University of Dhaka

Department of Computer Science and Engineering
Faculty of Engineering and Technology (FoET)
Second Science Complex, Mokarram Bhaban Area
University of Dhaka, Dhaka 1000, Bangladesh

Master of Science in Computer Science and Engineering Degree Program

1 Rules and Guidelines for Master of Science in Computer Science and Engineering Program

The rules and guidelines for the Master of Science in Computer Science and Engineering program are approved by the faculty committee meeting held on 25 Jan 2026, Academic council meeting held on 29 Jan 2026, and followed by the subsequent syndicate meeting. It will be effective from the Fall 2026 semester.

2 Program Title, Program Types and Credit Requirements

Program Title: Master of Science in Computer Science and Engineering

The Master of Science in Computer Science and Engineering, shortened as M.Sc. in CSE, will be offered in two pathways:

- M.Sc. in CSE by Research
- M.Sc. in CSE by Project

Both pathways will operate on a semester basis. Each semester of an academic year will be identified either as Spring or Fall, e.g., Spring 2026 and Fall 2026. No academic session will be maintained. New students will get admission once a year. The University shall have two regular semesters in each academic year:

- The Spring Semester, commencing on the first working day of January and
- The Fall Semester, commencing on the first working day of July.

However, the University reserves the right to change the starting date of any semester in case of emergencies or other unforeseen circumstances with prior approval of the appropriate authority. In such cases, a semester commencing **before June 30** shall be designated as the **Spring Semester** of that year; otherwise, it shall be designated as the **Fall Semester**. The credit distribution is shown in Table 1.

Table 1: **Credit Requirements for the M.Sc. in CSE Degree**

Course Type	**MSc in CSE by Research**	**MSc in CSE by Project**
Credit for Theory Courses	18	30
Credit for Thesis	18	-
Credit for the Project	-	6
Total Credits	**36**	**36**

2.1 Definition of Credit

- **Theory Courses:** One (1) credit corresponds to fourteen (14) contact hours of instruction, delivered in 14 weeks semester, excluding Mid-Term and Final Examination periods.
- **Thesis Work:** One (1) credit corresponds to an average of two (2) hours per week of formal and informal research, supervision meetings, and related scholarly activities throughout the final two semesters of the degree program.
- **Project Work:** One (1) credit corresponds to an average of two (2) hours per week of formal and informal project work, supervision meetings, and related development activities throughout the final two semesters of the degree program.

3 Admission and readmission

a. **Eligibility of Internal Candidates:** Graduates of the Department of Computer Science and Engineering, University of Dhaka, shall be eligible for admission to the M.Sc. in CSE program without an admission test, provided that they apply within two (2) years of the date of their graduation.

b. **Eligibility of External Candidates:** In accordance with the prevailing rules and regulations of the University of Dhaka, the Department may admit qualified candidates graduated from other universities (i.e., lateral entry) through a competitive admission test, subject to the availability of seats in the program.

c. **Readmission:** If a student fails to complete the degree within **three (3) semesters**, the student must **apply for readmission in the subsequent academic year** to extend his or her studentship. A student may be granted **a maximum of two (2) readmissions** and must complete the degree **within six (6) semesters** in total.

4 Program Calendar

The program comprises three semesters, each having a duration of six academic calendar months to be described as follows.

Classes	**14 active weeks**
Mid Semester Exam	1 week
Preparatory leave for Final Exams	10 days
Semester Final Exams	3 weeks
Publication of Results	Within 8 weeks of the last exam date
Vacation	Only the usual vacation set by the University of Dhaka

5 Course Enrollment

Milestones	**Date**
Course Registration	1 Week Before Class Start Date
Course Add/Drop	Within 2 Weeks of Class Start Date
Exam Registration	Within 3 Weeks of Class Start Date

- In a **non-thesis or non-project semester, if a student requires more than one course to complete the total credit requirements in theory courses**, the student must enroll in **at least two (2) courses**.
- For **M.Sc. in CSE by Research**, a student may enroll in **a maximum of four (4) courses** in a regular semester, and **no courses** are permitted in the **final (Thesis Defense) semester**.
- For **M.Sc. in CSE by Project**, a student may enroll in **a maximum of five (5) courses** in a regular semester and **up to two (2) courses** in the **final (Project Defense) semester**.
- A student must **finalize thesis or project enrollment by the end of the his/her first semester**.

6 Grades and Grade points

The University Grants Commission (UGC) and the University of Dhaka both gave their stamp of approval to the grading structure that would be followed for this program, which is detailed below.

Mark Obtained	Letter Grade	Grade Point
80-100	A+	4
75-79	A	3.75
70-74	A-	3.5
65-69	B+	3.25
60-64	B	3
55-59	B-	2.75
50-54	C+	2.5
45-49	C	2.25
40-44	D	2
< 40	F	0
	I	Incomplete
	W	Withdrawn

a) Only grades of "D" or higher shall be counted as credits earned by a student.

b) A student who receives an "F" grade in any course may re-enroll in the same course (if the course is offered) or register for an alternative approved course in the succeeding semester(s) to meet the requirements of the degree.

c) CGPA (Cumulative Grade Point Average) is the weighted average of the grade points obtained by a student in all the courses. CGPA will be calculated according to be following formula:

$$\text{CGPA} = \frac{\sum(\text{Grade Point in a course} \times \text{Credits for the course})}{\text{Total Credits Taken}}$$

d) In the tabulation process, only the total marks of a student in any course may be rounded up to the next integer. The published result of the program shall show only the letter grades earned and the Cumulative Grade Point Average (CGPA) at the end of each semester, with the CGPA rounded to two decimal places.

e) Marks distribution of a Theory course

I.	Attendance	5%
II.	Assignment/Presentation	10%
III.	Midterm examination	25%
IV.	Final Exam	60%
	Total Marks	**100%**

i. Guidelines for Attendance Mark

Attendance (%)	**Marks (05)**
90 and above	5
85 to 89	4.5
80 to 84	4
75 to 79	3.5
60 to 74	3
Less than 60	00

f) Marks distribution of a thesis or project

I.	Thesis/Project Defense	70%
II.	Thesis/Project report evaluation	30%
	Total Marks	**100%**

I. Thesis/Project Defense (70%)	**II. Thesis/Project report evaluation (30%)**
A. Supervisor: 30% B. External Examiner: 20% C. Internal Examiner: 20%	Under the two-examiner system, if the difference between the two evaluations exceeds 20%, the thesis will be reviewed by a third examiner.

7 Improvement and Retake

a. A student is not permitted to apply for re-examination for the purpose of grade improvement.

b. However, if a student obtains a grade of C (2.25) or below in a course, the student may re-enroll in the same course, provided that it is offered, or register for an alternative approved course in the succeeding semester.

8 Exam Committee Formation

a. At the beginning of each semester, the Department's Academic Committee shall constitute an Examination Committee for that semester. The Chairperson of the Examination Committee shall also serve as the Course Coordinator for that semester. The Course Coordinator is responsible for monitoring all academic activities during the semester and reporting to the Chairperson of the Department to prevent or resolve any unexpected situations.

b. The Examination Committee for a given semester shall consist of four (4) members proposed by the Academic Committee of the Department.

c. Membership for each semester's Committee shall include a Chairperson, two internal members from the Department of CSE, and one external member from outside the Department.

d. The Examination Committee shall, for each semester, manage and coordinate all examination-related activities strictly in accordance with the rules, regulations, and guidelines of the University of Dhaka, and within the framework of the departmental rules and regulations for the M.Sc. in CSE program.

9 Evaluation of the Courses

a. **Theory Courses Evaluation:**

The performance of students in theory courses shall be evaluated as follows:

I. Each theory course will be evaluated on the basis of attendance, quizzes/assignments/presentations, midterm examinations, and the semester final examination.

II. Attendance, quizzes/assignments/presentations, and midterm examination marks shall be awarded by the course teacher. These marks must be submitted to the Examination Committee and to the Controller of Examinations before the commencement of the semester final examination.

III. The percentage of attendance of students for each course (according to the prescribed format supplied by the Chairperson) together with the attendance sheet shall be submitted to the Chairperson of the Department before the commencement of the semester final examination.

IV. Midterm examination scripts must be shown to students before the last class of the semester.

V. Where more than one midterm examination is conducted, the midterm marks shall be calculated as the average of all such examinations; selecting only the "best" score is not permitted.

VI. For theory courses, the semester final examination scripts shall normally be evaluated by two examiners: the course teacher as the first examiner, and a second examiner from within the Department or from a relevant Department of the University of Dhaka. If no suitable second examiner is available within the University of Dhaka, one may be appointed from another university with the prior approval of the Vice-Chancellor.

VII. If the difference between the marks awarded by the two examiners is 20 percent or less, the average of the two marks shall be considered final.

VIII. In cases where the difference exceeds 20 percent, the script shall be evaluated by a third examiner. The marks of the two examiners whose marks are nearest to each other shall then be averaged to determine the final mark.

IX. If the differences between the third examiner's mark and those of the first and second examiners are equal, the final mark shall be the average of all three marks.

X. All evaluations, submissions, and examiner appointments shall be conducted in accordance with the existing rules and regulations of the University of Dhaka.

b. **Project Course Evaluation:**

I. Evaluation will be done out of 100 marks where there will be a **project defense of 70% marks and project report evaluation of 30% marks**.

II. Two examiners will evaluate the project report and their average mark will be considered. If the difference of marks between the two examiners is more than 20%, it will be evaluated by a third examiner. Marks of nearest two examiners will be taken for average. If differences are equal the average of three marks will be considered.

III. **Pre-defense:** A working and demonstrable prototype of the project is mandatory for participation in the pre-defense.

IV. **Final defense:** The final project must be carried out under a faculty supervisor, produce an original and demonstrable outcome, and be documented according to departmental guidelines. Students are required to attend pre-defense and final defense, presenting a working demo and responding to the evaluation committee's feedback. Failure to meet these requirements may result in project rejection or failure.

c. **Thesis evaluation**

Thesis will be coordinated by the examination committee. The examination committee may include external experts to assess the thesis. Thesis will be evaluated on the basis of 100% marks where there will be thesis defense (**70% marks**) and thesis report evaluation (**30% marks**). Evaluation will be done in following ways:

I. **Pre-defense**

The student shall present and defend the thesis work duly approved by the respective supervisor(s). Based on the evaluation, the Examination Committee may accept, reject, or conditionally accept the thesis for further processing. As a prerequisite for eligibility for the final thesis defense, the student must have initiated the process of submitting the research work for publication in an appropriate peer-reviewed journal ranked within an established quartile (Q1–Q4) or SCOPUS-indexed in the relevant subject category, or in a core-ranked conference (CORE: A*, A, or B or SCOPUS-indexed). Documentary evidence of such submission must be provided to the Examination Committee.

II. **Final defense**

The student shall submit the thesis, or a revised version of the thesis, that was accepted or conditionally accepted during the pre-defense (if applicable). The Examination Committee shall announce a specific date for the final thesis defense, and the student must defend the thesis on the scheduled date.

To be eligible for the final thesis defense, the student must have at least one research article arising from the thesis work that has been published or formally accepted for publication in an appropriate venue, as defined in section **(I) Pre-defense**.

Notwithstanding the above publication requirement, if the student has received formal peer-review reports from an appropriate journal or conference indicating that the manuscript is potentially publishable subject to revision, and the Thesis Examination Committee is satisfied that the work demonstrates sufficient scholarly merit and a reasonable likelihood of publication, the Committee may, at its discretion, permit the student to proceed with the final thesis defense.

III. **Thesis report evaluation**

Two external examiners will evaluate the thesis report and their average mark will be considered. In case of a difference of marks between the two examiners is more than 20% the thesis will be evaluated by a third examiner. Marks of nearest two examiners will be taken for average. If differences are equal, the average of three marks will be considered.

IV. The program may introduce an award to recognize and appreciate outstanding research and/or project work.

10 Requirement to Sit for Course Final Exam

- A student having 75% or more attendance on average in a course is eligible to appear in the semester final examination for that course.

- Students with 60–74% attendance in a course may be allowed to sit for the examination upon payment of fine as prescribed by the University. In addition to the usual fees, the Department may impose further fines according to the decision of its Academic Committee.
- Students with less than 60% attendance in a course will not be allowed to sit for the semester final examination of that course but may seek re-admission to the program.
- These attendance and eligibility requirements shall apply separately to each course taken by the student.

11 Duration of Examinations

a. The semester final exam will be arranged centrally by the Controller of Examination of the University of Dhaka and the duration will be 3 hours for a 3 credit course.

b. For a 3 credit course, duration of the midterm examination will be 75 to 90 minutes, defined by the respective course teacher.

12 Requirements for the Award of the M.Sc. in CSE Degree

a. A minimum CGPA of 2.50 after completion of the required number of course works and thesis or project defense.

b. No fail grade (F) is allowed for countable courses or Thesis/Project.

c. **Degree Completion Period**

A student may earn the M.Sc. in CSE degree within a minimum of three (3) semesters and a maximum of six (6) semesters from the date of first admission.

d. **Readmission**

A student may be granted readmission at most two times within the total six-semester limit, subject to the approval of the Academic Committee and compliance with University of Dhaka regulations.

e. Each readmission will facilitate studentship of consecutive **two** semesters within the maximum limit of 6.

13 Tabulations

a. The Examination Committee shall appoint two (2) tabulators for each semester.

b. The tabulators shall receive the marks of all courses from the Chairperson of the Examination Committee.

c. Each tabulator shall independently prepare the tabulation sheets. The two sheets shall then be compared and verified for consistency before being submitted to the Office of the Controller of Examinations through the Chairperson of the Examination Committee.

14 Other General Regulations

a. For any matter not covered in the above guidelines, existing rules of the University of Dhaka will be applicable.

b. Disciplinary and punishable actions will be applied according to the existing rules of the University of Dhaka.

