend attacks (including Gambler's Ruin), Selfish mining attacks, Eclipse attacks.

Distributed Systems: Doucer's Sybil attack impossibility result, Clocks: NTP and Lamport clocks, Lamport's byzantine general's result, Fischer, Lynch, and Paterson's(FLP) impossibility result.

More Bitcoin Details: Bitcoin's scripting language, Difficulty adjustment algorithms and hashrate estimation, Transaction malleability, Lightning networks, Segwit.

Ethereum: Ghost, ETHASH, OP codes, Patricia Merkle Trees, DAPPS. Programming Ethereum with Solidity.

Finance: Basic overview of economic metrics, Basic overview of Financial instruments (derivatives, etc), Initial Coin Offerings, Using futures contracts to insure DAPPS.

Improving Blockchain Performance: Bloom filters, Invertible Bloom Lookup Tables (IBLTs), Compact Blocks, Graphene, Low variance mining with Bobtail, Proof of stake based blockchains, DAG-based blockchains.

Week	Topics Covered	Mapped CLO(s)
Week 1	Course Introduction; Basics of Blockchain & Distributed Systems	CLO1, CLO2

Week 2	Applied Cryptography I: Hash Functions, Merkle Trees	CLO1
Week 3	Applied Cryptography II: Public/Private Key Cryptography (Elliptic Curve Crypto)	CLO1
Week 4	Blockchain Fundamentals I: Bitcoin Overview, Nakamoto Consensus, Transactions and Blocks	CLO2
Week 5	Blockchain Fundamentals II: P2P Networking, Ethics, and Double-Spend Attacks	CLO2
Week 6	Blockchain Attacks: Selfish Mining, Eclipse Attacks, Gambler's Ruin	CLO2
Week 7	Distributed Systems I: Sybil Attack Impossibility (Douceur's Result), NTP and Lamport Clocks	CLO3
Week 8	Distributed Systems II: Byzantine Generals Problem, FLP Impossibility Result	CLO3
Week 9	Ethereum Fundamentals I: GHOST, ETHASH, Patricia Merkle Trees	CLO4
Week 10	Ethereum Fundamentals II: Smart Contracts and DApps; Programming in Solidity	CLO4
Week 11	Finance in Blockchain I: Economic Metrics, Financial Instruments (Derivatives, ICOs)	CLO6
Week 12	Finance in Blockchain II: Using Futures to Insure DApps	CLO6
Week 13	Improving Blockchain Performance I: Bloom Filters, IBLTs, Graphene, Compact Blocks	CLO5
Week 14	Improving Blockchain Performance II: DAG-based Blockchains, Low-variance Mining, Proof of Stake	CLO5

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Class Test, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	1	Class participation and activity	28	5%
	2	Class test	1	5%
	3	Assignments/Report and Presentation	1	10%
	4	Midterm examination	2	20%
	5	Final examination	1	40%
	Total			

Learning Materials:

7. "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
8. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press.
9. Lewis, A. (2018). The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them. Mango Media Inc..
10. William Stallings, "Cryptography and Network Security, fourth edition, Prentice Hall, New Delhi, 2006.

Course Code: ICT 2007 (0714 02), **Course Title:** Management Information System (MIS)

Credit Hr.: 3.00, **Contact Hr.:** 3.00, **Course Type:** Optinal

Pre-requisites (if any): None

Rationale

In today's digital economy, effective management of information systems is crucial for organizational success. This course provides a comprehensive understanding of how organizations use information systems for strategic advantage, operational efficiency, and decision-making. It also covers technological, ethical, and managerial aspects of IS to prepare students to evaluate, design, and implement information systems in a dynamic business environment.

Course Objectives:

CO1: Understand the structure and role of IS in various organizational types and contexts.

CO2: Evaluate how organizations adapt and transform through IS and e-business solutions.

CO3: Analyze methodologies for IS planning, design, and development.

CO4: Assess the financial, strategic, and operational impact of IS investments.

