

**Curriculum  
Doctor of Philosophy  
in  
Information Technology  
(2026)**



**Rawalpindi Women University, Rawalpindi**

## Table of Contents

|                                                                                          |          |
|------------------------------------------------------------------------------------------|----------|
| Rawalpindi Women University Vision.....                                                  | iii      |
| Rawalpindi Women University Mission Statement.....                                       | iii      |
| Department Mission Statement.....                                                        | iii      |
| <b>1. Curriculum for Doctor of Philosophy in Information Technology (PhD (IT)) .....</b> | <b>1</b> |
| 1.1 Program Vision.....                                                                  | 1        |
| 1.2 Program Mission.....                                                                 | 1        |
| 1.3 Eligibility Criteria.....                                                            | 1        |
| 1.4 Degree Duration.....                                                                 | 1        |
| 1.5 Degree Completion Requirements.....                                                  | 1        |
| 1.6 Program Objectives and Outcomes.....                                                 | 1        |
| <b>2. Area Covered in PHD (IT) Program.....</b>                                          | <b>2</b> |
| <b>3. Scheme of Study of PhD Information Technology in the light of HEC Curriculum .</b> | <b>2</b> |
| <b>4. Course Outlines.....</b>                                                           | <b>5</b> |

## **Rawalpindi Women University Vision**

Empowering women through education, critical thinking and innovation for a better tomorrow.

## **Rawalpindi Women University Mission Statement**

Rawalpindi Women University aims to promote a robust learning environment with focus on humanitarian norms and cultural values where innovative research blends with effective learning to ensure a contributory role in society.

## **Department Mission Statement**

To deliver high-quality education in information technology, inspiring women to excel as innovative professionals, researchers, and ethical contributors to the global IT industry. By promoting economic independence, sustainable practices, and lifelong learning, the department aims to prepare students for dynamic challenges in technology-driven fields

# **1. Curriculum for Doctor of Philosophy in Information Technology (PhD (IT))**

## **1.1 Program Vision**

The vision of PHD (IT) program is to bridge the gap by producing qualified manpower for expansion and growth of software industry in Pakistan which will play a key role for the socio-economic uplift of the country. PHD (IT) Program offers an opportunity for the computer professionals to grab jobs in the software industry, academia, and research-oriented organizations

## **1.2 Program Mission**

PHD (IT) Program is aimed to create, expand, disseminate, and teach the IT body of knowledge through academics, applications, and research, which positively influence society locally, nationally, and internationally.

## **1.3 Eligibility Criteria**

The minimum requirements for admission in a PHD (IT) degree program are:

A degree earned after eighteen years of education (MS/M.Phil degree program, minimum 30 credit hours) in Computer Science/Information Technology/Software Engineering / Computer Engineering or equivalent qualification, earned from a recognized university after 18 years of education with at least CGPA of at least 2.5 (on a scale of 4.0). GRE/HAT (General) test with a 60% score or university admission test with a minimum of 60% score and interview shall only be considered for qualifying for admission and shall not contribute to the final merit list.

Note: "Eligibility criteria for admissions can be updated according to RWU policy"

## **1.4 Degree Duration**

The Ph.D. degree shall be awarded by the universities not before the completion of three years or six regular semesters and not after the completion of eight years or 16 regular semesters, save exceptions mentioned in the HEC Graduate Education Policy.

## **1.5 Degree Completion Requirements**

To become eligible for award of PhD degree, a student must satisfy the following requirements:

- a. Passed totaling at least 18 credit hours and Passing Viva Voce examination.
- b. Must have earned CGPA (Cumulative Grade Point Average) of at least 3.0 on a scale of 4.
- c. For award of PhD degree, a PhD researcher shall be required to publish research articles according to the RWU Postgraduate policy.
- d. Passing Viva Voce examination

## **1.6 Program Objectives and Outcomes**

The PHD (IT) comprises of both course work as well as research components. There are four 'core courses' aimed at strengthening the understanding and competence of students in information technology fundamentals. The University expects its PhD graduates to pursue careers either as 'IT Faculty Members' or as 'IT Scientists' in the industry.

### **Learning Outcomes:**

1. Students will be able to possess advanced knowledge of IT field
2. Students will be able to think creatively and critically; to solve non-trivial problems

3. Students will be able to use computing knowledge to develop efficient solutions for real life problems
4. Students will be able to design solutions and can conduct research related activities

## 2. Area Covered in PHD (IT) Program

| Course Group              | Credit Hours |
|---------------------------|--------------|
| Mandatory Course          | 02           |
| Elective                  | 18           |
| Research Thesis           |              |
| <b>Total Credit Hours</b> | <b>18</b>    |

## 3. Scheme of Study of PhD Information Technology in the light of HEC Curriculum

| First Year                |                     |           |             |                     |           |
|---------------------------|---------------------|-----------|-------------|---------------------|-----------|
| Semester I                |                     |           | Semester II |                     |           |
| S. No.                    | Course Title        | Cr. Hrs   | S. No.      | Course Title        | Cr. Hrs   |
| 1                         | XX XXX              | 3         | 1           | XX XXX              | 3         |
| 2                         | XX XXX              | 3         | 2           | XX XXX              | 3         |
| 3                         | CS 811              | 3         | 3           | XX XXX              | 3         |
| 4                         | UHQ-101/<br>ETH-103 | 1         | 4           | UHQ-102/<br>ETH-104 | 1         |
| Total                     |                     | <b>10</b> | Total       |                     | <b>10</b> |
| <b>Total Credit Hours</b> | <b>20</b>           |           |             |                     |           |

### Second Year

|                            |                                                 |
|----------------------------|-------------------------------------------------|
| <b>Comprehensive Exam</b>  | Within one year after completion of course work |
| <b>Synopsis Submission</b> | Within first six semesters                      |

**IT- 899 (Research Thesis)**

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### 3.1 Mandatory Course (3 Credit Hours)

| # | Code                 | Course Title                            | Credit hours |
|---|----------------------|-----------------------------------------|--------------|
| 1 | UHQ-101 /<br>ETH-103 | Understanding of Quran-I/<br>Ethics-I   | 1            |
| 2 | UHQ-102 /<br>ETH-104 | Understanding of Quran-II/<br>Ethics-II | 1            |

### 3.2 Tentative Elective Courses (15 Credit Hours)

| Sr. No. | Course Code | Course Title                                                  | Credit Hours |
|---------|-------------|---------------------------------------------------------------|--------------|
| 1.      | IT-811      | Special Topics Information Security and Assurance             | 3            |
| 2.      | IT-812      | Special Topics Information Technology Infrastructure          | 3            |
| 3.      | IT-813      | Special Topics Cloud Computing                                | 3            |
| 4.      | IT-814      | Special Topics Mathematical Methods of Information Technology | 3            |
| 5.      | IT-801      | Special Topics Ubiquitous Computing                           | 3            |
| 6.      | IT-802      | Special Topics Database Management System                     | 3            |
| 7.      | IT-815      | Special Topics Wireless Sensor Networks                       | 3            |
| 8.      | IT-816      | Special Topics Internet of Things                             | 3            |
| 9.      | IT-817      | Advance Software Defined Networking                           | 3            |
| 10.     | CS-812      | Advanced Topics in Requirement Engineering                    | 3            |
| 11.     | CS-813      | Advanced Topics in Global Software Development                | 3            |
| 12.     | CS-814      | Advanced Software Quality Engineering                         | 3            |
| 13.     | CS-815      | Advanced Topics in Software Project Management                | 3            |
| 14.     | CS-821      | Advanced Image Processing                                     | 3            |
| 15.     | CS-822      | Advanced Computer Vision                                      | 3            |
| 16.     | CS-823      | Deep Learning Topics in Computer Vision                       | 3            |
| 17.     | CS-831      | Advanced Topics in Artificial Intelligence                    | 3            |
| 18.     | CS-832      | Advanced Deep Learning                                        | 3            |
| 19.     | CS-833      | Advanced Natural Language Processing                          | 3            |
| 20.     | CS-834      | Advanced Machine Learning                                     | 3            |
| 21.     | CS-835      | Evolutionary Computing & Swarm Intelligence                   | 3            |
| 22.     | CS-841      | Advanced Topics in Computer Networks                          | 3            |
| 23.     | CS-842      | Advanced Security Management and Cryptography                 | 3            |
| 24.     | CS-843      | Advanced Topics in Distributed Systems                        | 3            |
| 25.     | IT-899      | Research Thesis                                               | 6            |

**Note:** Above mentioned is the proposed list from the pool of CS/IT Elective courses. The electives can be offered from the above-mentioned courses but not limited to only these. Any new course can be offered/added with the approval of BoS.