Table 2: MSc in CSE Course List (Fall 2026)

Course Code	Course Title	Credit
CSE-5001	Algorithm Engineering	3.0
CSE-5002	Network Routing and Switching	3.0
CSE-5003	Internet of Everything	3.0
CSE-5004	Wireless Mesh Network	3.0
CSE-5005	Image Processing	3.0
CSE-5006	Pattern Recognition	3.0
CSE-5007	Emerging Web Technologies	3.0
CSE-5008	Project Management	3.0
CSE-5009	Mobile Edge Computing	3.0
CSE-5010	Graph Drawing	3.0
CSE-5011	Deep Learning	3.0
CSE-5012	Computer and Network Security	3.0
CSE-5013	Embedded System Engineering	3.0
CSE-5014	Bioinformatics Algorithms	3.0
CSE-5015	VLSI Layout Algorithms	3.0
CSE-5016	Decision Diagrams for VLSI Design	3.0
CSE-5017	Applied Machine Learning	3.0
CSE-5018	Advanced Data Mining Techniques	3.0
CSE-5019	Network Performance Analysis	3.0
CSE-5020	Green Computing and Communications	3.0
CSE-5021	Data Center and Cloud Computing	3.0
CSE-5022	Applied Game Theory and Mechanism Design	3.0
CSE-5023	Text Mining	3.0
CSE-5024	Advanced Operations Research	3.0
CSE-5025	Generative Artificial Intelligence	3.0
CSE-5026	DNA Computing	3.0
CSE-5027	Applied Quantum Computing	3.0
CSE-5028	Digital Twin Systems	3.0
CSE-5029	Digital Forensics	3.0
CSE-5030	Pattern Mining	3.0
CSE-5031	Text Information Systems	3.0
CSE-5032	Wireless Network and IoT Security	3.0
CSE-5033	Cloud Security	3.0
CSE-5034	Network Monitoring and Management	3.0
CSE-5035	Distributed Ledger Technologies	3.0
CSE-5036	Program Analysis	3.0
CSE-5037	Research Methodology	3.0
CSE-5038	Data Driven Modeling	3.0
CSE-5040	Thesis	18.0
CSE-5041	Project	6.0

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Course Outline
CSE-5001 Algorithm Engineering

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5001
Course Title	*Algorithm Engineering*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Algorithmic Complexity: Review of computational complexity, asymptotic analysis, complexity classes, and problem classification. **Algorithmic Modeling and Design:** Algorithmic problem modeling, abstraction of real-world problems, design trade-offs, divide-and-conquer, dynamic programming, greedy strategies, and efficiency analysis. **Exact and Parameterized Algorithms:** Exact algorithms for combinatorial problems, parameterized complexity, fixed-parameter tractability, kernelization, and exponential-time algorithm design. **Approximation and Heuristics:** Approximation algorithms with performance guarantees, LP-based approximation techniques, polynomial -time approximation schemes, and practical heuristics. **Randomized and Online Algorithms:** Randomized algorithms, probabilistic analysis, Monte Carlo and Las Vegas algorithms, online algorithms, and competitive analysis. **Parallel and Distributed Algorithms:** Parallel computation models, distributed and cloud algorithms, scalability, and performance considerations. **Evolutionary Algorithms:** Evolutionary and bio-inspired algorithms, genetic algorithms, swarm intelligence, and optimization applications. **Advanced Applications:** Algorithmic evolution in big data analytics, computational biology, cybersecurity, and data-intensive domains.

3 Text and Reference Materials

T Textbook:

- Introduction to Algorithms, T. H. Coremen et al., MIT press, Fourth Edition, 2022.

– Algorithms; Robert Sedgewick, Kevin Wayne; Addison-Wesley Professional, Fourth Edition, 2022.

R References:

– Handbook of Approximation Algorithms and Metaheuristics; Thomas F. Gonzalez (ed.). CRC press, 2020.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the modern algorithmic paradigms (e.g., randomized, approximation, parallel, bio-inspired, and machine learning–based algorithms) and their applications in contemporary computing systems.
CO2	**Analyze** the complexity, scalability, and efficiency of algorithms under different computational models (sequential, parallel, distributed, and cloud).
CO3	**Design** innovative algorithmic solutions to complex real-world problems using modern computational techniques and platforms.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5002 Network Routing and Switching

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5002
Course Title	*Network Routing and Switching*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	Computer Networking

2 Syllabus

Modern Networking Foundations: Review of TCP/IP and OSI models, Evolution to intent-based networking, Network virtualization and overlays overview, VLANs, Trunking, and segmentation in modern LANs. **Dynamic Routing Protocols and Route Optimization:** RIPv2 (legacy), OSPFv3, EIGRP and route summarization, ECMP (Equal-Cost Multi-Path) routing, Routing convergence and optimization strategies. **BGP and Internet-Scale Routing:** iBGP and eBGP operation, BGP route selection and filtering, Border Gateway Protocol security (BGPsec, RPKI). **Switching:** Rapid Spanning Tree Protocol (RSTP) and MST Link aggregation (LACP), **Data Center switching:** leaf-spine architecture, **Switch Security:** DHCP Snooping, ARP Inspection, MACsec. **SDN, Controllers, and Network Automation:** SDN architecture and control/data plane separation, OpenFlow and modern SDN controllers (ONOS, OpenDaylight), Network automation, Introduction to Infrastructure as Code (IaC), Automating routing/switching tasks (with Ansible or Python scripts). **Ad Hoc Routing Protocols:** Proactive, Reactive, Hybrid, Position-Based, Mobility-assisted, QoS and Energy-Aware Routing prot0cols, VANETs and FANETs, Security in Ad Hoc Routing Attacks (e.g., blackhole, wormhole), Secure routing protocols. **Routing for Mobile and Delay-Tolerant Networks (DTNs)**: Protocols for high-latency or intermittent connectivity, Store-carry-forward approaches, Routing in vehicular ad hoc networks (VANETs). **Routing Protocols for Low-power and Lossy Networks (RPL)**: Pv6 Routing Protocol for LLNs (RFC 6550), DODAG structure, Objective Functions, Trickle Algorithm, RPL extensions: Multipath RPL, QoS-aware RPL. **AI Applicaiton in Network Routing and Switching:** Traffic Optimization and Intent-Based Networking, Predictive Analytics and Self-Healing etc.

3 Text and Reference Materials

T Textbook:

- Routing TCP/IP, Volumes 1 & 2; by Jeff Doyle, Jenifer Carroll
- Internet Routing Architectures 2nd Edition; by Sam Halabi, 2000

- Ad Hoc Wireless Networks: Architectures and Protocols; by C. Siva Ram Murthy and B.S. Manoj, 2004

R References:

- Computer Networking: A Top-Down Approach; by Kurose & Ross
- OSPF: Anatomy of an Internet Routing Protocol 1st Editionl by John Moy
- Data Communications and Networkingl by Behrouz A. Forouzan
- Network Programmability and Automation: Skills for the Next-Generation Network Engineer; by Jason Edelman, Scott Lowe, Matt Oswalt
- Software Defined Networks: A Comprehensive Approach; by Paul Goransson, Chuck Black
- Wireless Ad Hoc and Sensor Networks: Theory and Applications; by Carlos de Morais Cordeiro and Dharma P. Agrawal

4 Course Outcomes

CO	CO Description
CO1	**Apply** advanced routing and switching protocols to design scalable, secure, and optimized network infrastructures.
CO2	**Analyze** Software-Defined Networking (SDN) and network automation techniques to enhance network agility and performance.
CO3	**Evaluate** network security mechanisms to protect routing and switching infrastructures from threats, ensuring confidentiality, integrity, and availability

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5003 Internet of Everything

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5003
Course Title	*Internet of Everything*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Orientation and Overview of IoE: Conceptual difference between IoT and IoE, The four pillars of IoE, IoE lifecycle. **IoE Ecosystem Components:** IoE Device Architecture –Enhanced IoT motes with cognitive sensing, Multi-modal sensing units, and AI-enabled edge computing modules, Dynamic power management techniques, IoE process modeling — data-driven decision-making, Self-optimizing systems, and feedback loops. **Interconnectivity and Multi-domain Integration:** People-to-Machine (P2M), Machine-to-Machine (M2M), and Machine-to-People (M2P) communication, Cognitive network access and adaptive context-awareness, Semantic interoperability and ontology-based integration. **Advanced IoE Platforms and Middleware:** IoE platform architectures (data plane, control plane, intelligence plane), Middleware for distributed intelligence and real-time processing, IoE APIs and service exposure. **Intelligent Communication and Edge-Fog-Cloud Collaboration:** AI-driven data routing and decision making, Edge analytics vs. cloud analytics, Latency-aware orchestration in fog environments, Deployment strategies for federated IoE systems. **IoE Protocols and Real-time Systems:** Advanced IoT/IoE communication protocols, Time-sensitive networking (TSN) for industrial IoE, Cross-domain data fusion and real-time synchronization. **Artificial Intelligence in IoE:** Embedded AI and TinyML on smart devices, Learning at the edge: federated learning and decentralized AI, Real-time intelligent decision-making pipelines, Cognitive digital twins in IoE. **Secure Data Governance and Ethical IoE:** Multi-layer security in IoE, Identity and access management (IAM) in distributed IoE networks.

3 Text and Reference Materials

T Textbook:

- "Internet of Everything: Algorithms, Methodologies, Technologies and Perspectives" by Beniamino Di Martino, Antonio Esposito, Antonio Celesti, Sajal K. Das; Springer, 2021.
- "Architecting the Internet of Things" by Dieter Uckelmann, Mark Harrison, Florian Michahelles; Springer, 2011.

R References:

- "Fog and Edge Computing: Principles and Paradigms" by Rajkumar Buyya, Satish Narayana Srirama; Wiley, 2019.
- "Embedded Systems and Artificial Intelligence: Smart IoT Systems" by Leila Ben Saad, Habib Hamam, Ejaz Ahmed; Springer, 2022.
- Online web resources and papers.

4 Course Outcomes

CO	CO Description
CO1	**Demonstrate** a clear understanding of the Internet of Everything (IoE) architecture and distinguish it from traditional Internet of Things (IoT) systems, identifying its four pillars and integration lifecycle.
CO2	**Apply** knowledge of advanced IoE communication protocols, middleware platforms, and edge–fog–cloud collaborative models to design scalable, real-time, intelligent, and secured, interconnected IoE systems.
CO3	**Analyze** IoE ecosystem components, including cognitive device architecture, sensing, and AI-enabled edge modules to evaluate the interaction between devices, data, people, and processes in diverse application contexts by integrating multi-layer security and intelligent decision-making mechanisms.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

6 Text and Reference Materials

T Textbook:

- "Internet of Everything: Algorithms, Methodologies, Technologies and Perspectives" by Beniamino Di Martino, Antonio Esposito, Antonio Celesti, Sajal K. Das; Springer, 2021.
- "Architecting the Internet of Things" by Dieter Uckelmann, Mark Harrison, Florian Michahelles; Springer, 2011.

R References:

- "Fog and Edge Computing: Principles and Paradigms" by Rajkumar Buyya, Satish Narayana Srirama; Wiley, 2019.

- "Embedded Systems and Artificial Intelligence: Smart IoT Systems" by Leila Ben Saad, Habib Hamam, Ejaz Ahmed; Springer, 2022.
- Online web resources and papers.

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5004 Wireless Mesh Network

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5004
Course Title	*Wireless Mesh Network*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction: Introduction to wireless mesh networks, Mesh architecture, characteristics, application scenarios, critical design factors. **Medium access control layer:** Single-channel Single Radio MAC protocols, Multichannel Single radio MAC protocols, Multi radio MAC protocols, Channel assignment, Dynamic frequency selection, open research issues; Standards on Wireless Mesh Networks: IEEE 802.11s features, Components, Packet Format, Priority based access control: Enhanced Distributed Channel Access (EDCA) and HCF Controlled Channel Access (HCCA), Mesh Deterministic Access (MDA). **Network Layer:** Routing challenges, Design principles, Routing metrics, categories of routing protocol, Topology discovery for routing, Multi-path routing, cross-layer Multichannel routing protocols, hop count and multi bit-rate based routing protocols, Link-level and End-to-End QoS based routing protocols, Routing scalability, open research issues. **Transport Layer:** Challenges of a Transport Layer Protocol in Wireless Environments, Transport Layer Protocols for WMNs, Open research issues. **Network Security:** Typical attack scenarios and IEEE 802.11s; Network control and Management. **AI in wirless mesh network:** Traffic Management and Routing, Performance Optimization, Self-Healing and Security.

3 Text and Reference Materials

T Textbook:

- Introduction to Statistical Learning; by James et al., 2023.
- Machine Learning Yearning by Andrew Ng, 2021.

R References:

- Pattern Recognition and Machine Learning; by Bishop et al., 2006.
- Machine Learning Engineering, by Burkov, 2023.
- Natural Language Processing with Tranasformers, Tunstall et al., 2021.
- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow; by Aurélien Géron, 2022.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the fundamental architecture, characteristics, and critical design factors of wireless mesh networks, including the specific features and components defined by the IEEE 802.11s standard.
CO2	**Analyze** the performance and challenges of Medium Access Control (MAC), Routing, and Transport layer protocols in multi-radio/multi-channel environments to identify suitable strategies for various QoS and scalability requirements.
CO3	**Appraise** the security vulnerabilities of the IEEE 802.11s standard against typical attack scenarios and the selection of specific network control and management countermeasures for a secure mesh infrastructure.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5005 Image Processing

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5005
Course Title	*Image Processing*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Digital image fundamentals: representation, sampling and quantization, image acquisition, basic relationships between pixels, imaging geometry. **Image transforms:** discrete Fourier transform, discrete cosine transform, Walsh and Hadamard transforms, Hotelling transform. **Image enhancement:** in spatial domain and in frequency domain, image smoothing and sharpening; **Image restoration:** degradation models, inverse filter, Wiener filter. **Color and pseudo-color image processing**. **Morphological Processing:** erosion, dilation, opening, closing, hit-or-miss transform, and morphological reconstruction. **Image segmentation:** detection of discontinuities, thresholding, region-oriented segmentation, and the use of motion analysis in segmentation. **Image Compression:** Huffman coding, Golomb coding, LZW coding, run-length coding, predictive coding, and wavelet coding.

3 Text and Reference Materials

T Textbook:

- Digital Image Processing, R. C. Gonzalez and E. E. Woods, Prentice Hall, 4th edition (2018).

R References:

- Fundamentals of Digital Image Processing, A K Jain, Pearson India, First Edition (1989).

4 Course Outcomes

CO	CO Description
CO1	**Explain** the biological system of human vision to interpret the functions of image processing units
CO2	**Analyze** the properties of multiresolution analysis and apply the concepts in image processing.
CO3	**Design** real-life applications of image processing and design efficient engineering solution.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

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Course Outline
CSE-5006 Pattern Recognition

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5006
Course Title	*Pattern Recognition*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction: Introduction to Pattern Recognition, Feature Detection, Basics of Probability Theory, Conditional Probability, Random Vectors, Expectation, Correlation, Covariance, Basics of Linear Algebra and Transformation, Multilinear Analysis; **Bayes Decision Theory:** Discriminant Functions and Services, the Normal Distribution, Bayesian Classification, Estimating Probability Density Functions, Nearest Neighbor Rules, Bayesian Networks **Linear Classifiers:** The Perceptron Algorithm, Least-Squares Methods, Logistic Discrimination, SVM: separable and non-separable classes; **Nonlinear Classifiers:** Multilayer Perceptron, Back Propagation Algorithm, Decision Trees, SVM: The Non-Linear case, Combinations of Classifiers, Boosting; **Feature Selection:** Data Preprocessing, ROC Curves, Class Separability Measures, Feature Subset Selection, Neural Networks and Feature Generation/Selection, Bayesian Information Criterion; **Data Transformation and Dimensionality Reduction:** Basis Vectors and Images, Singular Value Decomposition, Independent Component Analysis, Nonlinear Dimensionality Reduction: Kernel PCA, Graph-based Methods; Discrete Fourier Transform, Haar Transform, Wavelets; **Additional Features and Template Matching:** Texture, Shape and Size Characterization; Fractals, Features for Audio, Template Matching Using Dynamic Time Warping and Edit Distance; **Context Dependent Classification:** Markov Chain Models, Hidden Markov Models, Viterbi and Baum-Welch Algorithms; **Clustering:** Sequential Algorithms, Hierarchical Algorithms, Functional Optimization-Based Clustering, Graph Clustering, Learning Clustering, Expectation-Maximization, Clustering High Dimensional Data, Cluster Validity Measures.