CO5: Examine the technical, managerial, and ethical challenges in implementing and managing IS.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: Understand the nature, components, and strategic role of information systems in organizations
- CLO2: Analyze the interaction between IS and organizational transformation, including e-business applications
- CLO3: Evaluate IS planning, design approaches, system development, and implementation strategies
- CLO4: Assess the cost-benefit, risks, and business value of IS investments
- CLO5: Explain technical infrastructure, change management, and ethical issues related to information systems

Mapping Course Learning Outcomes(CLOs) with PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	√											
CLO2	√	√		√								
CLO3	√	√	√	√	√							
CLO4	√	√		√	√							
CLO5	√				√	√						

Contents

Nature of information systems: nature & type, key characteristics; **Nature of organization:** nature & type, key characteristics. **Two way relationship between is and organization:** IS's influence on organization, organization's influence on IS; Introduction to e-business, **ebusiness transformation:** models, opportunities and challenges; **Defining the organization's need for IS:** determining the information need, drawing up a IS plan, IS design alternative, in-house development vs. outsourcing, Enterprise system vs. Functional modules, system lifecycle vs. other methodologies, automation, process improvement, BPR vs. paradigm shift; **Cost, benefit, nature of IS investment:** determining the cost and benefit of IS, determining the Risk factors, business value of IS investment; **Managing the transformation:** change management issues, prerequisites for successful change management. Social, Political, and Ethical Issues in the Information Age, Computer Hardware, Computer Software, Managing Data Resources, Telecommunications and Networks, Systems Development, Information Systems Quality, Security, and Control, Decision Support Systems, Artificial Intelligence.

Week	Topics	Mapped CLO(s)
Week 1	Nature & Types of Information Systems; Characteristics of Organizations	CLO1
Week 2	Strategic Role of IS in Organizations	CLO1
Week 3	Two-Way Relationship between IS and Organizations	CLO2
Week 4	Introduction to E-Business; Transformation Models, Opportunities, Challenges	CLO2
Week 5	Defining Information Needs, IS Planning and Roadmapping	CLO3
Week 6	IS Design Alternatives: In-House vs Outsourcing, Lifecycle vs Agile Methods	CLO3
Week 7	Enterprise vs Functional Systems; Automation, Process Improvement, BPR	CLO3
Week 8	IS Investment: Cost, Benefit, Risk, and Strategic Value	CLO4
Week 9	Change Management in IS Projects; Success Factors	CLO5
Week 10	Social, Political, and Ethical Issues in the Information Age	CLO5
Week 11	Technical Foundations I: Computer Hardware, Software	CLO5
Week 12	Technical Foundations II: Data Management, Telecommunications, Networks	CLO5
Week 13	Systems Development, IS Quality, Security, and Control	CLO5
Week 14	Decision Support Systems and Artificial Intelligence	CLO5

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Class Test,	1	Class participation and activity	28	5%
	2	Class test	1	5%

Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	3	Assignments/Report and Presentation	1	10%
	4	Midterm examination	2	20%
	5	Final examination	1	40%
	Total			100%

Learning Materials:

1. "Management Information System: Managing the Digital Firm", by Kenneth C. Laudon, Jane P. Laudon, Prentice Hall; 8 edition (February 20, 2003)
2. "Management Information System", by Raymond McLeod, Jr. and George Schell, Prentice Hall; 10 edition (May 6, 2006).
3. "Management Information Systems" by James A. O'Brien, George Marakas, McGrawHill/Irwin; 7 edition (January 14, 2005).
4. "Introduction to Information Systems Project Management", by David L. Olson, David Olson, McGraw-Hill/Irwin; 2 edition (May 8, 2003).
5. "Management Information Systems for the Information Age with CDROM" by Stephen Haag, Maeve Cummings, Irwin/McGraw-Hill (November 2007).

BNQF Code: 06112015, Course Code: ICT-2015,

Course Title: Project

Credit Hr.: 6.00, Contact Hr.: 6.00, Course Type: Core

Pre-requisites (if any): None

Rationale:

The MSc Project course is designed to give postgraduate students an opportunity to apply advanced theoretical knowledge to practical, real-world problems through independent or group-based project work. Unlike a thesis, which focuses on research and generation of new knowledge, the project course emphasizes design, implementation, and validation of systems, models, or prototypes.

Course Objectives:

1. To provide students with an opportunity to apply theoretical knowledge in solving real-world or industry-related problems.
2. To develop competence in designing, developing, and implementing software, systems, or prototypes.
3. To strengthen skills in project management, teamwork, and technical communication.
4. To expose students to professional practices, ethics, and innovation in computing/engineering.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

CLO1 Identify and define a real-world problem suitable for a project.

