Dr. B. C. Roy Engineering College, Durgapur

Department of CSE(AIML)

Field	Details
Course Name	Digital Image Processing for Secure System
Course Code	CY-701
Semester	7
Course Category	Professional Elective Courses
Credits	3
Hours per Week	3L:0T:0P

1. Prerequisites

• Proficiency in a programming language for scientific computing (e.g., Python or MATLAB) with experience using numerical libraries

• Fundamental linear algebra, calculus, and signal processing concepts (including vectors, matrices, Fourier transforms, and sampling theory)

• Introductory probability and statistics plus basic concepts of digital image processing

2. Course Learning Objectives

• Develop a deep conceptual understanding of digital image formation, representation, and the mathematical foundations (e.g., sampling, transforms, convolution) that underpin modern image processing techniques.

• Equip students with the ability to design, implement, and evaluate both spatial- and frequency-domain algorithms for image enhancement, restoration, and morphological processing across a variety of real-world scenarios.

• Guide learners in applying classical and advanced segmentation, feature extraction, and pattern analysis methods--including keypoint detection, texture analysis, and introductory deep-learning models--to extract meaningful information from visual data.

• Enable students to critically assess and employ classification, clustering, and compression strategies, while understanding their theoretical bases, performance metrics, and ethical implications related to bias and data handling.

• Foster the integration of motion analysis, camera-based modeling, and domain-specific applications (e.g., face recognition, medical imaging, biometrics) through project-oriented learning that bridges theory with emerging AI-driven computer vision technologies.

3. Teaching Methodology

• Lectures and Presentations

• Interactive Discussions and Case Studies

• Lab Sessions

• Guest Lectures

4. Evaluation System

Activities	Class Test Full marks	Assignment Full marks	Attendance Full marks	Total Marks
CIA-1	25	10	5	40
CIA-2	25	10	5	40
End Semester Examination (ESE)	–	–	–	60
Total				100

5. Course Modules

Module	Topics	Hours
1	**Foundations of Digital Imaging**	5
	- Overview of digital image formation and	

	acquisition - Sampling, quantization and common colour spaces (RGB, HSV, YCbCr) - Pixel relationships and image representation (grayscale & colour) - Basic geometric transformations: translation, rotation, scaling, affine - 2-D Discrete Fourier Transform (DFT) and its properties - Discrete Cosine Transform (DCT) - fundamentals for compression - Convolution fundamentals and linear image filtering	
2	**Image Enhancement and Restoration** - Spatial-domain enhancement * Point operations, gray-level transformations, histogram equalisation * Neighborhood operations: smoothing, median filter, high-pass sharpening - Frequency-domain enhancement * Filtering concepts in the DFT domain * Design of low-pass and high-pass filters - Image degradation models - Restoration techniques * Inverse filtering and basic Wiener (LMS) filter * Simple regularised restoration approaches	6
3	**Morphological Processing & Classical Segmentation** - Morphological processing (binary & grayscale) * Dilation, erosion, opening, closing * Structuring-element design and decomposition * Morphological gradients and hit-or-miss - Classical segmentation techniques * Basic edge detection (Sobel, Prewitt, gradient magnitude) * Edge linking and boundary following * Thresholding methods (global, Otsu) * Region-based segmentation: region growing, splitting/merging	7
4	**Feature Extraction, Advanced Segmentation & Intro to Vision AI** - Advanced edge and feature detectors * Canny, Laplacian of Gaussian (LoG), Difference of Gaussians (DoG) - Corner detection * Harris, Shi-Tomasi (good features to track) - Scale-space and key-point descriptors * Conceptual overview of SIFT, SURF, HOG	8