## 4. Course Outlines

**Department:** Information Technology

**Course Title:** Special Topics Information Security and Assurance

**Course Code:** IT-811

**Credit Hours:** 03

**Pre-requisite:** None

### Course Objectives

- To introduce students to the foundational concepts of information security, its goals, and assurance techniques.
- To explore different types of threats, vulnerabilities, and controls used to safeguard information systems.
- To understand cryptographic principles and protocols for securing communication and data.
- To analyze security policies, risk management techniques, and incident response processes.
- To enable students to assess and enhance the security posture of information systems.

### Learning Outcomes

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

1. Understand core concepts and principles of information security, including confidentiality, integrity, and availability. (C2 Understand)
2. Identify and assess different types of security threats and vulnerabilities. (C4 Analyze)
3. Apply appropriate security controls and countermeasures for protecting assets. (C3 Apply)
4. Evaluate the effectiveness of security policies, risk management, and compliance strategies. (C5 Evaluate)
5. Explain cryptographic algorithms and use them to secure communication. (C2 Understand)
6. Develop incident response plans and business continuity strategies. (C6 Create)

### Course Outline

#### Unit 1: Introduction to Information Security

- Definition and importance of information security
- Security goals: Confidentiality, Integrity, Availability (CIA triad)
- Threats, vulnerabilities, and risk
- Security policies, procedures, and awareness
- Security governance and compliance (ISO 27001, NIST)

#### Unit 2: Cryptography and Secure Communication

- Basics of cryptography: symmetric and asymmetric encryption
- Block ciphers (AES, DES), RSA, Diffie-Hellman
- Hashing functions: SHA-2, SHA-3, MD5
- Digital signatures, certificates, and Public Key Infrastructure (PKI)
- SSL/TLS and secure communication protocols

#### Unit 3: Access Control and Authentication

- Identification, authentication, and authorization
- Access control models: DAC, MAC, RBAC, ABAC
- Biometrics, smart cards, OTP, MFA
- Directory services and single sign-on (SSO)

- Identity and Access Management (IAM)

#### **Unit 4: Network and System Security**

- Network security fundamentals (firewalls, IDS/IPS, VPNs)
- Securing operating systems and applications
- Wireless network security (WPA3, EAP)
- Endpoint protection and anti-malware solutions
- Secure software development (DevSecOps, SDLC)

#### **Unit 5: Security Risk Management**

- Risk analysis and management process
- Threat modeling and vulnerability assessment
- Penetration testing and ethical hacking basics
- Business impact analysis (BIA)
- Security audits and assurance frameworks

#### **Unit 6: Incident Response and Disaster Recovery**

- Phases of incident response
- Computer forensics basics
- Business continuity planning (BCP)
- Disaster recovery strategies and tools
- Legal, ethical, and compliance issues in incident handling

#### **Unit 7: Security in Emerging Technologies**

- Cloud security challenges and controls (CSA, shared responsibility)
- IoT security and privacy
- Security in virtualization and container environments
- Blockchain and decentralized security models
- Artificial intelligence in cybersecurity

#### **Unit 8: Case Studies and Current Trends**

- Security breaches and lessons learned
- Industry standards and certifications (CISSP, CISM, CEH)
- Data privacy laws (GDPR, HIPAA, etc.)
- Cybersecurity strategies for organizations
- Latest research directions in security and assurance

#### **Recommended Books / Reference Material**

1. Stallings, W. (2018). Cryptography and Network Security, 7th Edition, Pearson.
2. Whitman, M., & Mattord, H. (2021). Principles of Information Security, 7th Edition, Cengage Learning.
3. Pfleeger, C. P., & Pfleeger, S. L. (2015). Security in Computing, 5th Edition, Pearson.
4. Anderson, R. (2020). Security Engineering: A Guide to Building Dependable Distributed Systems, 3rd Edition, Wiley.
5. NIST Special Publications (SP800 series), ISO/IEC 27000 series.
6. Online Resources: OWASP, SANS Institute, CIS Controls, CSA Security Guidance.

**Department:** Information Technology

**Course Title:** Special Topics Information Technology Infrastructure

**Course Code:** IT-812

**Credit Hours:** 03

**Pre-requisite:** None

### **Course Objectives**

- To provide foundational and advanced knowledge of the components and architecture of IT infrastructure.
- To understand the role of IT infrastructure in supporting business operations and enterprise systems.
- To analyze the deployment, management, and evolution of infrastructure services such as networking, computing, and storage.
- To explore cloud computing, virtualization, and data center technologies as part of modern IT infrastructure.
- To develop strategies for planning, implementing, and maintaining reliable, scalable, and secure infrastructure environments.

### **Learning Outcomes**

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

1. Describe the components of IT infrastructure and their roles in enterprise computing. (C2 Understand)
2. Evaluate different computing architectures including centralized, distributed, and cloud-based models. (C5 Evaluate)
3. Analyze network and storage technologies used in IT environments. (C4 Analyze)
4. Apply principles of virtualization and systems management to infrastructure planning. (C3 Apply)
5. Design and assess infrastructure for scalability, availability, and disaster recovery. (C6 Create)
6. Demonstrate understanding of current trends such as software-defined infrastructure and hybrid cloud. (C2 Understand)

### **Course Outline**

#### **Unit 1: Introduction to IT Infrastructure**

- Definition and scope of IT infrastructure
- Evolution of infrastructure models (on-premise to hybrid/cloud)
- Components: servers, storage, networking, OS, middleware
- IT infrastructure in enterprise environments
- ITIL and service-oriented infrastructure management

#### **Unit 2: Data Centers and Virtualization**

- Data center components and architecture
- Server virtualization (Hypervisors: Type I and Type II)
- Storage virtualization and network virtualization
- Benefits and challenges of virtualization
- Virtualization tools (VMware, Hyper-V, KVM)

#### **Unit 3: Networking in IT Infrastructure**

- Network fundamentals: LAN, WAN, switching, routing
- TCP/IP stack, DNS, DHCP, NAT, VPNs

- Network security: firewalls, IDS/IPS, NAC
- Software Defined Networking (SDN) overview
- Network infrastructure management and monitoring

#### **Unit 4: Storage and Backup Systems**

- Storage architectures: DAS, NAS, SAN
- RAID levels and data redundancy
- Backup strategies and disaster recovery
- Storage management and capacity planning
- Emerging trends in storage: Object storage, S3, NVMe

#### **Unit 5: Cloud and Hybrid Infrastructure**

- Cloud service models: IaaS, PaaS, SaaS
- Cloud deployment models: public, private, hybrid, multi-cloud
- Cloud infrastructure platforms: AWS, Azure, GCP
- Virtual private clouds and container orchestration (Docker, Kubernetes)
- Cost models, SLAs, and compliance in cloud infrastructure

#### **Unit 6: Infrastructure Security and Management**

- Infrastructure security challenges and solutions
- Identity and access management (IAM)
- Patch management and configuration control
- Monitoring tools (Nagios, Zabbix, Prometheus)
- Infrastructure automation with scripts and tools (Ansible, Terraform)

#### **Unit 7: Planning and Architecting IT Infrastructure**

- Business requirements analysis
- Infrastructure lifecycle management
- High availability and failover design
- Capacity planning and scalability
- Case studies of enterprise infrastructure design

#### **Unit 8: Trends and Future Directions**

- Software-defined everything (SDx)
- Edge computing and fog computing
- Green IT and sustainable infrastructure
- IT infrastructure in smart cities and IoT ecosystems
- Infrastructure as Code (IaC) and DevOps integration

#### **Recommended Books / Reference Material**

1. Olson, D. (2020). IT Infrastructure Architecture – Infrastructure Building Blocks and Concepts.
2. Forouzan, B. A. (2017). Data Communications and Networking, 5th Edition, McGraw-Hill.
3. Erl, T., Mahmood, Z., & Puttini, R. (2013). Cloud Computing: Concepts, Technology & Architecture, Prentice Hall.
4. Silberschatz, A., Galvin, P. B., & Gagne, G. (2020). Operating System Concepts, Wiley.
5. Nelson, R., & Phillips, A. (2021). Guide to Computer Network Security, Springer.
6. ITIL Foundation resources (AXELOS) and online labs/documentation for AWS, Azure, VMware.

**Department:** Information Technology  
**Course Title:** Special Topics Database Management System  
**Course Code:** IT-802  
**Credit Hours:** 03  
**Pre-requisite:** Database Management Systems (DBMS)

### **Course Objectives**

- To provide advanced knowledge of database design, modeling, and implementation techniques.
- To explore emerging database technologies including distributed, NoSQL, and big data systems.
- To develop skills for handling complex queries, transaction management, and database optimization.
- To understand the architecture and challenges of managing large-scale data.
- To expose students to real-world use cases involving performance tuning, indexing, and secure database systems.