- CLO2 Apply relevant theories, tools, and technologies to design and implement a solution.
- CLO3 Conduct experiments, testing, or validation to evaluate the solution.
- CLO4 Work effectively in teams or independently while demonstrating project management skills.
- CLO5 Communicate project outcomes through technical documentation and oral presentation.
- CLO6 Demonstrate ethical responsibility and awareness of societal/industrial impact.

Mapping Course Learning Outcomes (CLOs) with PLOs												
CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	✓	✓										
CLO2			✓		✓							
CLO3				✓					✓			
CLO4									✓		✓	
CLO5										✓		
CLO6						✓		✓				✓

Course Contents (Suggested Structure)
<ol style="list-style-type: none"> 1. Problem Definition & Proposal Writing – project scope, objectives, deliverables 2. Literature Review & Technology Survey – identifying existing solutions and gaps 3. System/Project Design – requirements, architecture, modeling, planning 4. Implementation & Development – coding, simulation, prototyping, or hardware/software integration 5. Testing, Evaluation & Validation – debugging, experiments, performance metrics 6. Report Writing & Documentation – technical report following standard format 7. Project Presentation & Demonstration – oral defense and prototype demonstration

Assessment Strategy	Course Evaluation Process and Mark Distributions		
Continuous Assessment: Attendance, project progress, assignment, demo defense Summative: Final project Document, Oral Defense (Viva Voce)	SL	Category	Mark%
	1.	Project Proposal & Presentation	
	2.	Mid-term Progress Report	
	3.	Project Demonstration / Prototype	
	4.	Supervisor’s Continuous Evaluation	
Make-up Procedures	5.	Final Document	80%
	6.	Oral Defense (Viva Voce)	20%
	Total:		100%

Learning Materials:

- Programming languages, frameworks, and tools (Python, Java, MATLAB, TensorFlow, etc.)
- Project management tools (Trello, Jira, GitHub)
- Research databases for background study (IEEE Xplore, Springer, ACM DL)
- University project labs and software licenses

Course Code: ICT 2002 (0714 02), **Course Title:** Advanced Internet of Things Sessional

Credit Hr.: 2.00, **Contact Hr.:** 3.00, **Course Type:** Core Engineering Course

Pre-requisites (if any): Internet of Things Sessional & Microprocessor and Embedded System Lab

Rationale

The Internet of Things (IoT) is revolutionizing modern industries by connecting physical devices with intelligent systems. This course equips MS in ICT students with essential knowledge of IoT architectures, communication protocols, enabling technologies, and real-world applications. It emphasizes both theoretical foundations and practical skills, including cloud integration, embedded systems, and system management using SDN and NFV. By completing this course, students will be prepared to design, develop, and manage IoT solutions that drive innovation and digital transformation across various sectors.

Course Objectives:

1. Understand fundamental IoT concepts, architectures, and communication models.
2. Analyze enabling IoT technologies (WSNs, cloud computing, big data, embedded systems).
3. Evaluate domain-specific IoT applications (smart cities, healthcare, agriculture, industry).
4. Design and develop IoT systems using hardware (Raspberry Pi, sensors) and cloud platforms (AWS, Google Cloud).
5. Apply system management techniques (SDN/NFV, NETCONF-YANG) for IoT integration.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: Explain IoT architecture, characteristics, and communication models.
- CLO2: Compare key IoT technologies (WSNs, cloud computing, protocols).
- CLO3: Analyze and evaluate IoT applications in smart cities, healthcare, and agriculture.
- CLO4: Design and implement IoT systems using embedded devices (Raspberry Pi) and cloud services (AWS).

CLO5: Apply SDN/NFV and IoT system management (NETCONF-YANG) for efficient deployment.