	- Introductory Convolutional Neural Networks (CNNs) * Basic architecture, convolution & pooling layers - Graph-cut and mean-shift segmentation (high-level concepts) - Texture-based segmentation basics		
5	**Pattern Analysis, Classification & Image Compression** - Clustering techniques (conceptual) * K-Means, Gaussian Mixture Models - Classification fundamentals * Discriminant functions, Bayesian classifier, k-Nearest Neighbours * High-level overview of Support Vector Machines * Evaluation metrics: accuracy, precision, recall, ROC/AUC - Image compression principles * Redundancy types and removal methods * JPEG basics (DCT), JPEG-2000 overview * Huffman and arithmetic coding, predictive coding (lossless & lossy) - Ethical considerations in data handling and model bias	8
6	**Motion Analysis and Real-World Applications** - Motion analysis fundamentals * Background modelling and frame differencing * Optical flow basics (Lucas-Kanade) * Kanade-Lucas-Tomasi (KLT) feature tracking - Camera motion estimation and video stabilisation (conceptual) - Application domains * Face detection & recognition pipeline * Object tracking (Kalman filter overview) * Fingerprint recognition basics * Medical imaging use-cases - Project-based case studies and emerging AI-driven vision trends	8

6. References

Textbooks:

1. Digital Image Processing- Rafeal C. Gonzalez, Richard E. Woods, 3rd Edition, Pearson, 2008

2. Digital Image Processing- S Jayaraman, S. Essakkirajan, T. Veerakumar-TMH,2010

Reference Books:

1. Digital Image Processing and analysis-human and computer vision application with using CVIP Tools - Scotte Umbaugh,2nd Ed, CRC Press,2011

2. Digital Image Processing with MATLAB & Labview - Vipula Singh Elsevier

7. Course Outcomes

ID	Statement	Action Verb	Knowledge Level
CY-701.1	Recall and list the fundamental concepts of digital image formation, including sampling, quantization, colour-space representations (RGB, HSV, YCbCr), pixel relationships, and the mathematical properties of the 2-D DFT and DCT.	Recall	Remember
CY-701.2	Explain how spatial-domain and frequency-domain techniques are used for image enhancement and restoration, describing point operations, histogram equalisation, convolution-based filtering, and the principles of inverse and Wiener filtering.	Explain	Understand
CY-701.3	Apply morphological operators (dilation, erosion, opening, closing) and classical segmentation methods (edge detection, thresholding, region growing, Otsu) to segment grayscale and colour images and evaluate the quality of the resulting regions.	Apply	Apply
CY-701.4	Analyze and compare advanced feature-extraction techniques-- including Canny, LoG, DoG, Harris, and Shi-Tomasi detectors-- as well as basic convolutional neural network (CNN) architectures, identifying their strengths and limitations for different vision tasks.	Analyze	Analyze
CY-701.5	Evaluate clustering (K-Means, GMM) and classification algorithms (k-NN, Bayesian, SVM)	Evaluate	Evaluate

	and image-compression schemes (JPEG/DCT, JPEG-2000, Huffman/arithmetic coding) using metrics such as accuracy, precision, recall, ROC/AUC, compression ratio, and discuss ethical implications of bias and data handling.		
CY-701.6	Design and implement an end-to-end computer-vision pipeline that incorporates motion analysis (optical flow, KLT tracking), object detection/tracking, and a selected AI/ML model to solve a real-world problem (e.g., face recognition, medical image analysis), and justify design choices based on performance and ethical considerations.	Design	Create

8. CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	1	-	-	-	1	-	2
CO2	3	2	2	2	3	1	-	-	-	2	-	2
CO3	2	2	3	3	3	1	1	1	2	2	2	2
CO4	3	3	2	3	3	1	1	2	2	2	2	3
CO5	3	3	2	3	3	2	1	3	2	2	2	3
CO6	3	3	3	3	3	3	2	3	3	3	3	3

9. CO-PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	2	3	1
CO4	3	2	2
CO5	3	2	3
CO6	3	3	3

Dr. B. C. Roy Engineering College, Durgapur

Department of CSE(AIML)

Field	Details
Course Name	Visual Cryptography)
Course Code	CY-702
Semester	7
Course Category	Professional Elective Courses
Credits	3
Hours per Week	3L:0T:0P

1. Prerequisites

• Fundamentals of Cryptography (including secret-sharing concepts)

• Basic image processing and digital imaging fundamentals (pixel representation, grayscale/halftone techniques)

• Proficiency in Python programming with experience using libraries such as OpenCV or similar image-processing tools

2. Course Learning Objectives

• Provide students with a comprehensive understanding of visual cryptography fundamentals, its historical evolution, and how it differs from traditional computational cryptography.