### **Learning Outcomes**

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

1. Explain advanced database concepts such as query optimization, transaction processing, and concurrency control. (C2 Understand)
2. Apply normalization, indexing, and optimization techniques to design efficient databases. (C3 Apply)
3. Analyze and manage distributed databases, NoSQL systems, and big data frameworks. (C4 Analyze)
4. Evaluate performance issues and suggest tuning strategies for SQL and NoSQL databases. (C5 Evaluate)
5. Design and implement secure and scalable data-driven applications. (C6 Create)
6. Demonstrate familiarity with advanced data models and emerging trends in data management. (C2 Understand)

### **Course Outline**

#### **Unit 1: Advanced Relational Database Concepts**

- Extended ER model and object-relational mapping
- Relational algebra review and optimization
- SQL: advanced queries (views, triggers, stored procedures, recursive queries)
- Indexing and hashing techniques
- Query processing and evaluation

#### **Unit 2: Database Design and Optimization**

- Functional dependencies and multivalued dependencies
- Advanced normalization (BCNF, 4NF, 5NF)
- Denormalization and physical design
- Query optimization strategies
- Cost-based optimization and execution plans

#### **Unit 3: Transaction Management**

- Transaction properties (ACID)

- Concurrency control mechanisms: locking protocols, timestamp ordering
- Serializability and conflict resolution
- Recovery system: log-based recovery, checkpoints
- Deadlock handling in DBMS

#### **Unit 4: Distributed and Parallel Databases**

- Distributed DBMS architecture and design
- Data fragmentation, replication, and allocation
- Distributed query processing
- Distributed transaction management and concurrency
- Parallel databases and performance issues

#### **Unit 5: NoSQL and Emerging Database Models**

- Limitations of relational model
- Introduction to NoSQL (Key-Value, Document, Column-family, Graph databases)
- Case studies: MongoDB, Cassandra, Neo4j
- Query languages for NoSQL
- CAP theorem and BASE properties

#### **Unit 6: Data Warehousing and OLAP**

- Data warehouse architecture and schemas (star, snowflake)
- ETL processes and tools
- OLAP operations: slicing, dicing, roll-up, drill-down
- Materialized views and cube computation
- Data mining integration

#### **Unit 7: Big Data and Cloud Databases**

- Hadoop ecosystem (HDFS, MapReduce)
- Introduction to Hive, Pig, and Spark SQL
- Cloud databases: characteristics and examples (Amazon RDS, Google BigQuery)
- Scalable storage systems (HBase, DynamoDB)
- Data consistency models in the cloud

#### **Unit 8: Security, Privacy, and Advanced Topics**

- Database security challenges and access control models
- Encryption, auditing, and user privilege management
- SQL injection and mitigation
- Temporal, spatial, and multimedia databases
- Trends: Data lakes, data mesh, blockchain databases

#### **Recommended Books / Reference Material**

1. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2020). Database System Concepts, 7th Edition, McGraw-Hill.
2. Elmasri, R., & Navathe, S. B. (2017). Fundamentals of Database Systems, 7th Edition, Pearson.
3. Cattell, R. (2011). Scalable SQL and NoSQL Data Stores, ACM Computing Surveys.
4. Harrison, G. (2015). Next Generation Databases: NoSQL, NewSQL, and Big Data. Apress.
5. Sadalage, P. J., & Fowler, M. (2012). NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. Addison-Wesley.

6. White, T. (2015). Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media.

**Department:** Information Technology

**Course Title:** Advance Mathematical Methods of Information Technology

**Course Code:** IT-814

**Credit Hours:** 03

**Pre-requisite:** None

### **Course Objectives**

- To provide foundational and advanced mathematical techniques required for solving problems in Information Technology.
- To enhance students' analytical skills and logical reasoning capabilities for application in IT-related domains.
- To introduce discrete mathematics, probability, linear algebra, graph theory, and optimization techniques.
- To build a mathematical framework for understanding algorithms, data structures, networks, and machine learning.
- To apply mathematical models to real-world IT problems including system modeling, decision making, and performance analysis.

### **Learning Outcomes**

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

1. Understand and apply discrete structures, set theory, and logic to formalize computing problems. (C2 Understand)
2. Apply linear algebra concepts to data representation and transformation in computing systems. (C3 Apply)
3. Analyze algorithms using combinatorics and probability theory. (C4 Analyze)
4. Utilize graph theory for modeling computer networks, trees, and relationships. (C4 Analyze)
5. Solve real-world IT problems using optimization and decision-making techniques. (C5 Evaluate)
6. Construct and interpret mathematical models for various applications in data science and systems design. (C6 Create)

### **Course Outline**

#### **Unit 1: Foundations of Discrete Mathematics**

- Sets, relations, and functions
- Logic and propositional calculus
- Predicate logic and quantifiers
- Mathematical induction and recursion
- Proof techniques: direct, contradiction, contrapositive

#### **Unit 2: Linear Algebra for IT**

- Matrices and matrix operations
- Systems of linear equations
- Vector spaces, basis, and dimension
- Eigenvalues and eigenvectors
- Applications in computer graphics, machine learning, and data science

### **Unit 3: Combinatorics and Probability**

- Counting principles, permutations, and combinations
- Binomial theorem and Pascal's triangle
- Basics of probability theory and distributions
- Conditional probability and Bayes' theorem
- Applications in algorithm analysis and information theory

### **Unit 4: Graph Theory and Trees**

- Basic concepts of graphs, types, and representations
- Trees, spanning trees, BFS, DFS
- Shortest path algorithms (Dijkstra, Floyd-Warshall)
- Graph coloring, planarity, and connectivity
- Applications in computer networks and social networks

### **Unit 5: Optimization and Linear Programming**

- Introduction to optimization and operations research
- Linear programming models and graphical method
- Simplex method and duality theory
- Integer programming and applications in resource allocation
- Introduction to dynamic programming and greedy algorithms

### **Unit 6: Advanced Topics and Applications**

- Boolean algebra and switching functions
- Markov chains and queuing theory
- Fuzzy logic and its IT applications
- Information theory and entropy
- Mathematical modeling in software reliability and performance evaluation

### **Recommended Books / Reference Material**

1. Kenneth H. Rosen (2019). Discrete Mathematics and Its Applications, 8th Edition, McGraw-Hill.
2. Gilbert Strang (2016). Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press.
3. Sheldon Ross (2014). A First Course in Probability, 9th Edition, Pearson.
4. C. L. Liu (2000). Elements of Discrete Mathematics, McGraw-Hill.
5. Wayne L. Winston (2004). Operations Research: Applications and Algorithms, Duxbury Press.
6. Kanti Swarup, Gupta & Man Mohan (2006). Operations Research, Sultan Chand & Sons.

**Department:** Information Technology

**Course Title:** Special Topics in Ubiquitous Computing

**Course Code:** IT-801

**Credit Hours:** 03

**Pre-requisite:** None (recommended: Computer Networks, Operating Systems, and Mobile Computing)

### **Course Objectives**

- To explore the fundamental principles, architectures, and enabling technologies of **ubiquitous/pervasive computing systems**.
- Equip students with the ability to **design, develop, and evaluate context-aware applications** for smart environments.
- Develop understanding of **context modeling, sensor-based systems, human-computer interaction, mobile and embedded systems**, and **privacy** in pervasive computing.
- Encourage critical thinking to assess the **socio-technical implications** of ubiquitous computing in real-world applications like smart homes, healthcare, retail, and urban systems.
- Provide hands-on experience in building prototypes using **IoT devices, context-aware systems**, and **middleware frameworks**.