Mapping Course Learning Outcomes(CLOs) with PLOs												
CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	√	√										
CLO2	√	√		√	√							
CLO3	√	√		√		√	√					
CLO4		√	√	√	√				√	√	√	
CLO5		√	√	√	√							

Week	Topics Covered	Mapped CLO(s)
Week 1	<p>Introduction to IoT Development Boards Objective: Familiarize with Raspberry Pi/Arduino/ESP32.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Set up the development environment (OS installation, GPIO configuration). Blink an LED using Python/C. Read sensor data (e.g., temperature sensor DHT11). 	CLO1, CLO4
Week 2	<p>IoT Communication Protocols Objective: Implement and compare IoT protocols.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Send sensor data via MQTT (using Mosquitto/Eclipse Paho). Simulate HTTP REST API communication (Flask/Django backend). Compare CoAP vs. MQTT for constrained devices. 	CLO1, CLO2
Week 3	<p>Wireless Sensor Networks (WSN) Objective: Create a basic WSN for data aggregation.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Deploy multiple sensor nodes (e.g., ESP32 with BME280). Transmit data to a gateway (Raspberry Pi) via LoRa/Wi-Fi/Zigbee. Visualize data in a dashboard (Grafana/Node-RED). 	CLO2, CLO4
Week 4	<p>Cloud Integration for IoT Objective: Connect IoT devices to cloud platforms.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Upload sensor data to AWS IoT Core or Google Cloud IoT. Store data in Amazon DynamoDB/Firebase. Trigger serverless actions (AWS Lambda). 	CLO4, CLO5
Week 5	Class Test 1	
Week 6	<p>Smart Home Automation Objective: Build a basic home automation system.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Control lights/fans via voice commands (Google Assistant/Alexa). Implement motion-based automation (PIR sensor + relay). 	CLO3, CLO4

	<ul style="list-style-type: none"> Secure communication using TLS/HTTPS. 	
Week 7	<p>IoT in Agriculture (Smart Irrigation)</p> <p>Objective: Design a soil moisture-based irrigation system.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Monitor soil moisture (capacitive sensor). Automate water pump control via NodeMCU + Blynk app. Send alerts for low moisture (Telegram/Email). 	CLO3, CLO4
Week 8	<p>Industrial IoT (Machine Monitoring)</p> <p>Objective: Simulate predictive maintenance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Monitor vibration/temperature using MPU6050. Send data to ThingSpeak/Ubidots. Detect anomalies using simple ML (Python scikit-learn). 	CLO3, CLO5
Week 9	<p>IoT Security & Edge Computing</p> <p>Objective: Implement security measures.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Secure MQTT with TLS/SSL. Implement JWT-based authentication. Run edge analytics (TensorFlow Lite for sensor data). 	CLO2, CLO5
Week 10	Class Test 2	
Week 11	<p>Smart City Application (Traffic/Pollution Monitoring)</p> <p>Objective: Simulate a smart city IoT network.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Deploy air quality sensors (MQ135). Analyze real-time pollution data (Python + Matplotlib). Optimize traffic signals using dummy RFID-based vehicle detection. 	CLO3, CLO4
Week 12	<p>IoT System Management (SDN/NFV & NETCONF-YANG)</p> <p>Objective: Explore SDN-based IoT management.</p> <p>Tasks:</p> <ul style="list-style-type: none"> Simulate SDN-controlled IoT devices (Mininet + OpenDaylight). Use NETCONF/YANG for device configuration. Virtualize IoT services using Docker/Kubernetes. 	CLO5
Week 13	Review Class	CLO1, CLO2, CLO5
Week 14	Review Class	CLO2, CLO3, CLO4

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Class Test, Assignment, Presentation	1	Class participation and activity	28	10%
	2	Assignments/Report and Presentation	1	10%

Summative: Mid Semester Exam and Final Semester Exam	3	Midterm examination (Lab)	2	20%
	4	Final examination (Viva, Lab)	1	60%
	Total			100%

Learning Materials:

1. Internet of Things: A Hands-On Approach
Arshdeep Bahga, VPT edition1, 2014.
2. Designing for Emerging - UX for Genomics, Robotics, and the Internet of Things Technologies, 2014.
3. Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014
4. Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013
5. CunoPfister, Getting Started with the Internet of Things, O’Reilly Media, 2011, ISBN: 978-1-4493-9357-1
6. Designing for Emerging - UX for Genomics, Robotics, and the Internet of Things Technologies, 2014 by Jonathan Follett, O’Reilly
7. From Machine-to-Machine to the Internet of Things – Jan Holler
8. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – David Hanes

Course Code: ICT 2004 (0714 02), **Course Title:** Advanced Machine Learning Sessional

Credit Hr.: 2.00, **Contact Hr.:** 3.00, **Course Type:** Core Engineering Course

Pre-requisites (if any): Machine Learning Sessional

Rationale

Advanced Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to introduce machine learning, and the algorithmic paradigms it offers, in a principled way. The course provides a theoretical account of the fundamentals underlying machine learning and the mathematical derivations that transform these principles into practical algorithms.