• Enable learners to design, implement, and evaluate a variety of visual secret-sharing schemes-- including binary, grayscale, and color approaches--while articulating the trade-offs among pixel expansion, contrast, and security.

• Develop practical skills for creating secure, application-ready visual cryptography solutions, incorporating modern techniques such as random-grid, meaningful shares, QR-code integration, and AI-assisted share generation.

• Cultivate the ability to critically assess visual cryptography systems using quantitative security metrics and image-quality measures, and to propose mitigation strategies for common attacks and real-world implementation challenges.

• Foster interdisciplinary insight by linking visual cryptography to emerging domains (e.g., blockchain, privacy-preserving AI, digital watermarking) and guiding students to identify and explore future research and industry opportunities.

3. Teaching Methodology

• Lectures and Presentations

• Interactive Discussions and Case Studies

• Lab Sessions

• Guest Lectures

4. Evaluation System

Activities	Class Test Full marks	Assignment Full marks	Attendance Full marks	Total Marks
CIA-1	25	10	5	40
CIA-2	25	10	5	40
End Semester Examination (ESE)	–	–	–	60
Total				100

5. Course Modules

Module	Topics	Hours
1	**Foundations of Visual Cryptography** - What is visual cryptography? - definition and	6

		motivation - Historical background (Naor-Shamir model) and evolution - Contrast with conventional (computational) cryptography - Human visual system basics: contrast perception and visual decoding - Binary images, pixel representation, and stacking principle - Core terminology: pixel expansion, contrast, share, secret image, sub-pixel - Simple visual-only security model (information-theoretic view) - Representative use-cases: secure voting, banking cards, authentication, watermarking - Ethical and privacy considerations in visual-only security	
2		**Basic Visual Secret Sharing Schemes** - (2,2) visual cryptography scheme - step-by-step construction - Basis matrices and how they define share patterns - Share generation algorithm and practical demonstration - Reconstruction by OR-ing / physical stacking of shares - Extending to (k,n) threshold schemes - intuitive combinatorial idea - Trade-off analysis: pixel expansion vs. contrast (no heavy proofs) - Security intuition for threshold schemes (information leakage discussion) - Manual construction exercises and classroom labs	8
3		**Practical Techniques in Visual Cryptography** - Random-grid visual cryptography (no pixel expansion) - concept and generation - Reversible vs. irreversible schemes - when each is useful - Halftone visual cryptography - error-diffusion basics for gray-scale conversion - Meaningful / natural shares - creating shares that look like ordinary images - Overview of common attacks (geometric distortion, noise) and simple mitigation strategies - Practical guidelines for choosing a technique based on application constraints	7
4		**Color Visual Cryptography** - Color models relevant to VC: RGB, CMY, CMYK - Decomposing a color image into component layers	6

	for share creation - Generating color shares and handling pixel expansion in color space - Color halftone visual cryptography - adapting error diffusion to color - Multi-layer color schemes and their industry applications (brand protection, colored ID cards) - Performance considerations: storage, printing, and visual quality	
5	**Applications, QR Codes & AI-Aligned Use Cases** - Grayscale handling: dithering methods for VC preparation - QR-code based visual cryptography - embedding and decoding - Combining visual cryptography with steganography for layered security - Multi-secret and progressive visual cryptography - delivering several secrets from the same share set - Case study: watermark authentication for digital media - AI-focused scenarios: protecting model parameters, secure AI inference, and high-level overview of using CNNs to generate high-quality shares	7
6	**Implementation, Evaluation & Emerging Trends** - Security metrics: contrast, pixel expansion, information leakage - Image quality assessment for reconstructed images (objective & subjective measures) - Error-resilience: handling distortion, cropping, and printing defects - Hands-on implementation with Python / OpenCV (share generation, stacking, threshold schemes) - Share-generation algorithms and optimization for large images - Digital vs. physical stacking workflow - Real-world project examples: secure ID cards, access-control systems - Emerging trends aligned with AI: blockchain-anchored VC, deep-learning-assisted share generation (conceptual overview), privacy-preserving AI pipelines - Future research directions and open challenges (without deep mathematical detail)	8