## Learning Outcomes

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

1. Explain the architecture and design challenges of ubiquitous computing systems. (C2 Understand)
2. Apply models and frameworks for **context awareness** and **adaptive systems**. (C3 Apply)
3. Design and prototype **smart environment applications** using sensors and embedded systems. (C6 Create)
4. Evaluate privacy, ethical, and security concerns in pervasive computing. (C5 Evaluate)
5. Analyze key protocols, middleware, and system software enabling ubiquitous computing. (C4 Analyze)
6. Integrate ubiquitous computing solutions with **cloud, edge, and mobile platforms**. (C3 Apply)
7. Conduct research or case studies on **cutting-edge applications** in domains like health, smart cities, and intelligent transportation systems. (P4 Articulation)

## Course Outline

### Unit 1: Introduction to Ubiquitous Computing

- History and vision (Mark Weiser's vision)
- Characteristics and key features of ubiquitous systems
- Applications in healthcare, transportation, smart homes, retail, and education
- Ubiquitous vs. pervasive vs. mobile computing

### Unit 2: Context-Awareness and Smart Environments

- Definition of context and context modeling
- Context acquisition, reasoning, and management
- Context-aware systems and adaptive behavior
- Smart spaces and ambient intelligence
- User modeling and personalization

### Unit 3: System Architecture and Middleware

- Architectures for ubiquitous systems
- Middleware and platforms for context-aware computing (e.g., Context Toolkit, OpenIoT)
- Service discovery, messaging, and device interoperability
- Edge, fog, and cloud integration

#### Unit 4: Sensing, Communication, and Device Integration

- Sensor types and their applications (wearable, ambient, mobile)
- Embedded systems and hardware platforms (Arduino, Raspberry Pi, ESP32)
- Communication protocols: Bluetooth, ZigBee, MQTT, CoAP, LoRa
- Energy efficiency and mobility management

#### Unit 5: Security, Privacy, and Ethical Issues

- Threats and risks in ubiquitous computing
- Data protection and anonymization
- User consent and ethical data collection
- Case studies: surveillance, location tracking, and health monitoring

#### Unit 6: Emerging Trends and Case Studies

- Ubiquitous AI and machine learning for context prediction
- Brain-computer interfaces (BCI)
- Digital twins and ubiquitous simulation
- Case studies in smart cities, precision agriculture, assisted living
- Research trends and future directions

#### Recommended Books / Reference Material

1. Krumm, J. (2018). Ubiquitous Computing Fundamentals (2nd Edition). CRC Press.
2. Poslad, S. (2011). Ubiquitous Computing: Smart Devices, Environments and Interactions. Wiley.
3. Cook, D. J., & Das, S. K. (2012). Smart Environments: Technology, Protocols and Applications. Wiley.
4. Want, R., & Schilit, B. (2021). Ubiquitous Computing (Foundations and Trends in Human–Computer Interaction).
5. Journal articles from IEEE Pervasive Computing, ACM Ubicomp Conference, and Springer Smart Environments series.

**Department:** Information Technology

**Course Title:** Special Topics in Cloud Computing

**Course Code:** IT-813

**Credit Hours:** 03

**Pre-requisite:** Computer Networks, Operating Systems, and Distributed Systems (recommended)

#### Course Objectives

- Introduce fundamental principles and architectures of **cloud computing**, including virtualization, service models, deployment models, and resource management.
- Provide understanding of **cloud infrastructure**, data storage, and distributed computing technologies used in large-scale enterprise and scientific applications.
- Enable students to evaluate **cloud services**, platforms, and **security frameworks** in real-world contexts.
- Equip students with knowledge to **design scalable, fault-tolerant cloud applications** using industry-standard tools and platforms.
- Stimulate research on emerging topics such as **serverless computing, edge computing, and container orchestration**.

#### Learning Outcomes

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

1. Explain the core concepts, architectures, and models in cloud computing. (C2 Understand)
2. Analyze different cloud service models (IaaS, PaaS, SaaS) and deployment types (public, private, hybrid). (C4 Analyze)
3. Design and evaluate **scalable and elastic cloud-based systems**. (C6 Create)
4. Compare and apply **virtualization and containerization** technologies for resource abstraction and optimization. (C3 Apply)
5. Address challenges in **cloud security, identity management, and compliance**. (C5 Evaluate)
6. Explore the integration of cloud computing with **big data, AI/ML, and IoT**. (P4 Articulation)
7. Critically assess future directions in **edge computing, multi-cloud systems, and serverless computing**. (C6 Create)

## Course Outline

### Unit 1: Introduction to Cloud Computing

- History and evolution of cloud computing
- Key characteristics and benefits
- Service models: IaaS, PaaS, SaaS
- Deployment models: Public, Private, Hybrid, Community
- Case studies of popular providers (AWS, Azure, GCP)

### Unit 2: Cloud Architecture and Virtualization

- Cloud architecture and components
- Virtualization: hypervisors (Xen, KVM, VMware), containers (Docker, LXC)
- Resource provisioning and elastic scaling
- Infrastructure orchestration: OpenStack, Kubernetes, Terraform (overview)

### Unit 3: Cloud Storage and Data Management

- Cloud storage models: block, object, and file storage
- Distributed file systems (HDFS, GFS)
- Data consistency and availability (CAP theorem, eventual consistency)
- NoSQL databases in the cloud (MongoDB, Cassandra)

### Unit 4: Cloud Application Development and Platforms

- Platform as a Service (PaaS)
- Cloud-native application design
- Serverless computing and Function-as-a-Service (AWS Lambda, Azure Functions)
- Microservices and 12-factor applications
- DevOps in the cloud (CI/CD pipelines)

### Unit 5: Security and Privacy in Cloud Computing

- Threats, vulnerabilities, and risk analysis
- Identity and access management (IAM)
- Data encryption at rest and in transit
- Regulatory compliance (GDPR, HIPAA)
- Multi-tenancy and isolation

## Unit 6: Emerging Trends and Case Studies

- Edge and fog computing
- Multi-cloud and hybrid cloud management
- Green cloud computing and sustainability
- AI/ML on the cloud: managed services
- Case studies in healthcare, finance, education, and government
- Research directions in cloud federation and cloud standardization

## Recommended Books / Reference Material

1. Rajkumar Buyya, Christian Vecchiola, & S. Thamarai Selvi. Mastering Cloud Computing (Morgan Kaufmann, 2013).
2. Thomas Erl. Cloud Computing: Concepts, Technology & Architecture (Prentice Hall, 2013).
3. George Reese. Cloud Application Architectures (O'Reilly, 2009).
4. Toby Velte, Anthony Velte, & Robert Elsenpeter. Cloud Computing: A Practical Approach (McGraw-Hill, 2010).
5. Journal articles from IEEE Cloud Computing, ACM Digital Library, and Springer Cloud Computing journals.
6. Documentation from AWS, Microsoft Azure, and Google Cloud Platform.

**Department:** Information Technology

**Course Title:** Special Topics in Wireless Sensor Networks

**Course Code:** IT-815

**Credit Hours:** 03

**Pre-requisite:** Computer Networks, Embedded Systems (recommended)

## Course Objectives

- Introduce students to the fundamentals of **wireless sensor networks (WSNs)** including architecture, design, protocols, and real-world applications.
- Enable students to design, develop, and analyze **WSN systems** using simulation tools and analytical methods.
- Cover communication protocols, energy efficiency, and scalability challenges specific to **resource-constrained wireless devices**.
- Provide insight into WSN security, data aggregation, and integration with IoT and cloud platforms.
- Stimulate research thinking on **adaptive, self-organizing, and intelligent sensor networks**.

## Learning Outcomes

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

1. Explain the architecture, operation, and characteristics of wireless sensor networks. (C2 Understand)
2. Analyze communication protocols for medium access control, routing, and transport layers in WSNs. (C4 Analyze)
3. Model and simulate WSN deployments using appropriate tools. (P2 Manipulation)
4. Evaluate WSN performance in terms of latency, power consumption, coverage, and reliability. (C5 Evaluate)
5. Design and propose efficient sensor network architectures for specific applications. (C6 Create)

6. Understand WSN security concerns and apply basic cryptographic and data protection techniques. (C3 Apply)
7. Explore integration of WSNs with **IoT, Edge Computing, and Cloud Services**. (P4 Articulation)

## **Course Outline**

### **Unit 1: Introduction to Wireless Sensor Networks**

- Overview and applications of WSNs
- Comparison with traditional networks
- Challenges in WSNs: energy, memory, computation, latency
- Sensor node architecture and components
- Network architecture and design goals

### **Unit 2: Medium Access Control (MAC) Protocols**

- MAC challenges in WSNs
- Energy-efficient MAC protocols
- S-MAC, T-MAC, B-MAC
- Adaptive duty-cycling techniques
- TDMA and contention-based access schemes

### **Unit 3: Routing Protocols**

- Routing challenges and metrics in WSNs
- Flat routing: Directed Diffusion, Rumor Routing
- Hierarchical routing: LEACH, TEEN, PEGASIS
- Location-based routing: GEAR, GAF
- Data-centric vs. address-centric routing

### **Unit 4: Localization, Time Synchronization & Coverage**

- Node localization techniques (GPS-free)
- Time synchronization protocols: TPSN, RBS
- Coverage models and connectivity
- Mobility in WSNs
- Sensor deployment strategies

### **Unit 5: Power Management and Energy Harvesting**

- Energy-efficient communication
- Sleep/wake scheduling
- Energy-aware routing and MAC
- Energy harvesting techniques
- Battery models and lifetime prediction

### **Unit 6: Security and Fault Tolerance in WSNs**

- Threats and attacks on WSNs
- Lightweight cryptographic techniques
- Key management in resource-constrained environments
- Secure routing and data aggregation
- Fault detection and recovery strategies

## **Unit 7: WSN Platforms, Programming & Simulation**

- Sensor operating systems: TinyOS, Contiki
- WSN programming models
- Simulation tools: NS-3, Cooja, TOSSIM
- Performance evaluation metrics
- Case studies on environmental monitoring, smart agriculture, military systems

## **Unit 8: Advanced Topics and Research Trends**

- Wireless Body Area Networks (WBANs)
- Integration with Internet of Things (IoT)
- Cognitive WSNs
- Mobile sink strategies and delay-tolerant WSNs
- WSN in smart cities and edge computing environments

## **Recommended Books / Reference Material**

1. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2005.
2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, Wireless Sensor Networks: Technology, Protocols, and Applications, Wiley, 2007.
3. Bhaskar Krishnamachari, Networking Wireless Sensors, Cambridge University Press, 2005.
4. C. Siva Ram Murthy and B. S. Manoj, Ad Hoc Wireless Networks: Architectures and Protocols, Pearson, 2004.
5. Research papers from IEEE Sensors Journal, ACM Transactions on Sensor Networks, and Ad Hoc Networks (Elsevier).
6. Online documentation of TinyOS, Contiki, and NS-3.