3 Text and Reference Materials

T Textbook:

- S. Theodoridis, and K. Koutroumbas, Pattern recognition. 4th ed., San Diego, CA: Academic Press, 2009.

R References:

- C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
- Duda, Hart and Stork, Pattern Classification, Second Edition, Wiley, 2001.
- T.M. Mitchell, Machine learning, Mc Graw-Hill, New York, 1997.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the basic concepts of pattern recognition and about the state-of-the art algorithms.
CO2	**Apply** pattern recognition techniques in practical problem.
CO3	**Design** optimized pattern recognition techniques.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5007 Emerging Web Technologies

6 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5007
Course Title	*Emerging Web Technologies*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

7 Syllabus

Fundamentals of web Technologies: Web 2.0, Web 3.0, Web hosting, deployment and performance tuning basics. **Front-End Framework and Libraries:** Introduction to React, Angular, or Vue, Component-based development, State management, Routing on the client side. **Back-End Technologies:** Basics of SOA, SOAP, WSDL and UDDI, Working with APIs (RESTful), Node.js basics, Authentication and Session Management. **Introduction to Microservices:** Foundation (How to model Microservices, Types of Coupling, Domain-Driven Design for Micorservices), Splitting the Monolith, Microservice Communication Styles. **Web Security:** HTTPS and SSL/TLS, Common vulnerabilities (XSS, CSRF, SQL Injection), Authentication vs. Authorization, Password hashing and salting, Secure coding best practices. **Deployment and Tools:** Git and version control, Docker basics, CI/CD basics. **Advanced Topics:** Progressive Web Apps (PWA), Single Page Applications (SPA) concepts. **AI in Web Development:** Generative AI and Coding Assistance, AI-Powered Web Design, Enhanced Security.

8 Text and Reference Materials

T Textbook:

- Robbins, J. (2025). Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics (6th ed.). O'Reilly Media.
- Felke-Morris, Terry. Web Development and Design Foundations with HTML5. 10th ed. Boston: Pearson, 2021.

R References:

- Krug, Steve. Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability. 3rd ed. San Francisco: New Riders, 2024.
- Zeldman, Jeffrey, and Ethan Marcotte. Designing with Web Standards. 3rd ed. Berkeley: New Riders, 2020.

9 Course Outcomes

CO	CO Description
CO1	**Implement** modern front-end architectures using component-based frameworks and client-side routing to build responsive Single Page Applications (SPAs) and Progressive Web Apps (PWAs).
CO2	**Analyze** the transition from monolithic architectures to microservices by evaluating different communication styles, coupling types, and RESTful API integration strategies within a Node.js environment.
CO3	**Design** a secure and automated deployment pipeline that mitigates common vulnerabilities (XSS, CSRF, SQLi) through secure coding practices while leveraging Generative AI tools for code optimization and CI/CD workflow automation.

10 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5008 Project Management

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5008
Course Title	*Project Management*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to project management: History of project management, project management profession, project management software, project management context and processes, project phases and life cycle, understanding organizations, suggested skills for a project manager, project management process groups, developing an information technology project management methodology. **Project integration management:** project plan development and execution, integrated change control, **Project scope management:** project initiation, strategic planning and project selection, scope planning and the scope statement, work breakdown structure, scope verification and scope change control, **Project time management:** importance of project schedules, activity sequencing, activity duration estimation, schedule development, controlling project schedule changes, software supported time management, limitations of project management software, **Project cost management:** basic principles of cost management, resource planning, cost estimating, cost budgeting, cost control, software supported cost management, **Project quality management:** quality of information technology projects, modern quality management, quality planning, quality assurance, quality control, improving information system/technology project quality, **project human resource management:** keys to managing people, motivation theories, organizational planning, software supported human resource management, **project communication management:** communication planning, information distribution, performance reporting, administrative closure, software supported project communication, **Project risk management:** risk management planning, common sources of risk in information technology projects, risk identification, risk monitoring and control, software supported project risk management, **Project procurement management:** procurement planning, solicitation planning, source selection, contract administration, contract close-out **Initiating:** developing the project charter, roles of project and senior managers in project initiation, planning: developing the project plans, human resource and communication planning, quality and risk planning, executing: project leadership, core team development, scope verification, quality assurance, disseminating information, controlling: schedule control, scope change control, quality control, performance and status reporting, managing resistance to change, closing: administrative closure.

3 Text and Reference Materials

T Textbook:

- A Guide to the Project Management Body of knowledge (PMBOK guide), Project Management Institute (PMI), 6th edition, 2017.
- Project Management: A Systems Approach to Planning, Scheduling, and Controlling, Harold Kerzner, 13th Edition, Wiley, 2022.

R References:

- Project Management: Case studies, Harold Kerzner, seventh Edition, Wiley.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the fundamental concepts, principles, and life cycle of project management, including initiation, planning, execution, monitoring, and closure.
CO2	**Apply** project management tools and techniques (such as WBS, Gantt charts, PERT/CPM, and risk analysis) to plan, schedule, and control project activities effectivelyAnalyze project constraints involving scope, cost, quality, time, and resources, and develop strategies to balance competing project objectives.
CO3	**Formulate** a comprehensive project management plan by integrating scope baselines, resource-loaded schedules, and cost budgets with robust risk mitigation and quality assurance strategies.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5009 Mobile Edge Computing

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5009
Course Title	*Mobile Edge Computing*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Orientation and Fundamentals of Mobile Edge Computing (MEC): Definition, motivations, and comparison between MEC, Fog, and Cloud Computing; ETSI MEC architecture and standardization. **MEC Architecture and Deployment Models:** Key components: MEC servers, user equipment, orchestrators, and virtualization infrastructure; hierarchical edge computing; different types of deployment strategies; network slicing and multi-access edge. **Computation Offloading and Task Scheduling:** Offloading models: partial vs. full offloading; energy-delay tradeoffs; computation task profiling and mobility-aware offloading; task partitioning; deadline-sensitive and priority-based scheduling strategies. **Edge Resource Management and Virtualization:** Resource provisioning in dynamic and mobile environments; edge containerization vs. virtualization; orchestration using Kubernetes and lightweight platforms; predictive resource scaling and dynamic service placement. **MEC in Next-Gen Wireless Networks:** Integration with 5G and beyond — URLLC, eMBB, mMTC; support for V2X communication and autonomous vehicles; SDN/NFV integration for flexible MEC management; programmable data planes for low-latency services. **Data Processing and Analytics at the Edge:** Streaming data analytics; event-driven edge processing; real-time data filtering and transformation; comparison of edge, fog, and cloud analytics. **Artificial Intelligence at the Edge:** Edge AI platforms and frameworks; TinyML for embedded edge inference; on-device learning and federated learning; intelligent caching and adaptive service migration using reinforcement learning. **Emerging Trends and Applications of MEC:** MEC in smart cities, eHealth, industrial automation, UAVs, and AR/VR; green MEC — energy-aware computation and carbon footprint analysis; digital twins at the edge; MEC integration with satellite and remote sensing.

3 Text and Reference Materials

T Textbook:

- "Mobile Edge Computing: A Complete Guide"; by Gerardus Blokdyk, 5STARCooks, 2020.

- "Edge Computing: Models, Technologies and Applications" by Weisong Shi, Han Yu, and Schahram Dustdar; Springer, 2022.
- "Cloud, Fog, and Edge: Technologies and Applications" by Alfredo Cuzzocrea et al.; CRC Press, 2021.

R References:

- "Fog and Edge Computing: Principles and Paradigms" by Rajkumar Buyya and Satish Narayana Srirama; Wiley, 2019
- "Edge Computing: A Primer" by Jie Cao, Quan Zhang, and Weisong Shi; Springer, 2020.
- "Architecting the Internet of Things: State of the Art" by Dieter Uckelmann et al.; Springer, 2011.

4 Course Outcomes

CO	CO Description
CO1	**Describe** the fundamental principles, architecture, and components of Mobile Edge Computing (MEC) and its distinction from other computing paradigms.
CO2	**Analyze** various task offloading, scheduling, and resource management strategies to evaluate their impact on performance metrics such as latency, energy, and scalability.
CO3	**Apply** edge computing concepts and frameworks to design solutions for real-time, distributed, and network-integrated systems for advanced applications of MEC, including the use of AI, green computing, and domain-specific edge technologies.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5010 Graph Drawing

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5010
Course Title	*Graph Drawing*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Graph Drawing: Historical background, motivation and applications of graph drawing across networks, visualization, VLSI design, and software engineering; drawing styles and aesthetic criteria including planarity, symmetry, minimal crossings, readability, and layout metrics. **Graph Theoretic Foundations:** Basic graph theory concepts, planar and non-planar graphs, combinatorial embedding, duality, and fundamental properties essential for drawing algorithms. **Straight-Line and Convex Drawings:** Techniques for straight-line graph drawing including shift and realizer methods, compact grid layouts, convex drawings and convexity testing, grid embeddings with convexity guarantees, and algorithmic implementations. **Orthogonal and Rectangular Drawings:** Orthogonal graph drawing via network flows, linear-time orthogonal layouts, rectangular layouts and matchings, Thomassen's theorem, box-rectangular drawing extensions, and complexity considerations. **Octilinear and Advanced Drawing Styles:** Octagonal (octilinear) drawings, mixed angular resolution, bend minimization and aesthetic constraints, and practical layout strategies for metro maps and schematic diagrams. **Tree and Layered Drawings:** Algorithms for tree layouts, hierarchical and layered drawings (Sugiyama framework), crossing reduction, alignment, and constraints handling. **Non-Planar and Beyond:** Quasi-planar, 1-planar, and k-planar graph drawings; beyond planar graph classes, crossing-optimal and drawing quality metrics, and recent theoretical results and practical heuristics. **Algorithmic and Complexity Issues in Graph Drawing:** Complexity of drawing problems, performance analysis, data structures and implementation practices, graph drawing toolkits and libraries, and open problems in large-scale and dynamic graph visualization.

3 Text and Reference Materials

T Textbook:

- Hand Book of Graph Drawing and Visualization by Roberto Tamassia, CRC Press, 2014.

- Planar Graph Drawing, T. Nishizeki, Md. Saidur Rahman, World Scienctific, Singapore, 2004.

R References:

- Graph Drawing: Algorithms for the visualization of Graphs, G. D. Batista, Peter Eades, Roberto Tamassia, I. G. Tollis, Pearson, 1998.
- Beyond Planar Graphs, Seok-Hee Hond, Takeshi Tokuyama, 2020.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the fundamental concepts and theoretical foundations of graph drawing, including planarity, embeddings, and aesthetic criteria.
CO2	**Analyze** different graph drawing models such as planar, convex, rectangular, orthogonal layouts etc..
CO3	**Design** algorithms for drawing various types of graphs (trees, planar graphs, clustered graphs, dynamic graphs, etc.) ensuring readability and minimal edge crossings.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5011 Deep Learning

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5011
Course Title	*Deep Learning*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Foundations of Deep Learning: Neural networks as universal function approximators; depth efficiency and representational power; theoretical motivation for deep architectures; inductive bias and hierarchical feature learning. **Feedforward Networks and Optimization:** Multilayer perceptrons (MLPs); forward and backpropagation; activation functions (ReLU, GELU, Tanh); weight initialization; loss functions (MSE, Cross-Entropy); optimization methods including SGD, Momentum, Adam, and LAMB; learning rate scheduling techniques such as warm-up, cosine annealing, and cyclical learning rates. **Generalization, Regularization, and Normalization:** Overfitting and underfitting in deep models; regularization techniques including L1/L2, Weight Decay, Dropout, and Label Smoothing; data augmentation methods such as Mixup and CutMix; Sharpness-Aware Minimization (SAM); normalization techniques including Batch Normalization and Layer Normalization. **Convolutional Neural Networks and Visual Learning:** Convolutional operations; receptive fields; padding, stride, and pooling; hierarchical feature learning; CNN architectures including LeNet, AlexNet, VGG, ResNet, DenseNet, and EfficientNet. **Object Detection with YOLO:** CNN-based object detection; YOLO architecture and its variants; real-time detection applications. **Recurrent Networks and Temporal Modeling:** Sequence modeling with RNNs; limitations of vanilla RNNs; LSTM and GRU architectures; gating mechanisms, memory modeling, and truncated BPTT; applications in time series, speech recognition, and sequential data. **Attention and Transformer Architectures:** Attention mechanisms; self-attention and multi-head attention; Transformer encoder–decoder architecture; positional encoding; Transformers as a general-purpose neural architecture across domains. **Graph Neural Networks and Structured Learning:** Representation learning on graph-structured data; Graph Convolutional Networks (GCNs), Graph Attention Networks (GATs), and message-passing frameworks; node-, edge-, and graph-level representations; applications in networks, molecular graphs, and recommendation systems. **Deep Reinforcement Learning:** Deep learning for sequential decision-making; value-based methods such as Deep Q-Networks (DQN); policy gradient methods including REINFORCE and Proximal Policy Optimization (PPO); actor–critic architectures such as A2C and SAC; applications in robotics, autonomous control, and strategic games.

3 Text and Reference Materials

T Textbook:

- *John D. Kelleher*, **Deep Learning**, First Edition, MIT Press, 2019.

R References:

- *Ian Goodfellow and Yoshua Bengio and Aaron Courville*, **Deep Learning**, First Edition, MIT Press, 2016.
- *Eli Stevens, Luca Antiga, and Thomas Viehmann*, **Deep Learning with PyTorch** , First Edition, Manning, 2020.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the theoretical foundations of deep learning, including function approximation, depth efficiency, optimization strategies, and generalization principles, and analyze how architectural and optimization choices influence learning behavior.
CO2	**Evaluate** deep learning models such as CNNs, Transformers, GNNs, and recurrent architectures for vision, sequential, and structured data, using appropriate training, regularization, and normalization techniques.
CO3	**Apply** deep learning methodologies to complex applied problems, including object detection, temporal modeling, multimodal learning, and sequential decision-making, and critically assess model performance through empirical evaluation and comparison.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5012 Computer and Network Security

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5012
Course Title	*Computer and Network Security*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Security basics: Confidentiality, integrity and availability (CIA Triad), threats, vulnerabilities, attacks, and attack agents, and common security threats. **Cryptographic primitives**: Classical encryption schemes, symmetric cipher, stream cipher, RC4, block cipher and data encryption standard, advanced encryption standard, key distributions, public key cryptography, certificates, digital signature, hash functions, message authentication code. **Internet protocols**: PGP, IPSec, SSL/TLS, HTTPS, VPN, Tor protocols, DNSSec, DNS cache poisoning attacks, email security, WiFi security, Bluetooth security. **Access control**: discretionary access control, mandatory access control, role-based access control (RBAC) and attribute-based access control (ABAC). **User Authentication**: password-based mechanism–dictionary and rainbow table attacks, token-based authentication, biometric-based authentication, remote authentication, Kerberos, RADIUS. **Denial of service attacks**: TCP vulnerabilities, denial of service attacks, Flooding attacks, DDOS attacks, reflector and amplifier attacks, defense against DOS, Botnets. **Web security**: PHP exploits, SQL injection, cross-site scripting, browser side exploits. **Malicious softwares**: types of Malware, infected content, vulnerability exploits, social engineering, system corruption, bots, zombie, key loggers, phishing, spyware, backdoors, counter measures. Buffer overflow exploits and defenses, software and operating system security, Intrusion detection and prevention system, defense in depth, firewalls-packet filtering and proxy-server based firewall. **Vulnerability and Threat Modeling:** system and asset identification, vulnerability identification and assessment, threat identification and analysis, threat modeling techniques, risk evaluation and threat prioritization, security control and mitigation strategies. **Applications of Computer and Network Security:** Data Protection and Privacy, Secure Remote Work (VPNs), IoT and Smart Home Security.