6. References

Textbooks:

1. Moni Naor and Adi Shamir, Visual Cryptography, Springer Lecture Notes (Foundational Paper).

2. Chin-Chen Chang, Tai-Xing Yu, Visual Secret Sharing: Theory, Practice, and Applications, CRC Press.

Reference Books:

1. K. Shankar, S. Smys, Recent Trends in Image Security using Visual Cryptography, Springer.

2. Ching-Nung Yang, Advances in Visual Cryptography: Issues and Applications, World Scientific.

7. Course Outcomes

ID	Statement	Action Verb	Knowledge Level
CY-702.1	Recall and list the fundamental concepts, historical development, and human visual-system principles that form the basis of visual cryptography.	Recall	Remember
CY-702.2	Explain the core terminology (pixel expansion, contrast, share, sub-pixel) and describe how basic (2,2) and (k,n) visual secret-sharing schemes operate.	Explain	Understand
CY-702.3	Construct (2,2) and (k,n) visual secret-sharing shares manually and with Python scripts, and correctly reconstruct the secret image by physical or digital stacking.	Construct	Apply
CY-702.4	Analyze and compare practical visual-cryptography techniques (random-grid, halftone, meaningful shares) regarding pixel expansion, visual quality, and resistance to common attacks.	Analyze	Analyze
CY-702.5	Evaluate color visual cryptography and QR-code-based schemes for AI/ML security scenarios, selecting the most suitable method to protect model parameters or	Evaluate	Evaluate

	inference data.		
CY-702.6	Design, implement, and assess a complete visual-cryptography pipeline in Python/OpenCV that secures AI model artifacts, measuring contrast, pixel expansion, and robustness, and propose optimization strategies.	Design	Create

8. CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	1	1	1	1	1	1	2
CO2	2	2	1	2	2	1	1	1	1	1	1	2
CO3	3	2	2	2	3	1	1	1	2	2	1	2
CO4	2	3	2	3	2	2	1	2	1	2	1	2
CO5	2	3	3	2	2	2	1	2	1	2	2	2
CO6	3	2	3	3	3	2	1	2	2	2	2	2

9. CO-PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	2	3	1
CO4	3	2	1
CO5	3	3	2
CO6	3	3	2

Dr. B. C. Roy Engineering College, Durgapur

Department of CSE(CS)

Field	Details
Course Name	Cloud Computing
Course Code	CY-703
Semester	7
Course Category	Open Elective Courses
Credits	3
Hours per Week	3L:0T:0P

1. Prerequisites

• Fundamentals of computer networks, operating systems, and distributed systems

• Basic Linux/Unix command-line and scripting skills (e.g., Bash, Python)

• Introductory knowledge of virtualization concepts and cloud service models

2. Course Learning Objectives

• This course introduces students to fundamental concepts and applications of the subject

• Students will learn theoretical foundations and practical skills relevant to the field

3. Teaching Methodology

• Lectures and Presentations

• Interactive Discussions and Case Studies

• Lab Sessions

• Guest Lectures

4. Evaluation System

Activities	Class Test Full marks	Assignment Full marks	Attendance Full marks	Total Marks
CIA-1	25	10	5	40
CIA-2	25	10	5	40
End Semester Examination (ESE)	_	_	_	60
Total				100