**Department:** Information Technology

**Course Title:** Special Topics in Internet of Things

**Course Code:** IT-815

**Credit Hours:** 03

**Pre-requisite:** Computer Networks, Embedded Systems (recommended)

## **Course Objectives**

- Introduce the foundational concepts of the Internet of Things (IoT), including architecture, devices, communication protocols, and data handling.
- Enable students to design, implement, and evaluate IoT systems using sensors, actuators, and microcontrollers.
- Cover end-to-end IoT solutions involving data collection, cloud integration, analytics, and real-time decision-making.
- Explore industry use-cases and research challenges in IoT across domains like smart homes, healthcare, agriculture, and industry.
- Equip students with the tools and techniques required to prototype IoT systems and integrate them with modern cloud and edge platforms.

## **Learning Outcomes**

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

1. Explain the architecture and components of IoT systems. (C2 Understand)
2. Identify and evaluate appropriate communication technologies and protocols for IoT. (C3 Apply)

3. Analyze and implement data acquisition and transmission in resource-constrained environments. (P2 Manipulation)
4. Develop and simulate IoT applications using microcontrollers and software frameworks. (C6 Create)
5. Design secure and scalable IoT systems integrated with edge/cloud computing platforms. (P4 Articulation)
6. Evaluate societal, ethical, and environmental implications of IoT deployments. (C5 Evaluate)

## **Course Outline**

### **Unit 1: Introduction to IoT**

- Definition and scope
- History, evolution, and trends
- Characteristics of IoT systems
- IoT reference architecture
- IoT vs. traditional embedded systems vs. cyber-physical systems

### **Unit 2: IoT Hardware and Device Platforms**

- Microcontrollers (Arduino, ESP32, Raspberry Pi)
- Sensors and actuators: interfacing and control
- Device communication and power management
- GPIO, I2C, SPI, UART interfaces

### **Unit 3: Communication and Networking in IoT**

- Network layer protocols: IPv6, 6LoWPAN
- Data link protocols: ZigBee, BLE, LoRaWAN, NB-IoT
- Transport protocols: MQTT, CoAP, AMQP
- Edge computing and fog computing

### **Unit 4: Data Acquisition and Processing**

- Analog to digital conversion
- Signal processing for sensor data
- Real-time data transmission
- Local vs. remote processing (edge vs. cloud)

### **Unit 5: IoT Platforms and Cloud Integration**

- Overview of cloud services for IoT (AWS IoT, Google IoT Core, Azure IoT Hub)
- Data ingestion pipelines
- Storage, visualization, and dashboard tools
- RESTful APIs and webhooks

### **Unit 6: Security and Privacy in IoT**

- Vulnerabilities in IoT devices
- Data encryption and secure communication
- Identity and access management
- Blockchain in IoT
- Case studies: DDoS via IoT, firmware attacks

## **Unit 7: Industrial and Research Applications of IoT**

- Smart homes and buildings
- Smart cities and transportation
- Industrial IoT (IIoT) and Industry 4.0
- Healthcare and wearable technology
- Precision agriculture

## **Unit 8: Recent Trends and Challenges**

- AIoT – Artificial Intelligence in IoT
- Interoperability and standardization
- Energy-efficient networking
- Legal, ethical, and environmental considerations
- Future research directions in IoT

## **Recommended Books / Reference Material**

1. Pethuru Raj, Anupama C. Raman. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.
2. Arshdeep Bahga, Vijay Madisetti. Internet of Things: A Hands-On Approach, VPT, 2014.
3. Adrian McEwen and Hakim Cassimally. Designing the Internet of Things, Wiley, 2013.
4. Dieter Uckelmann et al. Architecting the Internet of Things, Springer, 2011.
5. Jan Holler et al. From Machine-to-Machine to the Internet of Things, Elsevier, 2014.
6. Research papers from IEEE IoT Journal, ACM Transactions on IoT, and relevant conference proceedings.
7. Online documentation for platforms like AWS IoT Core, Google Cloud IoT, Node-RED, and Arduino IDE.

**Department:** Information Technology

**Course Title:** Advance Software Defined Networks

**Course Code:** IT-817

**Credit Hours:** 03

**Pre-requisite:** Computer Networks

## **Course Objectives**

- To introduce the motivation, principles, and architecture of Software Defined Networking (SDN).
- To understand the separation of control and data planes and how SDN enables network programmability.
- To familiarize students with SDN controllers, southbound and northbound APIs, and OpenFlow protocol.
- To explore SDN use-cases in data centers, cloud computing, and WANs.
- To analyze security, scalability, and performance issues in SDN-based architectures.
- To develop the ability to simulate and experiment with SDN tools and platforms.

## **Learning Outcomes**

After completing this course, students will be able to:

1. Explain the need for and advantages of Software Defined Networking. (C2 Understand)
2. Differentiate between traditional and SDN architectures. (C3 Apply)

3. Design and configure SDN networks using appropriate protocols and platforms. (P2 Manipulation)
4. Use SDN controllers and APIs to program network behavior. (C4 Analyze)
5. Evaluate and apply SDN solutions to real-world networking problems. (C5 Evaluate)
6. Investigate security, scalability, and fault tolerance in SDN environments. (C6 Create)

## **Course Outline**

### **Unit 1: Introduction to SDN**

- Traditional networking vs. SDN
- Control plane vs. data plane
- Benefits and challenges of SDN
- SDN architecture and layers
- Centralized vs. distributed control

### **Unit 2: OpenFlow and Southbound Interfaces**

- Introduction to OpenFlow
- Flow tables and match-action rules
- OpenFlow protocol versions
- Packet processing and forwarding
- Switch-controller communication

### **Unit 3: SDN Controllers**

- Role of controllers in SDN
- Centralized and distributed controllers
- Popular SDN controllers: Ryu, ONOS, OpenDaylight, Floodlight
- Controller-to-device (southbound) and controller-to-app (northbound) APIs
- Controller clustering and scalability

### **Unit 4: Northbound APIs and Network Programming**

- Need for northbound APIs
- RESTful APIs and SDKs
- Network programmability with Python/Java
- Policy definition and enforcement
- Intent-based networking

### **Unit 5: SDN Applications and Use Cases**

- Traffic engineering and load balancing
- Network function virtualization (NFV)
- Security: firewalls, DDoS detection
- Data center networking
- SDN in ISPs, cloud providers, and enterprise networks

### **Unit 6: SDN Virtualization and Emulation**

- Network slicing and virtualization
- Overlay networks and tunneling (VXLAN, GRE)
- Tools for SDN simulation and emulation: Mininet, GNS3, NS-3
- SDN in containerized and virtualized environments (Docker, Kubernetes)

## **Unit 7: Security and Fault Tolerance in SDN**

- Threats and attack surfaces in SDN
- Secure controller-switch communication
- Authentication and authorization in SDN
- Controller failure and recovery
- Trust and verification frameworks

## **Unit 8: Research Trends and Future of SDN**

- SDN and 5G
- SD-WAN
- AI/ML for SDN
- Open standards and open-source SDN
- Future challenges and emerging trends

## **Recommended Books / Reference Material**

1. Kreutz, D., Ramos, F. M. V., Verissimo, P., Rothenberg, C. E., Azodolmolky, S., & Uhlig, S. (2015). Software-Defined Networking: A Comprehensive Survey. IEEE Communications Surveys & Tutorials.
2. Feamster, N., Rexford, J., & Zegura, E. (2014). The Road to SDN: An Intellectual History of Programmable Networks. ACM SIGCOMM.
3. Thomas D. Nadeau, Ken Gray. SDN: Software Defined Networks. O'Reilly Media, 2013.
4. Paul Goransson, Chuck Black, Timothy Culver. Software Defined Networks: A Comprehensive Approach, 2nd Edition, Morgan Kaufmann, 2016.
5. Mininet documentation and OpenFlow specifications (<https://www.opennetworking.org/>).
6. Research papers from IEEE, ACM, and Elsevier on SDN technologies and use cases.