3 Text and Reference Materials

T Textbook:

- Computer Security Principles and Practice; by Lawrie Brown and William Stallings, 4th Edition, Pearson publisher, 2017.

R References:

- Computer & Internet Security: A Hands-on Approach; by Wenliang Du, 2nd edition, Wenliang Du, 2019.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the fundamentals of computer security.
CO2	**Analyze** the fundamental cryptographic primitives.
CO3	**Evaluate** the fundamental of network security application and system security.
CO4	**Design** security techniques and mechanisms to mitigate cyber security risks and threats.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5013 Embedded System Engineering

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5013
Course Title	*Embedded System Engineering*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Fundamentals of Embedded System: Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal), Cyber-physical interfacing concepts, Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components. **Program modeling concepts:** DFG, FSM, Petri-net, UML, Models of computation for real-time systems. **Embedded Hardware and Design:** Introduction to ARM-v7-M (Cortex-M3) architecture, 3-stage pipeline, Thumb-2 instruction set, Nested Vector Interrupt Controller (NVIC), Operating Modes: Thread mode and Handler mode, Memory mapping and Memory Protection Unit (MPU), Resource-constrained model deployment. **Embedded Serial Communication:** Study of basic communication protocols like SPI, SCI, I2C, CAN, Wireless extensions for distributed systems. **Embedded Software, Firmware Concepts and Design:** Embedded C-programming concepts (from embedded system point of view): registers and I/O, memory map and instruction sets. Optimizing for Speed/Memory needs, Model quantization and knowledge distillation, Interrupt service routines, macros, functions, modifiers, data types, device drivers. **Applications of Embedded System Engineering:** Split / Federated learning, Edge computing, Precision agriculture, IoT architectures for sensor data analysis.

3 Text and Reference Materials

T Textbook:

- "Digital Design and Computer Architecture, ARM Edition, Morgan Kaufmann (2015)" by Sarah Harris, David Harris.
- "Embedded Systems with ARM Cortex-M Microcontrollers with Assembly Language and C" by Yifeng Zhu.

R References:

- "Embedded System Design – A unified hardware and software introduction" by F. Vahid (John Wiley).
- David A. Patterson and John L. Hennessy, "Computer Organization and Design – The Hardware / Software Interface ARM edition" Morgan Kaufmann.

4 Course Outcomes

CO	CO Description
CO1	**Demonstrate** the embedded system fundamentals, including ARM Cortex-M3 microcontroller architecture, memory organization, and cyber-physical interfacing with sensors and actuators.
CO2	**Apply** program modeling techniques such as Finite State Machines (FSM), Petri-nets, and UML to design real-time embedded firmware incorporating RTOS concepts and interrupt-driven execution.
CO3	**Analyze** embedded serial communication protocols including SPI, SCI, I2C, and CAN, considering resource constraints and power supply aspects such as battery- and solar-based systems.
CO4	**Develop** embedded C programs for ARM-based platforms using efficient memory usage, interrupt service routines, device drivers, and optimization techniques for resource-constrained model deployment.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5014 Bioinformatics Algorithms

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5014
Course Title	*Bioinformatics Algorithms*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Algoriths and Complexity: review on algorithms design techniques. **Molecular biology basics:** DNA, RNA, genes, and proteins. **Restriction mapping:** practical and impractical restriction mapping algorithms. **Motif and motif finding:** randomized and combinatorial pattern matching algorithms. **Genome rearrangement:** reversal, greedy and approximation algorithm. **DNA sequence alignments:** dynamic programming algorithms for global and local sequence alignment, and splice alignment, space-efficient sequence alignments, and sub-quadratic alignment. **Gene prediction:** statistical algorithms, and similarity based algorithms, **DNA sequencing:** genome sequencing, protein sequencing, and spectrum graphs algorithms. **pattern matching:** Exact pattern matching, heuristic similarity search algorithms, approximate string matching, BLAST, FASTA. **Clustering:** Microarrays, hierarchical clustering, K-means clustering, CAST clustering algorithm. **Genome Assembly:** fragment assembly, sequencing by hybridization, and graph algorithms. **Evolutionary trees:** rooted and unrooted tree, distance based tree construction, reconstruction of trees from additive matrices.

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3 Text and Reference Materials

T Textbook:

- An Introduction to Bioinformatics Algorithms, Author: Neil C. Jones and Pavel A. Pevzner (The MIT Press, First Edition, published in 2004.)

R References:

- Computational Molecular Biology: Sorin Istrail, Pavel Pevzner, and Michael Waterman, editors.

4 Course Outcomes

CO	CO Description
CO1	**Explain** molecular biology fundamentals to computational solutions.
CO2	**Apply** algorithms for solving biological problems.
CO3	**Evaluate** different algorithms for their suitability and purpose.
CO4	**Design** algorithmic approaches for existing biological problems.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

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Course Outline
CSE-5015 VLSI Layout Algorithms

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5015
Course Title	*VLSI Layout Algorithms*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction: Overview of the VLSI design problem and design automation flow; VLSI design cycle and physical design cycle; abstraction, hierarchy, and design domains; design styles including full-custom and semicustom design; objectives such as area, speed, power, and design time; role of CAD tools in physical design automation. Basic graph algorithms and computational complexity concepts relevant to VLSI design automation; data structures for graph representation; shortest-path and spanning tree algorithms; computational geometry algorithms used in layout representation, constraint modeling, and geometric optimization. **Partitioning algorithms:** Circuit representation and netlist modeling; objectives and cost functions in partitioning; group migration and iterative improvement techniques; Kernighan–Lin style algorithms; simulated annealing principles, evaluation functions, and convergence behavior; performance-driven and connectivity-aware partitioning for large-scale designs; applications of partitioning in placement, multi-chip design, and hierarchical decomposition. **Floorplanning and placement algorithms:** Floorplanning concepts, representations, and optimization objectives; constraint-based floorplanning methods; rectangular dualization and rectangular drawing techniques; shape functions and floorplan sizing; integer programming based floorplanning approaches; constructive and simulation-based placement algorithms; iterative improvement and partitioning-based placement strategies; wire-length estimation and timing considerations. Pin assignment algorithms: pin accessibility, congestion reduction, and interconnect optimization. **Routing algorithms:** Routing problem formulation and models; maze routing algorithms; line-probe routing techniques; shortest-path based routing; rectilinear steiner tree based algorithms; river routing and channel routing concepts; orthogonal drawing based routing algorithms; local and global routing issues. **Compaction algorithms:** Design rules and symbolic layout; constraint-graph based compaction; longest-path and shortest-path formulations; virtual grid based compaction; hierarchical and multi-level compaction techniques; applications of compaction in layout optimization. Algorithms for Multi-Chip Module (MCM) physical design automation: partitioning, placement, routing, and compaction issues specific to multi-chip environments.

3 Text and Reference Materials

T Textbook:

- Algorithms for VLSI Physical Design Automation by Naveed A. Sherwani, Springer New york, 1993.
- Algorithms for VLSI Design Automation by Sabih H. Gerez, Wiley.

R References:

- Layout Optimization in VLSI Design, Edited by Bing Lu, Ding-Zhu Du, Sachin S. Sapatnekar, Springer, 2001

4 Course Outcomes

CO	CO Description
CO1	**Explain** the principles of VLSI physical design, including partitioning, floorplanning, placement, routing, and compaction.
CO2	**Analyze** various algorithmic techniques (e.g., graph algorithms, simulated annealing, force-directed placement, maze routing) used in layout generation and optimization.
CO3	**Apply** mathematical and heuristic approaches to solve layout problems such as wirelength minimization, timing optimization, and congestion reduction..

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5016 Decision Diagrams for VLSI Design

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE-5016
Course Title	*Decision Diagrams for VLSI Design*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Foundations of Binary Decision Diagrams: Binary Decision Diagram; Co-Factors, Shannon Expansions and Their Properties; Binary Decision Trees. **Variable Ordering and Reduction Techniques:** Heuristic Variable Ordering, Dynamic Variable ordering, Reduction rules and How they led to Reduction, Evolution and Satisfiability, Minimization of Decision Diagrams Classical Methods: Exchange of Neighbor Variables' Exact Minimization, Heuristic Minimization. **Reduced Ordered Binary Decision Diagrams (ROBDD):** Reduced Ordered Binary Decision Diagram (ROBDD), Canonicity of ROBDDs, BDD Size Bounds. **Construction and Classical Applications of ROBDDs:** Construction of Decision Diagrams for Product Configuration, Solving Eight Queens Problem Using ROBDD. **Operations and Implementation of ROBDDs:** if then else Operator on ROBDDs, ROBDD Implementation Concepts, Logical Operations such as Conjunctions, Disjunctions and Negation on ROBDD, Manipulation of BDD Using ITE algorithm. **Boolean Function Analysis and Verification Using BDDs:** Finding the Exact Cover of Boolean Functions Using BDD, Proof of Correctness and Equivalence of Combinational Circuits Using ROBDD. **Advanced BDD Structures and Extensions:** Quantified Boolean Formula, Multi-rooted BDDs: Shared Binary Decision Diagram, MTBDD, BDD for Characteristic function, Variable ordering for BDD for CFs. **BDD Variants and Hardware Realizations:** Reversible Decision Diagram, Transistor-Mapped Binary Decision Diagram for CMOS Circuits, TDM Realizations Using SBDDs and SMTMDDs. **BDD-Based Optimization and Applications:** Binary Decision Diagrams and Integer Programming, Decision Diagrams and Scheduling Problems, Optimizing Binary Decision Diagrams for Interpretable Machine Learning Classification. **BDD Applications in VLSI and Reliability Analysis:** Decision Diagrams for Formal Verifications of VLSI Circuits, Fault Tree Analysis and Product Configuration, Power Analysis and Optimization of VLSI Circuits Using BDDs, Automated Test Pattern Generation (ATPG) for VLSI Circuits Using BDDs. **Multiple-Valued Decision Diagrams:** Multiple-Valued Functions, Decision Diagrams for Multiple-Valued Functions, Shared Multiple-Valued Multi-Terminal Decision Diagrams (SMTMDDs).

3 Text and Reference Materials

T Textbook:

- David Bergman, Andre A. Cire, Willem-Jan van Hoeve, and John Hooker, "Decision Diagrams for Optimization", Springer Nature, October 2016.
- Shin-ichi Minato, "Binary Decision Diagrams and Applications for VLSI CAD", Kluwer Academic Publishers, 1996.

R References:

- Liudong Xing and Suprasad V. Amari, "Binary Decision Diagrams and Extensions for System Reliability Analysis", Wiley Publishers, June 2015.
- Rolf Drechsler and Bernd Becker, "Binary Decision Diagrams: Theory and Implementation", Springer Science and Business Media, LLC, 1998.

4 Course Outcomes

CO	CO Description
CO1	**Apply** graph-based algorithms for solving real-world problems.
CO2	**Implement** the large-scale binary VLSI circuits.
CO3	**Design** the multiple-valued VLSI circuits for real-world applications.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5017 Applied Machine Learning

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE-5017
Course Title	*Applied Machine Learning*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction and Machine Learning (ML) Project Lifecycle: Theoretical vs applied ML. ML pipeline overview. Problem framing and data understanding. **Data Preparation and Feature Engineering:** Handling missing data, outliers, feature scaling, encoding, and transformation. **Model Selection and Evaluation:** Cross-validation, bias-variance tradeoff. Evaluation metrics for classification, regression, and ranking. Model interpretability. **Supervised Learning in Practice:** Review of linear regression, logistic regression, naive bayes, SVM, neural networks, decision tree, ensemble methods. Regularization. Hyperparameter tuning. **Unsupervised Learning in Practice:** Clustering with real data (K-Means, DBSCAN, Agglomerative). Dimensionality reduction (PCA, t-SNE) in applied scenarios. Outlier detection. **Time Series Forecasting:** Stationarity, autocorrelation, ARIMA, LSTM. Evaluation: MAPE, RMSE. **NLP with ML:** Neural networks for sequential data: RNN, LSTM, GRU, transformers. Text preprocessing, word embeddings. Traditional ML for text: TF-IDF, Naive Bayes, SVM. **Applied Deep Learning:** CNNs for image classification. LeNet, AlexNet, VGG, ResNet basics. Transfer learning. **ML in practice:** Handling imbalanced datasets, feature selection techniques, feature engineering, data leakage and fairness, robustness and adversarial examples. Exploratory data analysis for ML. **ML Case Studies:** Healthcare, agriculture, social welfare etc.

3 Text and Reference Materials

T Textbook:

- Introduction to Statistical Learning; by James et al., Springer, 2023.
- Machine Learning Yearning by Andrew Ng, Stanford Lecture Notes, 2021.

R References:

- Pattern Recognition and Machine Learning; by Bishop et al., Springer, 2006.
- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow; by Aurélien Géron, Packt Publishing, 2022.