5. Course Modules

Module	Topics	Hours
1	**Fundamentals of Cloud Computing** - Definition and motivation for cloud computing - Historical evolution and roots of cloud computing - Five essential characteristics (on-demand self-service, broad network access, resource pooling, rapid elasticity, measured service) - Benefits, challenges and basic cloud economics - Cloud deployment models: public, private, community, hybrid (advantages & disadvantages) - Overview of cloud service models: IaaS, PaaS, SaaS (functions, pros/cons) - Basic cloud-native concepts and governance considerations - Cloud reference architecture layers - Prerequisite foundations (computer networks, operating systems, distributed systems) - brief overview - Introductory security considerations (confidentiality, integrity, availability)	5
2	**Virtualization and Infrastructure as a Service**	7

	- Virtualization fundamentals and reference model - Types of virtualization: server, storage, network, desktop, application - Hypervisor categories: Type 1 (bare-metal) vs. Type 2 (hosted) and examples (VMware ESXi, Xen, Microsoft Hyper-V) - Virtual machine lifecycle: creation, provisioning, migration, consolidation, de-commissioning - VM migration techniques (live vs. cold migration) and performance considerations - Containerization basics and contrast with VM virtualization - Core concepts of Infrastructure as a Service (IaaS) - IaaS platforms and components (OpenStack architecture, key services) - Hybrid IaaS architectures and integration of private & public clouds - Resource scheduling, auto-scaling and basic cost-control mechanisms	
3	**Cloud Service Models, Platforms and SLA Management** - Detailed IaaS characteristics, suitability, major providers (AWS EC2/S3, Azure VMs, OpenStack, CloudStack, VMware vCloud) - Detailed PaaS characteristics, suitability, providers (Google App Engine, Azure PaaS, OpenNebula, Cloud Foundry) - Detailed SaaS characteristics, suitability, providers (Salesforce, Google Workspace, Microsoft 365) - Emerging service models: Function-as-a-Service (serverless), Container-as-a-Service, AI-as-a-Service, Database-as-a-Service, Storage-as-a-Service - Cloud service lifecycle: planning, creation, operation, termination - SLA management: types, lifecycle phases, key metrics, operationalization - Cloud governance and compliance frameworks (ISO 27001, SOC 2, GDPR, HIPAA) - Overview of major cloud platforms (AWS, Azure, Google Cloud, IBM Cloud, SAP Cloud) and their service catalogs	8
4	**Cloud Storage, Data Management and Monitoring** - Cloud storage architecture and virtualized data centre (VDC) design - Object, block and file storage models; comparison and use cases - Distributed file systems: Google File System (GFS) and Hadoop Distributed File System (HDFS) -	6

		features and limitations - Storage virtualization techniques and Data-as-a-Service concepts - Database-as-a-Service fundamentals and common offerings - Monitoring and management: key metrics, performance monitoring, capacity planning, auto-scaling strategies - Cloud cost modeling, cost-benefit analysis and budgeting basics - Disaster recovery planning, backup strategies and business continuity in the cloud	
5		**Security, Risk Management and Compliance in the Cloud** - Cloud security foundations: multi-tenancy, isolation, trust models - Virtualization security: hypervisor hardening, VM escape mitigation - Data security technologies: encryption at rest & in-transit, tokenization, key management - Identity and Access Management (IAM), federation and zero-trust principles - Security-as-a-Service offerings and content-level security controls - Risk categories: policy/organizational, technical, legal and risk assessment methods - Compliance, legal issues and data sovereignty (GDPR, HIPAA, PCI-DSS) - SLA security aspects, incident response processes and DevSecOps practices	8
6		**Migration, Deployment Strategies, Applications and Emerging Trends** - Cloud migration fundamentals: drivers, benefits, risks - Seven-step migration model (assessment, planning, design, implementation, testing, deployment, optimization) - Migration phases: feasibility, onboarding, pre-production, production, termination - Application migration strategies: re-host, re-platform, refactor, re-architect (including containerization) - Scalability and fault-tolerance patterns in the cloud (auto-scaling, load balancing, multi-region deployment) - Emerging trends: edge computing, IoT integration, inter-cloud orchestration, serverless computing - Cloud-native application domains: scientific, healthcare, geoscience, business (CRM, ERP), social	8

	networking, media, gaming - Case studies of platform usage (AWS, Azure, Google App Engine, Kubernetes, serverless services)	