## **Course Title: Research Methodology**

**Course Code:** CS-811

**Credit Hours:** 03

**Pre-Requisite:** Nil

### **Objectives**

This course equips students with essential research skills for academic and applied computer science research. It covers research paradigms, qualitative and quantitative methods, research design, ethics, data collection and analysis, and scholarly writing. Emphasis is placed on producing research proposals and critically evaluating existing literature.

### **Learning Outcomes (Aligned with Bloom's Taxonomy)**

By the end of this course, students will be able to:

- Identify and explain various research paradigms and methodologies (Knowledge, Comprehension).
- Critically evaluate scholarly literature (Analysis).

- Design a research study including problem formulation, hypothesis development, and methodology (Application, Synthesis).
- Apply qualitative and quantitative data collection and analysis techniques (Application).
- Compose a comprehensive research proposal and academic writing (Synthesis, Evaluation).
- Assess ethical issues in research and apply proper citation and referencing styles (Evaluation, Application).

## **Course Outline**

### **Unit 1:        Foundations of Research**

Scientific inquiry involves systematic investigation guided by different research paradigms like positivism and interpretivism. It uses **deductive reasoning** to test hypotheses and **inductive reasoning** to develop theories from observations. Research types include **basic research** to expand knowledge and **applied research** to solve practical problems. **Exploratory research** investigates new areas, while **descriptive research** focuses on detailing specific characteristics of a subject.

### **Unit 2:        Literature Review and Problem Identification**

Sources of literature and search strategies, Gap analysis, Formulating research questions and hypotheses.

### **Unit 3:        Research Design and Methodologies**

Qualitative, quantitative, and mixed-methods approaches, Experimental, survey, case study, ethnography, grounded theory ,Sampling methods and techniques

### **Unit 4:        Data Collection and Analysis**

Tools for qualitative and quantitative data collection, Interview and observation protocols Statistical tools (SPSS, R) Validity, reliability, and triangulation

### **Unit 5:        Writing and Presenting Research**

Structure of research proposals and papers Citation and referencing using APA  
Ethical considerations in research Peer-review process and academic publishing

## **Recommended Books / Reference Material (APA 6th Edition Style)**

1. Kumar, A., & Praveenakumar, S. G. (2025). Research methodology. Authors Click Publishing.
2. Susilawati, A., Al-Obaidi, A. S. M., Abduh, A., Irwansyah, F. S., & Nandiyanto, A. B. D. (2025). How to do research methodology: From literature review, bibliometric, step-by-step research stages, to practical examples in science and engineering education. Indonesian Journal of Science and Technology, 10(1), 1-40.
3. Marra, M., & Nielsen, B. B. (2025). Research methodology: Best practices for rigorous, credible, and Denscombe, M. (2025).
4. Decolonial research methodology: an assessment of the challenge to established practice. International Journal of Social Research Methodology, 28(2), 231-240. impactful research. Journal of International Business Studies, 1-3.

**Advanced Topics in Requirement Engineering**  
**PhD. Computer Science**  
**Course Code: CS-812**  
**Credit Hours: 03**

**Objectives**

This course provides an in-depth understanding of advanced concepts in requirements engineering (RE), a critical phase in the software development life cycle. Students will explore systematic techniques for eliciting, analyzing, documenting, validating, and managing software requirements in complex and evolving environments, with a focus on large-scale and global software systems. The course bridges theory with current research and industrial practices to prepare students for academic and applied research in RE.

**Learning Outcomes**

- Identify and classify various types of software requirements and apply elicitation techniques effectively (Knowledge, Application).
- Analyze stakeholder needs and model requirements using appropriate tools and techniques (Analysis, Application).
- Evaluate and validate requirements for correctness, consistency, completeness, and feasibility (Evaluation).
- Develop formal and semi-formal specifications of software systems (Synthesis, Application).
- Design and manage requirement change processes in dynamic and distributed

environments (Synthesis, Evaluation).

- Critically appraise current research trends and tools in advanced requirements engineering (Evaluation).

## **Course Outline**

### **Unit 1.        Fundamentals and Scope of Advanced Requirements Engineering**

Overview of RE phases and artifacts, Requirements in large-scale and distributed systems, Functional vs. non-functional requirements, Introduction to RE standards and frameworks (e.g., IEEE, ISO)

### **Unit 2.        Requirements Elicitation and Analysis**

Techniques: interviews, workshops, ethnography, prototyping, use case modeling, Requirements prioritization and negotiation, Stakeholder analysis and domain modeling, Cognitive and socio-technical aspects of elicitation.

### **Unit 3.        Requirements Specification and Modeling**

Natural language vs. formal specification, Use cases, user stories, and scenario-based modeling, UML, SysML, and goal-oriented requirements language (GRL), Formal methods: Z, Alloy, and temporal logic

### **Unit 4.        Validation, Verification, and Requirements Quality**

Validation and verification techniques, Requirements inspections, reviews, and testing Quality attributes of requirements (correctness, ambiguity, traceability, consistency), Tool support and automation for requirements validation

### **Unit 5.        Requirements Management and Evolving Systems**

Traceability, versioning, and configuration management Requirements change management in agile and DevOps Requirements reuse and patterns recent trends in RE research: AI-driven RE, requirements mining, and crowd-based requirements.

## **Recommended books/reference material**

1. Sommerville, I., & Sawyer, P. (2021). Requirements engineering: A good practice guide (2nd ed.). Wiley.
2. Hull, E., Jackson, K., & Dick, J. (2022). Requirements engineering (4th ed.). Springer.
3. Barbosa, L., Freire, S., Maciel, R. S., Mendonça, M., Kalinowski, M., Codabux, Z., & Spínola, R. (2025). Attributes of a great requirements engineer. *Journal of Systems and Software*, 219, 112200.
4. Cabrero-Daniel, B. (2025). How reliance on GenAI might limit human creativity and critical thinking in Requirements Engineering.
5. Chen, X., Hu, X., Huang, Y., Jiang, H., Ji, W., Jiang, Y., ... & Zhang, L. (2025). Deep learning-based software engineering: progress, challenges, and opportunities. *Science China Information Sciences*, 68(1), 1-88.

**Advanced Topics in Global Software Development**  
**PhD. Computer Science**  
**Course Code: CS-813**  
**Credit Hours: 03**

**Objectives**

This course explores the complexities and advanced practices of Global Software Development (GSD), where distributed teams collaborate across geographic, cultural, and organizational boundaries. It examines communication, coordination, collaboration, project management, process models, and socio-technical issues inherent in GSD. Emphasis is placed on empirical research, tool support, and strategies for managing quality, productivity, and innovation in global software engineering environments.

**Learning Outcomes**

- Explain the principles, challenges, and opportunities of global software development (Knowledge, Comprehension).
- Analyze socio-cultural, temporal, and organizational factors affecting GSD (Analysis).
- Evaluate coordination and communication strategies in distributed software teams (Evaluation).
- Design distributed team structures and processes to support global collaboration

(Synthesis, Application).

- Apply tools and best practices to manage global software projects effectively

(Application).