4 Course Outcomes

CO	CO Description
CO1	**Apply** machine learning algorithms for solving real-world problems.
CO2	**Evaluate** ML pipelines involving preprocessing, modeling, tuning, and deployment.
CO3	**Design** machine learning pipelines for real-world applications.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
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Course Outline
CSE-5018 Advanced Data Mining Techniques

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5018
Course Title	*Advanced Data Mining Techniques*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction: Basic and beyond the basic concepts of data mining, advanced concepts of clustering, outlier detection, classification, pattern mining and correlation analysis; **Advanced Clustering:** Partitioning methods, Hierarchical methods, Density and Grid-based methods; Evaluation of Clustering; Probabilistic model-based clustering: Fuzzy clusters, Expectation-maximization algorithm; Clustering high-dimensional data: challenges, axis-parallel and arbitrarily oriented subspace approaches; Biclustering: usefulness, types of biclusters, biclustering methods; Dimensionality reduction for clustering: Linear dimensionality reduction, Nonnegative matrix factorization, Spectral clustering; Clustering graph and Network data; Semisupervised Clustering; **Outlier Detection:** Basic concepts, Statistical approaches: parametric and nonparametric methods; Proximity-based approaches: distance and density-based outlier detection; Reconstruction-based approaches; Clustering- vs. Classification-based approaches; Mining contextual and collective outliers: transforming contextual outlier detection to conventional outlier detection, modeling normal behavior with respect to contexts, mining collective outliers; Outlier detection in high-dimensional data: Extending conventional outlier detection, finding outlier in subspaces, outlier detection ensemble; **Advanced Classification:** Feature selection and engineering; Rule-based and pattern-based classification, Bayesian belief network, Support vector machines, Classification by backpropagation, Classification with weak supervision: semi-supervised classification, Active learning, Transfer learning, Distant supervision; Classification with rich data type: stream, sequence and graph data classification; Multiclass classification, Interpretability of classification, Linear and nonlinear regression; **Advanced Pattern Mining and Correlation:** Mining multilevel, multidimensional and quantitative association rules, Mining high dimensional data, Mining rare and negative patterns, Mining compressed patterns by pattern clustering, Extracting redundancy-aware top-k patterns, Constraint-based and interesting pattern mining, Mining sequence and subgraph patterns, Frequent pattern mining methods for text mining, data classification and clustering, Privacy-preserving data mining, Big data mining.

3 Text and Reference Materials

T Textbook:

- Jiawei Han, Jian Pei, H. Tong, Data Mining: Concepts and Techniques, 4th Edition, Morgan Kaufmann Publishers, Elsevier, 2023.

R References:

- 1. Mohammed J. Zaki, Wagner Meira Jr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
- 2. Charu C. AggarWal, Data Mining: The Textbook, Springer, 2015.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the basics of advanced Data Mining algorithms and based on that guidance solve real-life DM problems in response.
CO2	**Evaluate** the performance of a DM solution with analysis and investigation.
CO3	**Design** optimized advanced DM techniques gradually based on the feedbacks from the previous learning and deploy new cutting-age techniques wherever needed.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5019 Network Performance Analysis

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5019
Course Title	*Network Performance Analysis*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Overview of Probability Theory: Random experiment, sample space, event, probability distributions, expected value, variance, conditional probability, laws of large numbers, central limit theorem, and Bayes' theorem. **Random Processes:** Random walks and gambler's ruin, Processes with independent increments and martingales, Brownian motion, Counting processes and the Poisson process, Stationarity, Joint properties of random processes, Conditional independence. **Markov Chains:** Transition probabilities, periodicity, stability and ergodicity, Discrete-Time Markov Chain (DTMC), Continuous-Time Markov Chain (CTMC), recurrence and transience, reversibility, Kolmogorov's Equation, truncation of a Markov Chain, Random Walk. **Queuing Theory:** Little's law, M/M/1, M/M/K, M/G/1, G/M/1, G/M/K, G/G/1 queuing models. **Traffic Models:** Modeling Poisson, On/Off, Markov, Video, Web, and Backbone traffic arrival and departure patterns; circuit, real-time, and elastic traffic, TCP flow and congestion control, RTT, window size, throughput analysis, TCP variants: Reno, Cubic, and BBR. **Multiple Access Techniques:** Aloha, CSMA/CD, CSMA/CA, IEEE 802.11 DCF, Cellular networks: LTE, 5G NR performance metrics, Mobility and handover impact, Interference modeling and mitigation. **Analysis of scheduling algorithms:** first-in-first-out (FIFO), static priority, round robin (RR), weighted round robin (WRR), processor sharing (PS), generalized processor sharing (GPS), fair queuing (FQ), weighted fair queuing (WFQ), frame-based fair queuing (FFQ), core-stateless fair queuing (CSFQ), and random early detection (RED). **Performance Study Case Studies:** QoS and QoE modeling, Delay Tolerant Networks (DTN), SDN and performance, programmability, Energy-efficient networking, Cross-layer optimization in wireless networks.

3 Text and Reference Materials

T Textbook:

- Analysis of Computer and Communication Networks; by Fayez Gebali, 2008.
- Introduction to Probability Models by Sheldon M. Ross, 11th Edition, 2014.
- Queuing Systems, Volume 1: Theory. 1st Edition, by Leonard Kleinrock.

R References:

- Network Performance Analysis, 1st Edition, by Thomas Bonald and Mathieu Feuillet, 2011
- ns-3.45: A discrete event network simulator for Internet Systems, https://www.nsnam.org/, 2025.

4 Course Outcomes

CO	CO Description
CO1	**Analyze** network performance using fundamental metrics such as delay, throughput, jitter, and packet loss.
CO2	**Apply** queueing theory and stochastic processes to model wired and wireless networks.
CO3	**Evaluate** the impact of protocols and technologies (e.g., TCP, UDP, LTE, 5G) on network performance.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5020 Green Computing and Communications

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5020
Course Title	*Green Computing and Communications*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Orientation and Fundamentals of Green Computing: ICT energy footprint and carbon emissions, trade-offs between energy efficiency, performance, and cost. Sustainability principles in computing and communications. **Green Networking Architectures:** Energy-efficient wireless access networks, green MAC protocols for 5G/6G, energy harvesting communications, green IoT ecosystems. **Green Data Centers and Virtualization:** Virtualization and containerization for energy-efficient computing, carbon-aware cloud resource management, and demand response in ICT infrastructures. **Low-Carbon Edge and Fog Computing:** Energy scheduling in MEC/fog systems, cooperative cloud–edge task distribution, renewable-powered edge infrastructures, DT-enabled synchronization for sustainability. **SDN/NFV and Programmable Networks for Energy Efficiency:** Software-defined and virtualized infrastructures for energy optimization, traffic engineering, energy-aware QoS, transport, routing, and MAC protocols for green networking. **Green Wireless and Mobile Systems:** MIMO and massive MIMO for energy efficiency, UAV-assisted green wireless, energy-efficient VoIP, energy-aware spectrum allocation. **Sustainable ICT and Internet of Energy:** Smart grid integration, demand response strategies, IoE (Internet of Energy), AI-assisted smart energy ecosystems. **Emerging Trends in Green Computing:** AI/ML for green mobile/IoT devices, energy-efficient chip design, sustainable storage methodologies, recycling, and circular computing systems. **Next-Generation Paradigms:** Energy-efficient quantum computing, neuromorphic and bio-inspired architectures, sustainability–security trade-offs in ICT.

3 Text and Reference Materials

T Textbook:

- Green Communications: Principles, Concepts and Practice – Konstantinos Samdanis, Peter Rost, Andreas Maeder, Wiley, 2015.

- Green Information and Communication Systems for a Sustainable Future – Atayero, Akinbiyi, Springer, 2019.
- Energy-Efficient Computing and Networking – Nikolaos Paterakis, Mohamed Benbouzid, Springer, 2019.

R References:

- Green Cloud Computing: Energy Efficiency and Sustainability in Cloud and Edge Systems – Kanwal, Springer, 2021.
- Energy Harvesting for Wireless Sensor Networks: Technology, Components and System Design – Olfa Kanoun, Springer, 2018.
- Recent Journal Articles.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the principles of green computing and communications, including ICT's energy footprint, sustainability trade-offs, and low-carbon design objectives.
CO2	**Analyze** energy-efficient architectures and protocols across data centers, edge/fog computing, SDN/NFV-based networks, and wireless/mobile systems.
CO3	**Evaluate** advanced techniques such as AI/ML-driven optimization, Internet of Energy (IoE), and virtualization strategies for improving energy efficiency and sustainability in large-scale ICT infrastructures to address real-world challenges in sustainable and green computing.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5021 Data Center and Cloud Computing

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5021
Course Title	*Data Center and Cloud Computing*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Data Centers (DC): Definition and evolution, Types of data centers, Key components. **Data Center Architecture**: Traditional vs. Modern (Software-Defined) Data Centers, Compute, Storage, and Network Architectures. **Data Center Networking**: Network Topologies (Fat-tree, Spine-Leaf, Clos), Software-Defined Networking (SDN), Network Virtualization, Traffic Engineering and Load Balancing. **Cooling and Power Optimization**: Power Usage Effectiveness (PUE) and Energy Efficiency, Cooling Techniques (Hot/Cold Aisle Containment, Liquid Cooling), Renewable Energy and Sustainable Data Centers, AI for Predictive Cooling and Power Management. **Introduction to Cloud Computing**: Defining Cloud Computing, Key Drivers, Evaluating Barriers, Cloud Adoption Strategies. **Cloud Service Models**: Software as a Service (SaaS) - Characteristics, Use Cases, Security and Multi-tenancy. Platform as a Service (PaaS) - Development and Deployment Platforms, Serverless Computing (AWS Lambda, Azure Functions). Infrastructure as a Service (IaaS) - Virtualization vs. Bare Metal Cloud, Managing Compute, Storage, and Networking in IaaS, Case Studies. **Cloud Storage and Management**: Cloud Storage Models, Distributed File Systems, Data Replication and Consistency Models, Big Data in Cloud. **Cloud and DC Interconnect**: Direct Connect (AWS), ExpressRoute (Azure), Software-Defined Interconnects, Latency and Bandwidth Optimization. **Cloud-Managed Data Centers**: DC-as-a-Service (DCaaS) concepts, AWS/Azure/GCP control planes for on-prem DCs, Automated provisioning. **Business and Migration Strategies**: Building a Business Case for Cloud Adoption, Cloud Migration Strategies, Disaster Recovery and Business Continuity in the Cloud. **AI in Data Center and Cloud Computing:** Operational Efficiency and Sustainability, Predictive Maintenance, Security.

3 Text and Reference Materials

T Textbook:

- The Data Center Handbook; by Hwaiyu Geng, 2021.

- Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS); by Michael J. Kavis, 2021–2022.

R References:

- Sustainable Data Centers: Design and Implementation; by Ian Bitterlin, Emiliano Cevenini, Springer (2022).
- Cloud Computing: Concepts, Technology & Architecture, by Thomas Erl, Zaigham Mahmood, Ricardo Puttini, 2013.
- Cloud Native Transformation: Practical Patterns for Innovation, Pini Reznik, Jamie Dobson, Michelle Gienow, 2019.
- Architecting Cloud Computing Solutions; by Kevin L. Jackson, Scott Goessling, 2018.
- IEEE Transactions Papers on Cloud Computing
- ACM Digital Library: Special issues on Data Centers and Cloud

4 Course Outcomes

CO	CO Description
CO1	**Analyze** the architecture, components, and operational principles of modern data centers and evaluate their efficiency in terms of performance, energy consumption, and scalability.
CO2	**Implement** various cloud service models (IaaS, PaaS, SaaS) and design cloud-native solutions using virtualization, containerization, and serverless architectures.
CO3	**Evaluate** strategies for cloud adoption, migration, and disaster recovery, and formulate business continuity plans considering cost, performance, and sustainability trade-offs.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5022 Applied Game Theory and Mechanism Design

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5022
Course Title	*Applied Game Theory and Mechanism Design*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction: Introduction to game theory, History, different families of game, strategies, payoffs, rationality, equilibrium **Normal-form games:** simultaneous-move games with pure and mixed strategies, zero-sum game, constant-sum game, rollback, dominance, best-response algorithms, Min-Max methods, Nash equilibrium, price of anarchy; **Extensive-form games:** sequential-move games, game trees, strategy, centipede game, combining sequential and simultaneous moves, two-stage and multi-stage game, sub-game, sub-game perfection, rollback equilibrium; **Uncertainty and Information:** games with perfect and imperfect information (Bayesian game), complete and incomplete information game, cheap talk, conflicting interests, signaling game, Bayes-Nash equilibrium; **Repeated games:** finite and infinite repetition, Grims strategy, tit-for- tat, asymmetric information, pooling and separation **Mechanism Design:** reverse game theory, incentive-compatibility constraint, participation constraint, social choice and voting theory, so- cial welfare, Groves-Clarke Mechanisms; **Auction:** types, auction rules and design, Dutch and English auctions, bidding strategy, Vickery Auctions.

3 Text and Reference Materials

T Textbook:

- "Game Theory" by D. Fudenberg and J. Tirole, The MIT Press, 1991.
- "Game Theory: Analysis of Conflict" by by Roger B. Myerson, Harvard University Press, 1991.

R References:

- "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations" by Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press.

- "Strategies and Games: Theory and Practice" by Prajit K. Dutta, The MIT Press.
- Online web resources and papers.

4 Course Outcomes

CO	CO Description
CO1	**Demonstrate** a clear understanding of the Internet of Everything (IoE) architecture and distinguish it from traditional Internet of Things (IoT) systems, identifying its four pillars and integration lifecycle.
CO2	**Apply** knowledge of advanced IoE communication protocols, middleware platforms, and edge–fog–cloud collaborative models to design scalable, real-time, intelligent, and secured, interconnected IoE systems.
CO3	**Analyze** IoE ecosystem components, including cognitive device architecture, sensing, and AI-enabled edge modules to evaluate the interaction between devices, data, people, and processes in diverse application contexts by integrating multi-layer security and intelligent decision-making mechanisms.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5023 Text Mining

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5023
Course Title	*Text Mining*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Vector representation of text: TF-IDF representation, Pointwise Mutual Information, Semantic embedding: Word2Vec, Learning word embeddings using Skip-Gram vs. Continuous Bag of Words models, Negative sampling, Contextual embedding: BERT. **Word Association Mining:** Paradigmatic vs. syntagmatic relationships; identifying paradigmatic relationships using context similarity; identifying syntagmatic relationships using conditional entropy and mutual information. **Statistical Language Models:** Text generation; parameter estimation; model evaluation; sampling from trained models; handling unknown words; smoothing; backoff and interpolation; discounting methods. **Text Classification:** Naive Bayes; Evaluation: Accuracy, precision, recall, F-measure; confusion matrices; micro/macro-averaging; cross-validation. Classifier Types: Generative vs. discriminative approaches; Logistic Regression for sentiment analysis, Stochastic Gradient Descent optimization, L1/L2 regularization, Multinomial Logistic Regression. Vector Space Methods: Rocchio classifier, decision boundaries, hyperplanes, KNN classifier; linear vs. non-linear classifiers; any-of vs. one-of classification. **Text Clustering:** Types of clustering: Flat vs. Hierarchical clustering, Hard vs. Soft Clustering, Partitional Clustering, Exhaustive vs. Non-exhaustive clustering, Distance metrics, Cluster evaluation using internal, alternative, and external quality criteria, K-means clustering, Termination conditions for K-means, Seed selection heuristics, Determining number of clusters in text documents: cluster validation methods. **Topic Models:** Topics as term distributions, Document topic coverage, Generative probabilistic models, Parameter estimation: MLE vs MAP, Single-topic mining limitations, Background topic model, Mixture models for topics, EM algorithm, Probabilistic Latent Semantic Analysis (PLSA): estimation, characteristics, limitations, Incorporating priors: conjugate priors, Beta and Dirichlet distributions, Latent Dirichlet Allocation (LDA): properties, differences from PLSA, generative process. **Text Summarization:** Extractive vs. Abstractive summarization, Single-document vs. Multi-document summarization, Generic vs. Query-focused summarization, Extractive methods: Graph-based approaches, statistical methods, Minimizing information redundancy: Maximum Marginal Relevance, Joint optimization of objective functions for text summarization, Metrics for summarization quality: ROUGE, BLEU, METEOR, Human evaluation methods.