6. References

Textbooks:

1. Cloud Computing Principles and Paradigms, by Rajkumar Buyya

2. Sharma Rishabh Cloud Computing Wiley Publication, ISBN: 978-81-265- 5306-8

3. Arshdeep Bahga, Vijay Madisetti Cloud Computing: A Hands-On Approach Self published, ISBN 1494435144, 9781494435141

4. Essentials of cloud Computing: K. Chandrasekhran, CRC press, 2014

5. Christian Vecchiola, Rajkumar Buyya, and S.Thamarai Selvi Mastering Cloud Computing McGraw Hill Publication, ISBN 978-1- 25-902995-0

Reference Books:

1. Singh Shailendra Cloud Computing Oxford University Press, ISBN: 978- 0199477388

2. Cloud Computing: A Practical Approach, Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill,rp2011.

3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, SPD, rp 2011.

4. Cloud Computing and SOA Convergence in Your Enterprise A Step-by-Step Guide by David S. Linthicum from Pearson 2010

7. Course Outcomes

ID	Statement	Action Verb	Knowledge Level
CY-703.1	Define the fundamental concepts, essential characteristics, and deployment models of cloud computing, and identify the prerequisite networking and operating-system foundations required for cloud services.	Define	Remember
CY-703.2	Explain the principles of	Explain	Understand

	virtualization, including hypervisor categories, virtual-machine lifecycle, containerization, and differentiate major IaaS platforms such as OpenStack, VMware vCloud, and public-cloud offerings.		
CY-703.3	Apply knowledge of cloud service models (IaaS, PaaS, SaaS, and emerging models) to design a cloud-based solution that meets given functional and non-functional requirements, incorporating appropriate SLA metrics and service-catalog selections.	Apply	Apply
CY-703.4	Analyze security, risk, and compliance considerations for a specified cloud architecture, assessing threats, IAM controls, encryption mechanisms, and relevant standards (ISO 27001, GDPR, HIPAA, PCI-DSS).	Analyze	Analyze
CY-703.5	Evaluate cost-benefit, performance, and monitoring data to optimize resource scheduling, auto-scaling, and disaster-recovery strategies for a cloud environment, producing a justified recommendation report.	Evaluate	Evaluate
CY-703.6	Create a comprehensive seven-step cloud migration plan that integrates security hardening, governance policies, and emerging technologies (edge computing, serverless, inter-cloud orchestration), and defend the chosen migration strategy with quantitative analysis.	Create	Create

8. CO-PO Mapping

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

CO6	3	3	3	3	3	2	2	2	3	3	3	3

9. CO-PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	2
CO3	2	2	3
CO4	3	2	3
CO5	2	1	2
CO6	3	3	3

Dr. B. C. Roy Engineering College, Durgapur

Department of CSE(AIML)

Field	Details
Course Name	Adhoc Sensor Network
Course Code	CY-704
Semester	7
Course Category	Open Elective Courses
Credits	3
Hours per Week	3L:0T:0P

1. Prerequisites

• Fundamentals of Computer Networks (OSI/TCP-IP stack, basic routing and transport concepts)

• Basic Wireless Communications and Signal Processing (propagation models, modulation, antenna basics)

• Programming proficiency in C/Python and familiarity with Linux/embedded development environments

2. Course Learning Objectives

• Enable students to critically analyze the fundamental principles, challenges, and emerging trends of wireless, ad-hoc, and sensor networking technologies, including IoT, edge computing, and AI-driven self-configuration.

• Guide learners in designing, evaluating, and optimizing MAC, routing, and transport protocols for highly dynamic, resource-constrained wireless environments, with emphasis on power-awareness, QoS, and scalability.