Course Objectives:

1. CO1: Introduce the foundational concepts of machine learning, including supervised and unsupervised learning, loss functions, and generalization theory.
2. CO2: Develop the ability to apply kernel and Bayesian methods for modeling complex data patterns and uncertainty.
3. CO3: Explore and implement ensemble techniques such as bagging, boosting, and random forests to enhance prediction accuracy.
4. CO4: Provide in-depth understanding of deep feedforward neural networks, focusing on model

design, optimization, and regularization.

- CO5: Enable students to model dependencies using structured probabilistic approaches and apply approximate inference techniques for deep learning problems.

Course Learning Outcomes (CLO):

After completing the course, students will be able to:

- CLO1: Apply supervised, unsupervised, and kernel-based learning algorithms to real-world datasets.
- CLO2: Implement Bayesian inference, probabilistic graphical models, and Gaussian processes for regression and classification.
- CLO3: Design, train, and optimize ensemble and deep neural network models using appropriate regularization and optimization techniques.
- CLO4: Utilize structured probabilistic models and modern ML tools for experimentation and model evaluation.
- CLO5: Analyze experimental results, compare different models, and communicate findings effectively through reports and presentations.

Mapping Course Learning Outcomes(CLOs) with PLOs

CLO	PLO											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	√	√			√							
CLO2	√	√			√							
CLO3	√	√	√		√				√			
CLO4	√	√	√		√							
CLO5	√	√	√		√				√	√		

Week	Topics Covered	Mapped CLO(s)
Week 1	Supervised Learning – Implement Logistic Regression on benchmark dataset; evaluate with accuracy, precision, recall, F1-score	CLO1
Week 2	Unsupervised Learning – K-means clustering and Principal Component Analysis (PCA) with visualization	CLO1
Week 3	Kernel Methods – Train SVM with linear and RBF kernels; compare decision boundaries & performance	CLO1
Week 4	Gaussian Processes – Regression on synthetic and real datasets; hyperparameter tuning	CLO2
Week 5	Class Test 1	
Week 6	Bayesian Inference – Build a Bayesian inference model; compare MAP vs. MLE estimation	CLO2
Week 7	Probabilistic Graphical Models – Construct Bayesian Belief Network; perform inference using sampling methods	CLO2
Week 8	Ensemble Learning – Implement Bagging and AdaBoost; compare with single decision trees	CLO3
Week	Random Forests – Train Random Forest classifier; analyze feature importance & control	CLO3

9	overfitting	
Week 10	Class Test 2	
Week 11	Deep Feedforward Neural Networks – Build and train a multi-layer perceptron using PyTorch/TensorFlow	CLO3
Week 12	Regularization & Optimization – Apply L2 regularization, dropout, and early stopping; evaluate generalization	CLO3, CLO4
Week 13	Structured Probabilistic Models – Implement Restricted Boltzmann Machine (RBM) or Variational Autoencoder (VAE) for representation learning	CLO4, CLO5
Week 14	Project Presentations / Case Studies Review / Course Recap	CLO1–CLO5 (All)

Assessment Strategy	Sl.	Assessment tool	Conducting Number	Mark distribution (%)
Exam Continuous Assessment: Attendance, Assignment, Presentation Summative: Mid Semester Exam and Final Semester Exam	1	Class participation and activity	14	10%
	2	Assignments/Report and Presentation	1	10%
	3	Midterm examination(Lab)	2	20%
	4	Final examination (Viva, Lab)	1	60%
	Total			

Learning Materials:

1. Pattern Classification (2nd ed.) Richard O. Duda, Peter E. Hart and David G. Stork September 3, 1997
2. Deep Learning, by Ian Goodfellow
3. Pattern Recognition and Machine Learning by Christopher M. Bishop
4. Introduction to Machine Learning by Alex Smola and S.V.N. Vishwanathan
5. Hands-on machine learning with scikit-learn, keras, and tensorflow 3rd edition
6. Machine Learning (2nd Edition) - Tom Mitchell (McGraw Hill)