- Assess emerging research trends in GSD and formulate original research questions

(Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.        Foundations of Global Software Development**

Historical evolution and key concepts of GSD, GSD process models: outsourcing, offshoring, nearshoring, hybrid, Global development life cycle and collaboration models, Distributed Agile, Lean, and DevOps in GSD

### **Unit 2.        Communication and Coordination in Distributed Teams**

Communication theory and tools (synchronous, asynchronous) Cultural differences, language barriers, and trust building Coordination models and distributed team dynamics Role of boundary spanners and knowledge brokers

### **Unit 3.        Project Management and Governance in GSD**

Global project planning and tracking, Risk management in distributed settings

Contractual and regulatory compliance, Governance models and leadership in virtual teams

### **Unit 4.        Software Engineering Tools and Infrastructure for GSD**

Collaboration platforms (e.g., Jira, Confluence, GitHub, Slack, MS Teams) Distributed version control and CI/CD pipelines Infrastructure automation and cloud-based development environments Security and privacy in cross-border development

### **Unit 5.        Research, Trends, and Case Studies in GSD**

Empirical studies on success factors and failure modes Measurement and metrics in global projects Ethical issues and labor dynamics Recent research directions: AI in GSD, global innovation hubs, crowdsourcing

### **Recommended books/reference material**

1. Maidin, S. S., Yahya, N., bin Fauri Fauzi, M. A., & Bakar, N. S. A. A. (2025). Current and Future Trends for Sustainable Software Development: Software Security in Agile and Hybrid Agile through Bibliometric Analysis. *Journal of Applied Data Sciences*, 6(1), 311-324.
2. Kolawole, I., & Fakokunde, A. Machine Learning Algorithms in DevOps: Optimizing Software Development and Deployment Workflows with Precision. *Journal homepage: www.ijrpr.com* ISSN, 2582, 7421. Mockus, A., Herbsleb, J. D., & Damian, D. (Eds.). (2021). Collaborative software engineering in the age of global development. Springer.
3. Prikladnicki, R., Audy, J. L. N., & Evaristo, R. (2022). Global software engineering: Principles and practices. Springer.
4. Mishra, D. (2025). Developing a knowledge-based perspective of coordination in global software development. *VINE Journal of Information and Knowledge Management Systems*, 55(2), 287-309.
5. Zamir, S., Rehman, A., Mohsin, H., Zamir, E., Abbas, A., & Al-Yarimi, F. A. (2025). Integrating Pull Request Comment Analysis and Developer Profiles for Expertise-based Recommendations in Global Software Development. *IEEE Access*.

### **Advanced Software Quality Engineering** **PhD. Computer Science** **Course Code: CS-814** **Credit Hours: 03**

#### **Objectives**

This course provides an in-depth exploration of software quality assurance and engineering practices for building reliable, maintainable, and robust software systems. It covers advanced concepts in software testing, quality metrics, verification and validation, standards, process improvement models, and quality management in agile and DevOps environments. Students will engage with current research and tools to evaluate and improve software quality in real-world contexts.

#### **Learning Outcomes**

- Explain the theoretical foundations of software quality and its key dimensions (Knowledge, Comprehension).

- Design and apply advanced testing techniques to ensure functional and non-functional quality (Application, Analysis).
- Evaluate and integrate software quality models, standards, and frameworks (Evaluation).
- Apply software quality metrics and defect analysis in process improvement (Application).
- Critically analyze quality assurance strategies in modern software development paradigms (Analysis, Evaluation).
- Formulate research questions and conduct scholarly investigations in software quality engineering (Synthesis, Evaluation).

## **Course Outline**

### **Unit 1.        Software Quality Fundamentals**

Software quality is guided by models like McCall, Boehm, and ISO standards, focusing on dimensions such as functionality, reliability, and usability. Quality plays a vital role throughout the software development life cycle, especially in ensuring assurance for safety-critical systems.

### **Unit 2.        Advanced Testing Techniques**

Software testing includes unit, integration, system, and acceptance levels, using white-box and black-box strategies. Advanced methods like mutation, fuzz, regression, and model-based testing are supported by automation tools like Selenium, JUnit, and TestNG.

### **Unit 3.        Software Quality Standards and Models**

Software quality is guided by ISO/IEC standards and models like CMMI, SPICE, and TMMi, supported by practices such as Six Sigma and Lean. Risk-based quality management focuses on prioritizing testing and assurance based on potential impact.

### **Unit 4.        Metrics, Measurement, and Defect Analysis**

Software quality is measured using metrics like defect density, test coverage, and reliability, supported by code quality tools such as SonarQube and PMD. Root cause analysis and defect prevention, along with empirical evaluation, help improve software reliability and performance.

### **Unit 5.        Quality in Agile and DevOps Environments**

Agile testing and TDD enable continuous testing in CI/CD pipelines, supported by DevOps quality gates. Emerging trends include AI test generation and quality in cloud-native microservices.

### **Recommended books/reference material**

1. Advance Edgar-Nevill, V. M. A. (2025). Evaluation of the SEI software capability model within an information systems context; in pursuit of software quality. WIT Transactions on Information and Communication Technologies, 8.d Software Project Management.
2. Díaz, A., Alvarado-Valiente, J., Romero-Álvarez, J., Moguel, E., Garcia-Alonso, J., Rodríguez, M., & Murillo, J. M. (2025). Service engineering for quantum computing: Ensuring high-quality quantum services. Information and Software Technology, 179, 107643.
3. Alenezi, M., & Akour, M. (2025). AI-Driven Innovations in Software Engineering: A Review of Current Practices and Future Directions. Applied Sciences, 15(3), 1344.

## **Advanced Topics in Software Project Management**

**PhD. Computer Science**

**Course Code: CS-815**

**Credit Hours: 03**

### **Objectives**

This course provides an in-depth understanding of software project management (SPM) in contemporary software engineering environments. It focuses on advanced principles, methodologies, frameworks, and tools required to effectively initiate, plan, execute, monitor, control, and close software projects. Emphasis is placed on large-scale, agile, distributed, and AI-augmented project management practices supported by empirical studies and real-world case analyses.

### **Learning Outcomes**

- Demonstrate advanced knowledge of software project management concepts, standards, and lifecycles (Knowledge, Comprehension).
- Apply estimation, scheduling, and risk management techniques to real-world projects (Application).
- Analyze and manage project resources, budgets, and timelines using industry-standard tools (Analysis, Application).
- Evaluate software process models and assess their suitability for specific project environments (Evaluation).
- Design adaptive management strategies for agile, global, and AI-enabled projects

(Synthesis, Application).

- Critically assess contemporary research trends in software project management (Evaluation).

## **Course Outline**

### **Unit 1. Principles and Frameworks of Software Project Management**

Software projects follow lifecycle models like Waterfall, Agile, and Spiral, guided by standards such as PMBOK and PRINCE2. They focus on managing scope, time, cost, and quality, with key roles including project manager, product owner, and scrum master.

### **Unit 2. Estimation, Scheduling, and Risk Management**

Estimation methods like COCOMO II and Story Points aid planning, while Gantt charts and CPM track progress. Risk is managed through identification, mitigation, and Monte Carlo simulations.

### **Unit 3. Resource Allocation and Communication Management**

Effective teams rely on leadership, budgeting, communication, and conflict resolution for success.

### **Unit 4. Agile and Distributed Project Management**

Agile frameworks like Scrum and Kanban support team agility, with tools like Jira and Trello aiding backlog and progress tracking.

### **Unit 5. Advanced Topics and Research in Project Management**

Project analytics and AI enhance decision-making, while DevOps integrates with management to support innovation and change. Empirical research guides practices, considering ethics, legality, and sustainability in global projects.

## **Recommended books/reference material**

1. Alabi, A. A., Mustapha, S. D., & Akinade, A. O. (2025). Leveraging Advanced Technologies for Efficient Project Management in Telecommunications. risk management (Cioffi et al., 2021; Lee et al., 2020), 17, 49.

2. Layton, M. C., Ostermiller, S. J., & Kynaston, D. J. (2025). Agile project management for dummies. John Wiley & Sons.
3. Madauss, B. J. (2025). Project Management: A comprehensive description of Theory and Practice. Springer Nature.
4. Madanchian, M., & Taherdoost, H. (2025). Exploring the Landscape of Multicriteria Decision Making in Software Project Management: Trends, Challenges, and Future Directions. EAI Endorsed Transactions on Scalable Information Systems, 12(1).

## **Advanced Image Processing**

### **PhD. Computer Science**

**Course Code: CS-821**

**Credit Hours: 03**

#### **Objectives**

This course offers an in-depth understanding of the mathematical foundations, algorithms, and state-of-the-art methods in digital image processing. It emphasizes advanced techniques such as image enhancement, restoration, segmentation, morphological processing, and feature extraction, with applications in medical imaging, computer vision, satellite imagery, and machine perception. Students will also explore recent advancements driven by deep learning and high-performance computing.

#### **Learning Outcomes**

- Demonstrate a comprehensive understanding of advanced image processing techniques and theoretical foundations (Knowledge, Comprehension).
- Apply enhancement, transformation, and restoration techniques to improve image quality (Application).
- Analyze and implement segmentation, edge detection, and morphological processing algorithms (Analysis, Application).
- Evaluate image features and descriptors for object recognition and pattern analysis (Evaluation).
- Investigate deep learning-based image processing techniques and their real-world applications (Analysis, Synthesis).
- Conduct scholarly research by formulating and solving complex image processing problems (Synthesis, Evaluation).

## **Course Outline**

### **Unit 1.      Mathematical Foundations and Transformations**

Digital images use color models for representation, with convolution and filtering applied in spatial and frequency domains. Techniques like Fourier, DCT, and Wavelet Transforms analyze image features efficiently.

### **Unit 2.      Image Enhancement and Restoration**

Image enhancement uses histogram equalization and contrast stretching, while denoising applies filters like Gaussian and median. Restoration involves deblurring with Wiener and inverse filtering.