• Develop the ability to apply advanced techniques--such as machine learning, software-defined networking, and blockchain--to enhance security, reliability, and performance of ad-hoc and sensor networks.

• Foster proficiency in using contemporary simulation and development platforms (e.g., NS-3, TinyOS/nesC, TOSSIM) to prototype, test, and benchmark network solutions across diverse application domains.

• Cultivate a systems-level perspective that integrates theoretical knowledge with practical case studies, preparing students to devise innovative, real-world solutions for applications like disaster response, smart agriculture, and industrial IoT.

3. Teaching Methodology

• Lectures and Presentations

• Interactive Discussions and Case Studies

• Lab Sessions

• Guest Lectures

4. Evaluation System

Activities	Class Test Full marks	Assignment Full marks	Attendance Full marks	Total Marks
CIA-1	25	10	5	40
CIA-2	25	10	5	40
End Semester Examination (ESE)	–	–	–	60
Total				100

5. Course Modules

Module	Topics	Hours
1	**Foundations of Wireless and Ad-Hoc Networks** - Fundamentals of wireless communication	6

	technology - Characteristics of the wireless channel (path loss, fading, interference) - Introduction to ad-hoc wireless networks and their key components - Core issues in ad-hoc networks: hidden terminal, scalability, high-mobility suitability - Power-aware concepts and basic power-management strategies - Self-organization, self-configuration and auto-configuration mechanisms - Basic Quality-of-Service (QoS) provisioning concepts - Overview of IoT, edge computing and AI-driven network self-configuration basics	
2	**MAC-Layer Design for Ad-Hoc Wireless Networks** - Design goals and constraints for MAC protocols in ad-hoc environments - Classification of MAC protocols * Contention-based MAC * Reservation-based MAC * Scheduling-based MAC * Directional-antenna MAC * Multichannel MAC - Influence of physical-layer characteristics on MAC design - Power-aware MAC techniques (duty-cycling, adaptive transmission power) - QoS provisioning at the MAC layer (latency, fairness, throughput) - Machine-learning assisted MAC scheduling and channel selection - SDN-oriented MAC control for flexible resource management	7
3	**Routing in Mobile Ad-Hoc Networks (MANETs)** - Routing fundamentals and design issues for highly dynamic topologies - Classification of routing protocols * Proactive (table-driven) - e.g., DSDV * Reactive (on-demand) - e.g., AODV, DSR * Hybrid - e.g., ZRP - Topology-based vs. position-based routing approaches - Opportunistic routing concepts and basic techniques - Power-aware and loop-free routing mechanisms - Reinforcement-learning and AI-enabled routing decisions	8

	- Scalability and high-mobility considerations - Broadcast storm mitigation and multicast/geocast strategies - Security aspects of routing (secure routing basics, cooperation, intrusion detection)		
4	**Transport-Layer and End-to-End Issues in Ad-Hoc Networks** - TCP protocol overview and operation - Challenges of TCP in MANETs (loss vs. mobility, congestion control) - TCP adaptations for ad-hoc environments (TCP-Westwood, TCP-Veno, ACK-based schemes) - General transport-layer solutions for reliable delivery and flow control - Transport-layer security and reliability requirements - IoT-focused transport protocols (CoAP, MQTT) and their use over ad-hoc links - AI-assisted loss prediction and lightweight reliability mechanisms	5	
5	**Wireless Sensor Networks: Architecture, Protocols & Platforms** - Introduction to wireless sensor networks (WSNs) and typical use cases - Sensor node architecture and hardware (Mica mote, transceiver design, energy consumption) - Design issues for WSNs: energy budgeting, clustering, dynamic adaptation - Energy-harvesting techniques and low-power hardware trends - Programming platforms (TinyOS, nesC, TinyGALS) and edge-AI processing on nodes - Simulation tools (NS-2/NS-3 sensor extensions, TOSSIM) - MAC protocols for WSNs * Low-duty-cycle & wake-up (S-MAC, Mediation Device Protocol) * Contention-based (PAMAS) * Schedule-based (LEACH, IEEE 802.15.4 MAC) - Routing protocols for WSNs * Energy-efficient routing * Geographic routing * AI-driven data-aggregation and routing optimisation - Data retrieval, high-level application support and integration with IoT platforms - Classification of WSNs and typical network scenarios	8	
6	**Security, Evaluation & Applications of Ad-Hoc**	8	