3 Text and Reference Materials

T Textbook:

- Text Data Management and Analysis - A Practical Introduction to Information Retrieval and Text Mining; by ChengXiang Zhai and Sean Massung, 2016.
- Speech and Language Processing - An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 3rd Ed., by Daniel Jurafsky and James H. Martin 2022.

R References:

- Introduction to Information Retrieval; by Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze, Cambridge University Press, 2008.
- Foundation of Statistical Natural Language Processing, by Christopher D. Manning and Hinrich Schutze, The MIT Press, 1999.

4 Course Outcomes

CO	CO Description
CO1	**Apply** vector representations, embeddings, and word association mining techniques for analyzing text data.
CO2	**Evaluate** statistical language models, including parameter estimation, smoothing, and sampling methods for text generation.
CO3	**Implement** text classification and clustering algorithms, incorporating evaluation metrics for real-world applications.
CO4	**Evaluate** topic models such as PLSA and LDA for discovering latent structures in text corpora.
CO5	**Create** extractive and abstractive text summarization methods, using optimization techniques and quality metrics.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

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Course Outline
CSE-5024 Advanced Operations Research

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5024
Course Title	*Advanced Operations Research*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Orientation and Overview of Advanced Operations Research: Evolution of OR as a scientific discipline, modeling methodology, decision-making philosophies, and the role of optimization in complex industrial and service systems. **Advanced Linear Programming and Duality:** Convex sets and LP geometry, graphical and simplex-based optimization, artificial variable techniques, revised simplex and dual simplex algorithms, duality theory, dual simplex method, revised dual simplex method. **Network Optimization and Flow-Based Models:** Transportation and transshipment models, assignment and matching problems, minimum-cost flow and multicommodity flow models, network simplex algorithms, and project scheduling using PERT/CPM with resource-constrained optimization strategies. **Game Theory and Strategic Decision Models:** Pure and mixed strategy games, minimax and maximin concepts, dominance rules, equilibrium analysis, and solving game-theoretic models using graphical and linear programming techniques. **Multi-objective and Goal Programming:** Formulation of multi-objective programming models, solution using graphical, simplex, and weighted goal programming approaches, tradeoff analysis, and Pareto-optimality in multi-criteria decision environments. **Nonlinear and Convex Optimization:** Fundamentals of convex functions and convex optimization, Kuhn–Tucker optimality conditions, quadratic programming, Wolfe's and Beale's algorithms, separable convex programming models, and applications of nonlinear optimization in engineering and management systems. **Computational Tools and OR Applications:** Use of modern solvers and modeling languages, simulation and numerical methods for optimization, implementation workflows using tools such as MATLAB or Python, and case studies involving inventory planning, project scheduling, multi-objective optimization, and nonlinear modeling under real-world constraints.

3 Text and Reference Materials

T Textbook:

- "Operations Research - An Introduction" by Hamdy A. Taha; Pearson Education, 2022.

R References:

- "Operations Research" by P Rama Murthy; New Age International, 2007.
- "Engineering Optimization" by S. S. Rao; John Wiley, 2009.

4 Course Outcomes

CO	CO Description
CO1	**Formulate** real-world decision problems as appropriate operations research models.
CO2	**Analyze** linear and network optimization problems using advanced solution techniques.
CO3	**Apply** inventory, stochastic, and project optimization models to practical planning problems.
CO4	**Evaluate** integer, multi-objective, and nonlinear optimization models using analytical and computational tools.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5025 Generative Artificial Intelligence

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5025
Course Title	*Generative Artificial Intelligence*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Generative Modeling and Latent Variables: Fundamentals of generative modeling and latent-variable formulations for modeling data distributions, contrasted with discriminative learning. **Classical Probabilistic Models and Variational Inference:** Classical generative models including Gaussian Mixture Models (GMMs) and Hidden Markov Models (HMMs); variational inference; KL divergence; Evidence Lower Bound (ELBO); practical challenges and scalable approximations. **Autoencoders and Variational Autoencoders:** Autoencoders as reconstruction-based models; Variational Autoencoders (VAEs) with probabilistic latent spaces; β-VAEs, Conditional VAEs (CVAEs), and disentangled representations; posterior collapse and mitigation strategies. **Generative Adversarial Networks:** Adversarial learning framework as a minimax game between generator and discriminator; GAN variants including DCGAN, WGAN, and Conditional GANs; challenges such as mode collapse, unstable training, and stabilization techniques. **Diffusion Models:** Denoising diffusion probabilistic models (DDPMs); forward and reverse stochastic processes; training objectives; sampling inefficiencies; applications in image, audio, and video generation. **Sequence Modeling with Transformers:** Evolution from RNNs and LSTMs to Transformer based architectures; attention mechanisms; positional encoding; decoder-only autoregressive models such as GPT; mathematical intuition and training complexity. **Fine-Tuning and Alignment of Generative LLMs:** Adaptation of pretrained models through instruction tuning, supervised fine-tuning (SFT), and reinforcement learning with human feedback (RLHF); parameter-efficient methods including LoRA and prompt tuning; alignment strategies, safety considerations, and compute-aware adaptation. **Retrieval-Augmented Generation (RAG):** Integration of embedding-based retrieval and vector databases with Transformer based generators to improve factuality and reduce hallucination. **Evaluation and Responsible Use of Generative AI:** Evaluation metrics including BLEU, ROUGE, FID, Inception Score, and perplexity; limitations of automatic metrics; human-centered evaluation; issues of hallucination, toxicity, dataset bias, misinformation, deepfakes, copyright, and misuse prevention. **Multimodal and Cross-Domain Generative Models:** Multimodal generative systems spanning text, vision, and audio; text-to-image, image-to-text, and vision-language modeling; creative synthesis and retrieval.

3 Text and Reference Materials

T Textbook:

- *David Foster*, **Generative Deep Learning**, Second Edition, O'Reilly Press, 2023.
- *Denis Rothman*, **Transformers for Natural Language Processing and Computer Vision**, Third Edition, Packt Publishing, 2023.

R References:

- *Kevin P. Murphy*, **Probabilistic Machine Learning: Advanced Topics**, First Edition, MIT Press, 2023.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the theoretical foundations of generative modeling, including latent-variable formulations, probabilistic inference, and optimization objectives underlying modern generative models.
CO2	**Implement** generative models such as VAEs, GANs, diffusion models, Transformer-based LLMs, and retrieval-augmented systems, using appropriate training, fine-tuning, and alignment techniques.
CO3	**Compare** generative AI systems with respect to quality, factuality, efficiency, and ethical considerations, applying suitable evaluation metrics and responsible AI practices in real-world and research contexts.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5026 DNA Computing

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5026
Course Title	*DNA Computing*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to DNA Computing: Basic principles, historical experiments (like Adleman's TSP experiment), and its place within unconventional computing paradigms; **Information Encoding:** How to represent problems as DNA sequences; **Molecular Operations:** Techniques like ligation (combining strands), hybridization (forming double helices), annealing (cooling to form bonds), melting (denaturing DNA), and separation by length or sequence; **DNA Models & Algorithms:** Formal models for DNA computation and strategies for designing DNA algorithms to solve complex problems; **Machine Learning & AI:** Applying artificial intelligence to analyze complex biological data; **Big Data:** Methods for handling and analyzing very large biological datasets; **Error Rates:** Understanding and managing the inherent errors in biological and chemical processes used in DNA computing; **DNA Strand Displacement:** A key mechanism for building enzyme-free DNA computing devices and logic circuits; **DNA-Based Devices:** Studies of specific implementations like strand displacement reaction networks (SDRNs), finite state automata, and molecular walkers; **Molecular Programming:** Principles of programming molecular systems using nucleic acids for tasks like program synthesis and self-assembly; **Bioinformatics & Molecular Biology:** Applications in analyzing biological data and the foundational molecular biology concepts that underpin DNA computing; **Nanotechnology & Nanostructure:** The role of DNA in building nanoscale structures for computational and other applications; **Specialized Applications:** Using DNA computing for areas like image cryptography, intelligent diagnostics, and information storage; **Medical Informatics:** Applying computational methods to healthcare and medical problems.

3 Text and Reference Materials

T Textbook:

- Hafiz Md. Hasan Babu, "DNA Logic Design: Computing with DNA", World Scientific Publishing Co. Pte Ltd., 2024.

– Gheorghe Păun, Grzegorz Rozenberg, and Arto Salomaa, “DNA Computing: New Computing Paradigms”, Springer Nature, 1998.

R References:

– Paun Gheorghe, Rozenberg Grzegorz; and Salomaa Arto, ”DNA Computing”, Springer Nature, 1998.
– Hafiz Md. Hasan Babu, “Reversible and DNA Computing”, Wiley Publishers, 2020.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the basics of DNA as a computational substrate, including its molecular properties and manipulation techniques like PCR.
CO2	**Analyze** the basic DNA logic gates (YES, AND, OR, NOT) to build functional DNA computing systems.
CO3	**Apply** the broader concept of biocomputing and the integration of DNA computing with nanotechnology to create autonomous, programmable molecular computers.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5027 Applied Quantum Computing

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5027
Course Title	*Applied Quantum Computing*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Quantum Physics and Information: Introduction to the physics behind quantum information processing and how quantum phenomena are applied to computation; **Qubits and Quantum States:** Understanding qubits as the basic unit of quantum information, and how they utilize superposition to represent multiple states simultaneously; **Quantum Gates and Circuits:** Building quantum circuits using universal sets of quantum gates (e.g., Pauli-X, Hadamard, CNOT) and understanding unitary transformations and quantum state evolution; **Entanglement and Measurement:** Exploring the concept of quantum entanglement and its role in quantum computing, along with the process of measuring quantum states; **Quantum Speedup:** Analyzing how quantum parallelism provides a potential speedup over classical algorithms for certain computational tasks; **Shor's Algorithm:** Studying the algorithm for efficiently factoring large numbers, a significant application of quantum computers; **Grover's Algorithm:** Learning about the algorithm that provides a quadratic speedup for searching unsorted databases; **Other Algorithms:** Other key algorithms such as the Deutsch-Jozsa algorithm and Bernstein-Vazirani algorithm are often covered; **Quantum Error Correction:** Understanding the methods and challenges of protecting quantum information from noise and errors to enable reliable quantum computation, and Basics of stabilizer codes and fault tolerance; **Quantum Machine Learning:** Exploring how to leverage quantum computing power for machine learning tasks, including variational algorithms; **Quantum Cryptography:** Investigating quantum communication protocols and their potential for creating unconditionally secure cryptographic systems; **Hardware and Implementations:** Studying the practical aspects of quantum computing hardware, such as different types of qubits and superconducting circuits; **Challenges and Future Directions:** Quantum supremacy and benchmarks; scalability challenges and quantum hardware limitations; and emerging trends in quantum computing research; **Quantum Simulations:** Quantum simulations in material science and chemistry.

3 Text and Reference Materials

T Textbook:

- Hafiz Md. Hasan Babu, "Quantum Computing: A Pathway to Quantum Logic Design", 2nd Edition, IOP Publishers, 2020
- Hafiz Md. Hasan Babu, "Quantum Biocomputing in Quantum Biology", Volume I, Springer Nature, 2025
- M. Nielsen and I. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, 2011.

R References:

- Paul Kaye, Raymond Laflamme, and Michele Mosca, "An Introduction to Quantum Computing", Oxford University Press, 2007.
- Hafiz Md. Hasan Babu, "A Foundation of Fault Tolerant Quantum Computing: A Powerful Complement to the Next Generation Innovative Computing", Volume I, Elsevier, 2025

4 Course Outcomes

CO	CO Description
CO1	**Explain** key quantum mechanics principles such as qubits, superposition, entanglement, and measurement in the context of computation.
CO2	**Analyze** quantum algorithms and circuits.
CO3	**Design** real quantum machines and quantum simulators, fostering hands-on experience.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
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Course Outline
CSE-5028 Digital Twin Systems

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5028
Course Title	*Digital Twin Systems*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Digital Twin Systems: Definition and evolution of Digital Twins, Physical– Virtual– Cyber integration, Applications in Industry 5.0 and Smart Cities. **Digital Twin Architecture and Platforms:** Layered architecture of Digital Twin systems, Data acquisition: IoT sensors, edge devices, Middleware, cloud, and fog computing, Digital Twin platforms and tools. **Modeling and Data Integration:** Physical system modeling (discrete, continuous, hybrid), Semantic models and ontologies for smart cities, Data fusion and synchronization, Real-time data pipelines. **Monitoring, Visualization, and Control:** Real-time monitoring frameworks, Visualization dashboards and 3D city models, Feedback and control loops, Fault detection and predictive maintenance. **Resource Optimization using Digital Twins:** Optimization techniques for urban resources, Energy, water, traffic, and waste management, AI/ML-based decision support. **Smart City Use Cases and Case Studies:** Smart energy grids, Intelligent transportation systems, Urban healthcare and emergency response, Environmental monitoring and sustainability. **Security, Privacy, and Ethical Issues:** Cybersecurity challenges in Digital Twin systems, Data privacy and governance, Ethical and responsible AI in smart cities, Trust and resilience of Digital Twins. **Research Trends and Future Directions:** Digital Twin for Industry 5.0, Human-centric and cognitive Digital Twins, Integration with Metaverse and XR, Open research challenges.

3 Text and Reference Materials

T Textbook:

- Tao, F., Zhang, H., Liu, A., & Nee, A. Y. C., Digital Twin Driven Smart Manufacturing, Academic Press, 2019.
- Manisha Vohra, Digital Twin Technology, Wiley Publication, February 2023.

R References:

- Mohammadreza Aghaei, Amin Moazami, Umit Cali, Digital Twin Technology for the Energy Sector, Elsevier, 2024.

– Rajesh Kumar Dhanaraj, Santhiya Murugesan, Balamurugan Balusamy, Valentina E. Balas, Digital Twin Technology for Healthcare 4.0, IET Publications, 2022.
– Recent IEEE, Elsevier, and ACM journal articles on Digital Twins and Smart Cities.

4 Course Outcomes

CO	CO Description
CO1	**Analyze** Digital Twin architectures and technologies for smart city systems.
CO2	**Design** scalable Digital Twin models for real-time monitoring and control of urban resources.
CO3	**Apply** data analytics, AI, and optimization techniques to improve efficiency and sustainability in smart city services.
CO4	**Evaluate** the performance, security, and reliability of Digital Twin systems in real-world urban scenarios.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

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Course Outline
CSE-5029 Digital Forensics

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5029
Course Title	*Digital Forensics*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Foundation of DIgital Forensics: Definition, Who needs it, objectives, branches, principles, digital evidence, digital forensics processes, digital forensics documentation, reporting and presentation, Frameworks, Standards, Methodologies, Legal and Law aspects of Digital forensics, People, Policy, Procedures and Guidelines, Technology, incidence response etc. **Legal system in Bangladesh**: Criminal vs. civil justice systems; courtroom proceedings; roles of lawyers, prosecutors, and defense attorneys; law enforcement; warrant requirements; e-discovery; judges and decision-makers; cybercrime and digital forensics laws; admissibility of digital evidence in Bangladesh; fingerprint analysis; privacy law; digital forensics. **Hard Disk and File Systems**: Different types of disk drives and their characteristics, Logical structure of the disk, Booting process of Windows, Linux, and Mac, Various file systems of Windows, Linux, and Mac, storage systems, and Encoding standards **Computer and Windows Forensics Analysis**: Computer architecture, File system and structure, Acquisition, Validation and discrimination, Extraction, Reconstruction, Reporting, Windows registry, Windows web browser forensics, Windows emails and event logs; **Live Forensics**: Performing live acquisition, Memory Forensics: Objectives, memory acquisition, memory forensics tools-Volatility, memory analysis; Network forensics: Basics of networks, OSI and TCP/IP, Network forensics overview, Network logs, Approcah to network forensics, constraints, information available, Analysis, Tools; **Mobile Device Forensics**: Mobile device forensics and challenges, Mobile forensics processes- Seizure, Isolation, Acquisition, Evidences presents in the mobile phone, Examination, Analysis, Presentation; Android- version, architecture, file systems; Android Forensics- workflow, logical, filesystems, Physical, software, Isolation, Obstacle, Preperation, USB debugging. **Logical Extraction**: Google - google account, history, youtube, browser; Application-AFLogicalOSE, ADIC, APKExtractor, Digital Well Being; Manual-Mobilego, ADB, Andriller **Physical Extraction**: Rooting android, ADB, Artifact Analysis using Autopsy **Investigating web attacks**: Basics of internet information services logs and Apache web server logs, Functionality of intrusion detection systems and web application firewall, Investigate attacks on web applications and servers. **Malware Forensics**: Static and dynamic analysis of malware, Analyze malware behavior on the system and on the network. **AI in Digital Forensics:** Data Triage and Filtering, Evidence Analysis, Multimedia Forensics.

3 Text and Reference Materials

T Textbook:

- Guide to Computer Forensics and Investigations, Bill Nelson, Amelia Phillips, Chris Steuart, 6th Edition, Cengage Learning, 2018.
- Windows Forensics Analyst Field Guide, Muhibullah Mohammed, 1st Edition, Pact Publishing, 2023.

R References:

- The Art of Memory Forensics, Michael Hale Ligh, Andrew Case, Jamie Levy, AAron Walters, 1st Edition, John WIlley and Sons, 2014.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the fundamental concepts, principles, and scope of digital forensics and its role in cybercrime investigations.
CO2	**Analyze** digital evidence following legal and ethical standards.
CO3	**Apply** forensic techniques and tools to analyze data from various digital media such as computers, mobile devices, and networks.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

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Course Outline
CSE-5030 Pattern Mining

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5030
Course Title	*Pattern Mining*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction: Basic concepts of mining different kinds of patterns from many real-life databases and discovering correlations among the patterns; **Frequent Pattern Mining:** Join-based, Enumeration -Tree-based and Recursive Suffix-based Pattern Growth algorithms; Pattern evaluation methods: Association rules and Correlation analysis; **Compressed and Approximate Pattern Mining:** Mining maximal and closed patterns, traditional and redundancy-aware top-k pattern mining, summarized pattern mining, semi-frequent pattern mining, error-tolerant pattern mining; **Weight and Utility-based Pattern Mining:** Basic concepts of weight and utility in pattern mining, challenges in maintaining the downward-closure property, different algorithms for mining weighted and high utility patterns; **Uncertain Pattern Mining:** Probabilistic model for pattern mining, various methods for uncertain pattern mining, constraint and streaming uncertain pattern mining; **Interesting Pattern Mining:** Spatial, Trajectory and Spatiotemporal pattern mining, Erasable and Decaying pattern mining, Regular pattern mining, Constraint-based pattern mining, Mining long patterns, Rare/Negative pattern mining; **Sequential Pattern Mining:** Concepts and primitives, Different sequential pattern mining techniques: level-wise candidate generation-and-test, vertical-data format, pattern growth, bitmap representation; Closed sequential pattern mining, Periodicity mining, Trend analysis and similarity search in time series data, Mining sequence patterns in biological data, Web access sequence mining: WAP and PLWAP mining algorithms; **Graph Pattern Mining:** Basic concepts, Methods for mining frequent subgraphs, Mining variant and constrained substructure patterns, Correlated frequent subgraph mining, Hypergraph mining, Graph indexing and similarity search; **Pattern Mining in Big Environment:** Pattern mining in incremental and dynamic databases, Mining data streams: different window-based stream data mining methods, lossy counting algorithm, handling concept drifts, leveraging synopsis structures: reservoir sampling and sketches; Parallel and distributed frequent pattern mining;

3 Text and Reference Materials

T Textbook:

- Charu C. AggarWal, Jiawei Han, Frequent Pattern Mining, Springer, 2014.
- Jiawei Han, Jian Pei, H. Tong, Data Mining: Concepts and Techniques, 4th Edition, Morgan Kaufmann Publishers, Elsevier, 2023.

R References:

- 1. Mohammed J. Zaki, Wagner Meira Jr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
- 2. Charu C. AggarWal, Data Mining: The Textbook, Springer, 2015.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the basics of Pattern Mining algorithms and based on that guidance solve real-life Pattern Mining problems in response.
CO2	**Evaluate** the performance of a Pattern Mining solution with analysis and investigation.
CO3	**Design** optimized Pattern Mining techniques gradually based on the feedbacks from the previous learning and deploy new cutting-age techniques wherever needed.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5031 Text Information Systems

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE-5031
Course Title	*Text Information Systems*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Text Information Systems: Course overview and goals. Real-world applications (search engines, QA, chatbots). Basics of natural language. Challenges in text processing. Review of foundation concepts (vectors, probability, machine learning basics). **Text Preprocessing and Representation:** Tokenization, normalization, stemming, lemmatization. Bag-of-Words, TF-IDF, document-term matrices. Introduction to word embeddings (Word2Vec etc.). **Classical Information Retrieval:** Boolean and Vector Space Models. Term weighting and cosine similarity. Evaluation (precision, recall, F1, MAP, NDCG.). **Web and Enterprise Search:** Crawling and indexing. Inverted index and ranking functions (BM25 etc.). Machine learning-based ranking. **Text Classification with Machine Learning:** Naive Bayes, Logistic Regression, SVM. Model evaluation (confusion matrix, ROC-AUC). **Neural Networks for Text:** Processing sequence data, RNN, LSTM, GRU., Attention mechanism. **Neural Representations of Text:** Word embeddings revisited. Contextual embeddings (BERT overview). Embedding visualizations and nearest neighbors. **Information Extraction:** Named Entity Recognition. Parts-of-speech tagging. Comparison among rule-based, statistical, and machine learning approaches. **Document Clustering and Topic Modeling:** K-means and Agglomerative Clustering. Latent Dirichlet Allocation (LDA). **Neural IR and Semantic Search:** Dual encoder models. Dense retrieval (Siamese BERT). **Selected Topics:** Question Answering and Chatbots. Recommender Systems for Text. Text Summarization and Generation. Ethical considerations in text retrieval.

3 Text and Reference Materials

T Textbook:

- Introduction to Information Retrieval; by Manning et al., Springer, 2011.
- Managing Gigabytes: Compressing and Indexing Documents and Images; by MOffat et al., Morgan Kaufmann, 2014.

R References:

- Search Engines Information Retrieval in Practice; by Croft et al., 2015.
- Speech and Language Processing, by Jurafsky and Martin, 2020.
- Natural Language Processing with Tranasformers, Tunstall et al., 2021.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the foundation concepts of information retrieval and text data representation.
CO2	**Apply** machine learning methods for text classification, ranking, and clustering.
CO3	**Design** text processing pipelines for real-world applications.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
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Course Outline
CSE-5032 Wirless Network and IoT Security

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5032
Course Title	*Wireless Network and IoT Security*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	CSE-5012: None

2 Syllabus

Wireless Communication: wireless network overview, wireless channel, signal propagation, signal-to-noise ratio, unintentional and intention interference. **Risks and Threats of Wireless:** wireless security objectives, passive and active threat model, performance vs. security tradeoffs. **Wireless Physical Layer Technologies:** anti-jamming/jamming-resistance, CSMA/CA, coverage and exposure, selfishness at MAC layer, MAC misbehavior, data-driven misbehavior detection, frequency hopping spread spectrum (FHSS), direct sequence spread spectrum (DSSS), orthogonal frequency division multiplexing (OFDM). **Wireless Network security**: key exchange and key management protocols in wireless networks, authentication and authorisation in WLAN, 801.X EAP. **Secure routing**: selfishness in packet forwarding, wireless transport security, attacks on naming and addressing, sybil and replication attacks, security associations, secure neighbor discovery. **Security of Wireless Sensor Networks (WSNs):** WSN architectures and protocols, security threats, vulnerabilities, key establishment and distribution, security protocols and mechanisms, securing routing protocols, secure data aggregation, Security of different Wireless technologies used in WSN. **IoT security:** challenges and vulnerabilities in IoT, IoT architecture: mobile apps, cloud platforms, end devices. **Fundamentals of IoT Security:** authentication and authorisation, data encryption, secure boot and firmware updates, device identity management. **Securing IoT Communication:** MQTT, CoAP, HTTP, network segmentation and isolation, protecting data in transit and at rest, intrusion detection systems for IoT. **IoT Device Security:** secure hardware design, trusted platform modules (TPM), securing sensors and actuators, protecting edge devices and IoT gateways. **IoT Cloud Security:** IoT cloud platforms and services, identity and access management,virtualization security, co-hosting threats and side channel attacks, verifiable computation, securing IoT data in cloud, data encryption in cloud storage, API security in IoT cloud services. **IoT Application Security:** threat modeling for IoT applications, implementing secure coding practices, permission model, access control, mobile platform security model, privilege escalation, collusion attack, malicious ad library, etc., and defenses, vulnerability assessment and penetration testing, secure remote monitoring and control.

3 Text and Reference Materials

T Textbook:

- Security and Cooperation in Wireless Networks: Thwarting Malicious and Selfish Behavior in the Age of Ubiquitous Computing; Levente Buttyan & Jean-Pierre Hubaux, Cambridge University Press, 2007.
- Security Issues for Wireless Sensor Networks; Parag Verma, Ankur Dumka, Anuj Bhardwaj, Navneet Kaur, Alaknanda Ashok, Anil Kumar Bisht, Raksh Pal Singh Gangwar, 1st edition, CRC Press, 2022.
- Securing the Internet of Things; Shancang Li & Li Da Xu, 1st edition, Syngress, Elsevier, 2017.
- Internet of Things Security: Architectures and Security Measures; Chuan-Kun Wu, 1st edition, Springer, 2021.
- Internet of Things Security: Principles and Practice; Qinghao Tang & Fan Du, 1st edition, Springer-Nature New York Inc, 2021.

4 Course Outcomes

CO	CO Description
CO1	**Explain** the fundamental of wireless network security and IoT security.
CO2	**Evaluate** security risks, threats, and vulnerabilities for mitigation in wireless network and IoT network.
CO3	**Apply** security techniques and mechanisms to mitigate security risks and threats.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

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Course Outline
CSE-5033 Cloud Security

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5033
Course Title	*Cloud Security*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Cloud Security: Fundamentals of cloud security, examples of cloud breaches, introduction to cloud architecture, components of cloud applications, major cloud providers, fundamental security considerations, and the shared responsibility model. **Identity and Access Management (IAM):** cloud accounts, policies and permissions, groups and roles, temporary credentials, secrets management, customer account management and external access, IAM best practices. **Compute and Configuration Management:** secure instance/virtual machine deployment, hardware virtualization , software virtualization, memory virtualization, storage virtualization, data virtualization, network virtualization, virtualization security recommendations, host configuration management, image management, application security, security requirements for the Web/Mobile applications and Internet of Things (IoT) deployments on the cloud, threat modeling, Platform as a Service (PaaS) and Software as a Service (SaaS) Challenges, container services, cloud storage, security criteria for building an internal cloud, security criteria for selecting external cloud, key strategies and best practices for securing cloud. **Data Protection and Automation:** data classification, data at rest encryption, availability, data in transit encryption, life cycle management, key management systems (KMS), different types of keys, key policies, key rotation, infrastructure as code, productivity services, cloud access security brokers (CASB). **Networking and Logging:** public cloud networking, remote management of IaaS systems, segmentation, network protection services, cloud logging services, log collection and analysis, cloud monitoring requirement, cloud log analysis and monitoring, network Visibility. **Cloud Detection Services Compliance, Incident Response, and Penetration Testing:** security assurance, cloud auditing, privacy, Government clouds, risk management, penetration testing, legal and contractual requirements, compliance standard, incident response and forensics.

3 Text and Reference Materials

This course is taught in combination of text book, research papers and technical documents published by different cloud security standardization entities and cloud service providing vendors.

T Textbook:

- Securing the cloud; by Vic (J.R.) Winkler, Syngress Publications, Elsevier, 2011.
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing; by Ronald L. Krutz, Russell Dean Vines, 1st Edition, Wiley, 2010.
- Cloud Computing Security: Foundations and Challenges; by John R Vacca, 1st Edition, CRC Press, 2016.

4 Course Outcomes

CO	CO Description
CO1	**Explain** cloud security technologies and paradigms.
CO2	**Evaluate** cloud infrastructures and inherent components and classify security risks, threats, and vulnerabilities for mitigation.
CO3	**Apply** security techniques and mechanisms in a cloud environment to mitigate cyber security risks and threats.
CO4	**Explore** real-world cloud computing and their impact on data confidentiality, integrity, and availability.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5034 Network Monitoring and Management

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5034
Course Title	*Network Monitoring and Management*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Foundations of Network Monitoring and Management: Network management goals, FCAPS functional model, management architectures (centralized, distributed), and the role of monitoring in modern IP networks. **Management Standards and Protocols:** SNMP architecture and MIB structures, SNMPv1/v2/v3 operations, RMON concepts, model-driven management using NETCONF and YANG, and an overview of modern telemetry frameworks. **Monitoring and Measurement Techniques:** Active and passive monitoring, packet capture and flow-based telemetry (NetFlow, sFlow, IPFIX), performance metrics (latency, jitter, loss, throughput), traffic measurement, and basic anomaly detection. **Fault and Performance Management:** Fault detection, alarm correlation, performance baselining, SLA monitoring, QoS-aware measurement, and configuration management fundamentals including versioning and automated updates. **Network Management in Programmable and Virtualized Environments:** Basics of Software-Defined Networking (SDN) for monitoring, controller-based visibility, monitoring in data centers and virtualized infrastructures, and observability in cloud and containerized environments. **Security and Emerging Trends:** Security monitoring concepts, log and event analysis, secure management protocols, and current trends such as streaming telemetry, zero-touch configuration, and monitoring approaches in large-scale and multi-cloud networks. **AI in Network Monitoring and Management:** Proactive Anomaly Detection, Root Cause Analysis, Enhanced Security.