	and Sensor Networks - Security threats and attacks in ad-hoc and sensor networks (jamming, tampering, black-hole, flooding, etc.) - Key management and distribution mechanisms suitable for resource-constrained nodes - Secure routing protocols (e.g., SPINS) and AI-enhanced secure routing concepts - Intrusion detection systems and cooperative defence mechanisms - AI-based anomaly detection and machine-learning driven IDS - Countermeasures and mitigation techniques for identified attacks - Network design and performance evaluation (node placement, topology design, routing-table analysis, metrics) - Comparison with other network types (cellular, WMNs, mesh networks) - Real-world applications and case studies (disaster response, smart agriculture, industrial IoT) - Emerging trends: blockchain for trust management, software-defined networking, AI-enabled network optimisation	

6. References

Textbooks:

1. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks Architectures and Protocols", Second Edition, Pearson Publication, Reprinted in 2015.

2. Holger Karl and Andreas Willig,"Protocol and Architecture for Wireless Sensor Networks", First Edition, John wiley publication, Reprinted in 2011.

Reference Books:

1. Fei Hu, Xiaojun Cao and Auerbach," Wireless Sensor Networks -- Principles and Practice," CRC Press, Taylor & Francis Group, 2010.

2. Raheem Beyah, Janise McNair and Cherita Corbett. "Security in Ad hoc and Sensor Networks" World Scientific Publications / Cambridge University Press, 2010

7. Course Outcomes

ID	Statement	Action Verb	Knowledge Level
CY-704.1	Identify and describe the fundamental concepts of wireless communication, the characteristics of the wireless channel, and the basic components and QoS requirements of ad-hoc and IoT-edge networks.	Identify	Remember
CY-704.2	Apply power-aware MAC design techniques to implement a contention-based or reservation-based MAC protocol and evaluate its latency, throughput and fairness under varying mobility and interference conditions.	Apply	Apply
CY-704.3	Analyze and compare proactive, reactive, hybrid, and AI-enhanced routing protocols for MANETs, selecting the most suitable approach for a given high-mobility scenario and justifying the choice with performance metrics.	Analyze	Analyze
CY-704.4	Design a transport-layer solution that adapts TCP (or an IoT-focused protocol such as CoAP/MQTT) for reliable end-to-end delivery in mobile ad-hoc environments, incorporating AI-based loss prediction to improve congestion control.	Design	Create
CY-704.5	Evaluate wireless sensor network architectures and protocols by building a simulation model (using NS-3/TOSSIM) that measures energy consumption, data aggregation efficiency, and AI-driven routing optimisation across diverse deployment scenarios.	Evaluate	Evaluate
CY-704.6	Synthesize a comprehensive security framework for ad-hoc and sensor networks that integrates key management, secure routing, and AI-based intrusion-detection mechanisms, and assess its effectiveness through quantitative threat-mitigation metrics.	Synthesize	Create

8. CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	1	1	1	1	2	1	2
CO2	3	2	3	3	3	1	1	1	2	2	2	2
CO3	2	3	2	3	2	1	1	1	2	2	1	2
CO4	3	2	3	3	3	1	1	1	2	2	2	2
CO5	2	2	2	3	3	1	2	1	2	2	2	2
CO6	3	2	3	3	3	2	1	3	2	2	2	2

9. CO-PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	1	2	1
CO2	1	2	1
CO3	3	2	1
CO4	3	3	2
CO5	3	3	1
CO6	3	3	2