3 Text and Reference Materials

T Textbook:

- "Network Management: Principles and Practice" by Mani Subramanian; Pearson Education, 2010.
- "Principles of Computer Systems and Network Management" by Dinesh Chandra Verma; Springer Science & Business Media, 2010

R References:

- "Network Management, MIBs and MPLS: Principles, Design and Implementation" by Stephen B. Morris; Prentice Hall, 2003.
- "Network management Concepts and Practices" by J. Richard Burke; PHI, 2008.

4 Course Outcomes

CO	CO Description
CO1	**Explain** fundamental concepts, architectures, and standards of network monitoring and management.
CO2	**Analyze** network performance and faults using active and passive monitoring techniques and key metrics.
CO3	**Apply** network management protocols and tools to monitor and manage traditional and virtualized networks.
CO4	**Evaluate** security events and emerging trends in modern network monitoring environments.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5035 Distributed Ledger Technologies

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5035
Course Title	*Distributed Ledger Technologies*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Introduction to Distributed Ledger Technologies (DLTs): Cryptographic Primitives I: Hashes & Merkle Trees; Cryptographic Primitives II:Public-Key Crypto & Signatures, secp256k1 Curve Design, Schnorr Signatures (Taproot); Distributed Systems Basics for DLT, Formal FLP Impossibility Proof; Classical Consensus (BFT families): Safety & Liveness, PBFT vs HotStuff vs Tendermint Comparison. **Bitcoin: Architecture & Consensus:** Bitcoin Architecture: Blocks, UTXO, Scripts; Nakamoto Consensus: Proof-of-Work & Probabilistic Finality, Selfish Mining Attack; Network Dynamics: Propagation, Forks, Soft vs. Hard Forks; Economics of Mining: Incentives, Fees, Security Considerations. **Smart Contracts & Platforms:** Ethereum Architecture: Accounts, EVM, State, Account Abstraction (EIP-4337); Smart Contracts: Semantics, Tokens (ERC-20/721), Risks; Proof-of-Stake: Validators, Finality; PoS vs. PoW; Permissioned DLTs: Hyperledger/Corda; DAG-style Ledgers; Platform Survey: Throughput, Interoperability, Use Cases. **Scalability, Privacy, Security:** Methodology, Cross-chain Bridge Security Models. Scalability, Privacy, Security: The Scalability Trilemma: Constraints & Metrics, Formal Mathematical Proof; Off-chain Scaling: Payment/State Channels (e.g., Lightning), HTLCs & Atomic Swap Mechanisms; Sidechains & Rollups: Optimistic vs. ZK Approaches; Privacy in Public Ledgers: Pseudonymity, Mixers, Monero/Zcash; Zero-Knowledge Proofs: Intuition & DLT Applications, Bulletproofs Range Proofs, Recursive SNARKs (Mina Protocol); Security Case Studies: 51% Attacks, DAO, Reentrancy, Keys, DAO Hack Trie Structure Analysis. **Applications, Governance, and Futures:** Decentralized Finance (DeFi): AMMs, Lending, Risks (conceptual), AMM Constant Product Math; Non-financial Use Cases: Supply Chain, Identity, Voting, IoT; Enterprise DLT: Architecture & Trade-offs; Governance: On-chain vs. Off-chain, DAOs, Upgrade Politics, Moloch DAO Process Simulation; Legal/Regulatory & Ethics: Compliance, Privacy, Illicit Use; Web3 Stack: Storage (IPFS), Identity (DIDs), Data Ownership; Interoperability: Bridges, IBC/Polkadot; Multichain Security, Bridge Hack Case Studies 2022; CBDCs & Future Directions: Sustainability, Quantum Resistance, Project Hamilton Architecture; Synthesis & Review: Connecting Cryptography, Consensus, Apps.

3 Text and Reference Materials

T Textbook:

- Bitcoin and Cryptocurrency Technologies; by Narayanan, Bonneau, Felten, Miller, Goldfeder, 2016.
- Mastering Ethereum by Antonopoulos & Wood , 2018.

R References:

- Consensus in the Presence of Partial Synchrony by Dwork, Lynch, Stockmeyer, Journal of the ACM, 1988.
- The Byzantine Generals Problem by Lamport, Shostak, Pease ACM TOPLAS, 1982.
- Ouroboros: A Provably Secure Proof-of-Stake Blockchain Protocol by Kiayias et al. CRYPTO, 2017.

4 Course Outcomes

CO	CO Description
CO1	**Analyze** different distributed ledger architectures and compare their strengths and limitations.
CO2	**Evaluate** consensus mechanisms for scalability, security, and energy efficiency in different application contexts.
CO3	**Analyze** the role of cryptographic primitives (hashing, digital signatures, zero-knowledge proofs) in ensuring ledger integrity and privacy.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026

Course Outline
CSE-5036 Program Analysis

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5036
Course Title	*Program Analysis*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	None

2 Syllabus

Program Representations: ASTs, control-flow graphs, stack machines Program Semantics **Data-Flow Analysis:** theoretical framework, sample analyses, soundness and correctness, termination and complexity **Interprocedural Data-Flow Analysis:** context-sensitivity, precision, termination Control-Flow Analysis for Functional Languages **Pointer Analysis:** Andersen and Steengaard's analysis, field sensitivity for object-oriented languages, call graph construction with dynamic dispatch **Software Model Checking Satisfiability Modulo Theories:** SAT, SMT, DPLL Symbolic Execution and Concolic Testing **Fuzz Testing:** white-box and grey-box analysis **Dynamic Analysis:** examples for concurrency, software engineering applications **Program Synthesis:** Specification-driven program generation, constraint-based and example-based synthesis; applications in automation, rapid prototyping, and AI-assisted programming. **Program Repair:** Automated bug fixing, generate-and-validate and constraint-based approaches; applications in software maintenance and reliability. **Program Analyses for Improving Performance and Security:** Optimization driven analyses, information-flow and taint analysis, vulnerability detection; applications in secure and high-performance software systems.

3 Text and Reference Materials

T Textbook:

- Principles of Program Analysis; by Flemming Nielson, Hanne Riis Nielson, and Chris Hankin (Springer, 2022)
- Vega, Daniel. Static Program Analysis Techniques: Ensuring High-Quality Code. Independent Publishing, 2024.

R References:

- Blokdyk, Gerardus. Static Program Analysis A Complete Guide: 2020 Edition. 5STAR-Cooks, 2019.
- Nipkow, T., & Grumberg, O. (Eds.). (2022). Software safety and security: Tools for analysis and verification (4th ed.). IOS Press.

4 Course Outcomes

CO	CO Description
CO1	**Explain** fundamental concepts of program analysis, including program representations (ASTs, CFGs), semantics, and data-flow analysis frameworks.
CO2	**Apply** data-flow analysis techniques (e.g., interprocedural analysis, pointer analysis) to solve problems in software correctness and security.
CO3	**Analyze** the trade-offs between precision, soundness, and scalability in static and dynamic program analysis methods (e.g., SMT solvers, symbolic execution).
CO4	**Evaluate** the effectiveness of program analysis tools (e.g., fuzz testing, concolic testing) for detecting vulnerabilities or improving performance.
CO5	**Design** a program analysis pipeline (e.g., combining static and dynamic techniques) to address a real-world software engineering challenge.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
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Course Outline
CSE-5037 Research Methodology

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5037
Course Title	*Research Methodology*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Mandatory Course
Prerequisite Course	None

2 Syllabus

Foundations of Research and Paradigms: Overview of the research process, its role in academia and industry, major paradigms, and formulation of research problems, gaps, and hypotheses. **Literature Review and Scholarly Communication:** Systematic review techniques, use of digital libraries, critical analysis of prior work, and identification of research contributions. **Research Design and Methodology:** Selection of appropriate research designs (experimental, correlational, exploratory) and methodological frameworks based on problem context. **Data Collection and Sampling:** Qualitative and quantitative data collection approaches, sampling strategies, sample size considerations, and experimental planning with attention to bias and variability. **Data Analysis Techniques:** Core statistical methods including descriptive and inferential analysis, hypothesis testing, correlation and regression, along with introductory tools for analysis and visualization. **Qualitative and Mixed-Methods Research:** Basic qualitative analysis and integration of mixed-methods approaches with triangulation. **Research Ethics and Integrity:** Key ethical principles including consent, privacy, plagiarism, authorship, and intellectual property. **Research Proposal and Scientific Writing:** Proposal development, academic writing, and the publication process including journal selection and peer review. **Research Project Management:** Planning, scheduling, resource allocation, and documentation. **Critical Evaluation and Advanced Topics:** Assessment of research quality, validity, and reproducibility, along with emerging practices such as open science, data sharing, and interdisciplinary CSE research.

3 Text and Reference Materials

T Textbook:

- *John W. Creswell*, **Research Design: Qualitative, Quantitative and Mixed Methods Approaches**, 5th Edition, SAGE Publications, 2018.

R References:

- *Wayne C. Booth*, **The Craft of Research**, Fourth Edition, University of Chicago Press, 2016.

4 Course Outcomes

CO	CO Description
CO1	**Formulate** research problems, questions, and hypotheses by identifying gaps through systematic literature review.
CO2	**Analyze** research designs, data collection strategies, and quantitative/qualitative methods to select appropriate methodologies.
CO3	**Evaluate** research quality, ethical considerations, and scientific contributions through critical assessment and effective academic writing.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
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Course Outline
CSE-5038 Data-Driven Modelling

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5038
Course Title	*Data-Driven Modelling*
Course Credit	3.0 units
Contact Hours Per Week	3
Course Status	Mandatory Course
Prerequisite Course	None

2 Syllabus

Foundations of Data-Driven Modelling: Overview of data-driven vs model-driven approaches, types of data, data lifecycle, and challenges in real-world modeling. **Mathematical and Statistical Foundations:** Essential concepts from linear algebra, probability, and statistical inference for modeling and learning from data. **Data Preprocessing and Feature Engineering:** Data cleaning, handling missing values and outliers, normalization, feature extraction, selection, and dimensionality reduction. **Statistical and Machine Learning Models:** Core modeling techniques including regression, classification, clustering, and basic probabilistic models. **Deep Learning Fundamentals:** Introduction to neural networks and key architectures (MLP, CNN, RNN/Transformer) for representation learning. **Model Training and Optimization:** Loss functions, gradient-based optimization, regularization, and hyperparameter tuning. **Model Evaluation and Validation:** Performance metrics, cross-validation, bias–variance tradeoff, and reproducibility. **Time-Series and Sequential Modelling:** Basic forecasting methods and sequence modelling for temporal data. **Scalable Data-Driven Systems:** Introduction to large-scale and distributed data processing and model deployment concepts. **Interpretability and Ethics:** Model interpretability, SHAP, LIME, counterfactuals, fairness metrics, bias mitigation, data privacy (differential privacy basics), and responsible use of data-driven systems. **Applications and Research Directions:** Application of data-driven models in real-world domains and overview of emerging research trends.

3 Text and Reference Materials

T Textbook:

- *Steven L. Brunton and J. Nathan Kutz*, **Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control**, 2nd Edition, Cambridge University Press, 2022.
- *Gauthier Mercère*, **Data-Driven Model Learning for Engineers**, 1st Edition, Springer, 2023.

R References:

- *Kevin P. Murphy*, **Machine Learning: A Probabilistic Perspective**, 1st Edition, MIT Press, 2012.
- *Aurélien Géron*, **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow**, 3rd Edition, O'Reilly Media, 2022

4 Course Outcomes

CO	CO Description
CO1	**Analyze** data-driven modelling problems by applying mathematical, statistical, and machine learning principles, including data preprocessing, feature engineering, and appropriate model selection for diverse data types.
CO2	**Design** and **optimize** data-driven models, including statistical, machine learning, deep learning, and time-series approaches, with proper training strategies, validation techniques, and scalability considerations.
CO3	**Evaluate** the performance, interpretability, and ethical implications of data-driven models using advanced metrics, validation methods, and fairness, privacy, and reproducibility frameworks.

5 Assessment Methods

Assessment Method	Total
Final Exam	60%
Midterm Exam	25%
Assignment/Presentation	10%
Class Participation	5%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
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Course Outline
CSE-5040 Thesis

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5040
Course Title	*Thesis*
Course Credit	18 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	Completion of any six 3 credit theory courses

2 Course Description

The Master's Thesis course requires students to transition from theoretical learning to independent, original, and impactful scientific inquiry. Under the guidance of a faculty supervisor, students identify a real-life complex technical challenge, conduct an exhaustive literature review, and develop a novel solution through mathematical modeling and rigorous experimentation. This course culminates in a comprehensive written dissertation and possibly good quality publication(s), and an oral defense, demonstrating the student's readiness to contribute to the global research community or lead high-level industrial research projects.

3 Course Outcomes

CO	CO Description
CO1	**Formulate** a novel research question by critically analyzing existing literature and identifying gaps within a specialized domain of Computer Science and Engineering.
CO2	**Design and implement** a robust methodology, involving the creation of algorithms, systems, or frameworks, to solve the identified research problem.
CO3	**Defend** the research findings through a high-quality written thesis, possibly some good quality publication(s), and a formal presentation that adheres to professional scientific communication standards.

4 Assessment Methods

Assessment Method	Total
Thesis Defense	70%
Thesis report evaluation	30%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
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Course Outline
CSE-5041 Project

1 Basic Information

Faculty	Faculty of Engineering and Technology (FoET)
Department	Department of Computer Science and Engineering
Program	Master of Science in Computer Science and Engineering
Semester	**Fall 2026**
Course Code	CSE 5041
Course Title	*Project*
Course Credit	6 units
Contact Hours Per Week	3
Course Status	Elective Course
Prerequisite Course	Completion of any ten 3 credit theory courses

2 Course Description

The Master's Project course is a practice-oriented course designed for students to demonstrate advanced technical proficiency through the development of a tangible, high-level computing solution for a specific real-life problem. Unlike the research-focused thesis, this course emphasizes the engineering lifecycle — from requirements analysis and architectural design to implementation and deployment — to solve a real-world societal or industrial problem. Students apply advanced programming paradigms, modern frameworks, and project management methodologies to deliver a professional-grade product that meets specific functional and performance benchmarks.

3 Course Outcomes

CO	CO Description
CO1	**Design** a complex software or hardware system by translating high-level user requirements into detailed technical and architectural specifications.
CO2	**Implement** a functional, scalable solution using industry-standard tools and advanced computing techniques to address a practical challenge in the field of CSE.
CO3	**Evaluate** the performance and reliability of the developed project through rigorous testing protocols and comprehensive technical documentation.

4 Assessment Methods

Assessment Method	Total
Project Defense	70%
Project report evaluation	30%

Course Teacher
August 30, 2026

Chairman, Dept. of CSE, DU
August 30, 2026