### **Unit 3.      Segmentation and Morphological Processing**

Segmentation uses thresholding, region growing, and clustering, while edge detection applies Sobel and Canny filters. Morphological operations like dilation and erosion refine image structures.

### **Unit 4.      Feature Extraction and Pattern Recognition**

Texture and shape analysis use GLCM, LBP, and Hough transform, while interest points are detected with SIFT and SURF for object classification and tracking.

### **Unit 5.      Deep Learning and Applications in Image Processing**

CNNs and auto encoders power segmentation (U-Net, Mask R-CNN), super-resolution, and style transfer, with applications in medical, biometric, satellite, and industrial imaging.

## **Recommended books/reference material**

1. Hu, L. S., Smits, M., Kaufmann, T. J., Knutsson, L., Rapalino, O., Galldiks, N., ... & Cha, S. (2025). Advanced imaging in the diagnosis and response assessment of high-grade glioma: AJR expert panel narrative review. *American Journal of Roentgenology*, 224(1), e2330612.
2. Schmitt, R., Reidler, P., Haas-Lützenberger, E., Ruettermann, M., & Hesse, N. (2025). Identification of degenerative precursors at the wrist with advanced imaging: current updates. *Journal of Hand Surgery (European Volume)*, 50(1), 15-26.
3. Yan, F., & Venegas-Andraca, S. E. (2025). Lessons from twenty years of quantum image processing. *ACM Transactions on Quantum Computing*, 6(1), 1-29.
4. Tao, Z., Hou, Z., Deng, Y., Zhang, D., & Qi, J. (2025). Quantitative evaluation of pyramid belt wear using light-reflection characteristic of agglomerate coating and image processing. *Measurement*, 242, 116048.

## **Advanced Computer Vision**

### **PhD. Computer Science**

**Course Code: CS-822**

**Credit Hours: 03**

#### **Objectives**

This course offers an advanced exploration of computer vision, focusing on the theoretical foundations, algorithmic approaches, and recent advancements in the field. Topics include image understanding, 3D reconstruction, motion analysis, object recognition, and deep learning-based vision systems. The course prepares students to develop sophisticated vision applications across domains such as robotics, autonomous systems, and multimedia.

#### **Learning Outcomes**

- Understand advanced concepts and mathematical models underlying computer vision (Knowledge, Comprehension).
- Apply feature detection, matching, and tracking algorithms for image and video analysis (Application).
- Analyze and implement 3D vision techniques including stereo vision and structure from motion (Analysis).
- Evaluate object recognition and scene understanding methods using classical and deep learning approaches (Evaluation).
- Design and develop vision algorithms for real-world applications (Synthesis, Application).

- Critically review recent research and propose innovative solutions to open challenges in computer vision (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.        Foundations of Computer Vision**

Image formation relies on camera models and calibration, using geometric transformations, filtering, and feature extraction alongside photometric and color constancy techniques.

### **Unit 2.        Feature Detection, Matching, and Tracking**

Interest points (Harris, SIFT) and feature matching support optical flow and motion estimation, while tracking uses algorithms like Kalman and particle filters.

### **Unit 3.        3D Reconstruction and Scene Geometry**

Stereo vision and disparity maps enable depth estimation using epipolar geometry and fundamental matrices, supported by structure from motion and point cloud processing.

### **Unit 4.        Object Recognition and Scene Understanding**

Object detection and classification use bag-of-words and deep features, while semantic segmentation and scene parsing rely on contextual reasoning and spatial relationships.

### **Unit 5.        Deep Learning in Computer Vision**

CNN architectures like AlexNet and ResNet excel in vision, with region-based models (R-CNN variants) for detection. Generative models (GANs, VAEs) advance tasks, while emerging research explores video, 3D vision, and explainability.

## **Recommended books/reference material**

1. De Pramudito, D. K., & Fatchan, M. (2025). Optimizing Image Recognition in Low-Light Environments through Advanced Computer Vision Algorithms. The Journal of Academic Science, 2(1), 278-289. ep Learning in Computer Vision.
2. Pramudito, D. K., & Fatchan, M. (2025). Optimizing Image Recognition in Low-Light Environments through Advanced Computer Vision Algorithms. The Journal of Academic Science, 2(1), 278-289.
3. Feng, Y., Wang, Q., Su, Y., Ma, W., Du, G., Wu, J., ... & Wang, Y. (2025). Application of artificial intelligence-based computer vision methods in liver diseases: a bibliometric analysis. Intelligent Medicine.

## **Deep Learning Topics in Computer Vision**

### **PhD. Computer Science**

#### **Course Code: CS-823**

#### **Credit Hours: 03**

#### **Objectives**

This course offers a comprehensive study of deep learning methods applied to computer vision problems. It covers state-of-the-art neural network architectures, training strategies, and practical applications such as image classification, object detection, segmentation, and generative models. Students will gain hands-on experience with frameworks and critically assess recent research to push the boundaries of visual understanding.

#### **Learning Outcomes**

- Explain the fundamental principles of deep learning and its relevance to computer vision (Knowledge, Comprehension).
- Implement convolutional neural networks (CNNs) and advanced architectures for image analysis (Application).
- Analyze and optimize deep learning models using regularization, normalization, and hyperparameter tuning (Analysis).
- Evaluate performance metrics and conduct error analysis on vision tasks (Evaluation).
- Design and develop deep learning solutions for complex vision applications including detection and segmentation (Synthesis, Application).
- Critically review current research trends and propose novel approaches in deep learning for vision (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.      Foundations of Deep Learning for Vision**

Neural networks use backpropagation with activation, loss, and optimization functions. CNNs consist of convolution, pooling, and fully connected layers, with transfer learning enabling fine-tuning.

### **Unit 2.      Advanced CNN Architectures**

VGG, ResNet, DenseNet, and Inception are popular CNNs, while EfficientNet and MobileNet suit resource-limited devices. Semantic segmentation uses FCN, U-Net, and DeepLab, with RNNs and attention enhancing vision tasks.

### **Unit 3.      Object Detection and Localization**

Region proposal methods power R-CNN models, while single-shot detectors like YOLO and SSD enable fast detection using anchor boxes, bounding box regression, and non-max suppression for real-time, multi-scale object detection.

### **Unit 4.      Generative Models and Vision Applications**

GANs and VAEs enable image generation, translation, style transfer, and super-resolution, with applications in medical imaging, autonomous vehicles, and surveillance.

### **Unit 5.      Training, Evaluation, and Research Trends**

Data augmentation and synthetic data improve training, while regularization techniques like dropout enhance model generalization. Evaluation uses metrics like accuracy and mAP, with growing focus on explainability, robustness, fairness, and emerging trends like self-supervised learning and vision transformers.

## **Recommended books/reference material**

1. Ataei, S., Adibnazari, S., & Ataei, S. T. (2025). Data-driven Detection and Evaluation of Damages in Concrete Structures: Using Deep Learning and Computer Vision. arXiv preprint arXiv:2501.11836.
2. Chollet, F. (2021). Deep learning with Python (2nd ed.). Manning Publications.
3. Redmon, J., & Farhadi, A. (2018). YOLOv3: An incremental improvement. arXiv preprint arXiv:1804.02767.

4. Lin, T.-Y., et al. (2017). Feature pyramid networks for object detection. CVPR.
5. Al-Zuriqat, T., Noufal, M., Peralta, P., Dragos, K., & Smarsly, K. (2025, July). Automated defect detection in fused filament fabrication coupling deep learning and computer vision. In Proceedings of the 2025 European Conference on Computing in Construction (EC3).
6. Upadhyay, A., Chandel, N. S., Singh, K. P., Chakraborty, S. K., Nandede, B. M., Kumar, M., ... & Elbeltagi, A. (2025). Deep learning and computer vision in plant disease detection: a comprehensive review of techniques, models, and trends in precision agriculture. Artificial Intelligence Review, 58(3), 1-64.
7. Xu, Y., Khan, T. M., Song, Y., & Meijering, E. (2025). Edge deep learning in computer vision and medical diagnostics: a comprehensive survey. Artificial Intelligence Review, 58(3), 1-78.

## **Advanced Topics in Artificial Intelligence**

### **PhD. Computer Science**

**Course Code: CS-831**

**Credit Hours: 03**

#### **Objectives**

This course provides a deep exploration of advanced artificial intelligence (AI) concepts, methodologies, and applications. It covers logical reasoning, knowledge representation, search algorithms, machine learning techniques, and contemporary AI paradigms including multi-agent systems and explainable AI. Students will analyze AI research trends and develop AI-driven solutions for complex real-world problems.

#### **Learning Outcomes**

- Understand advanced AI theories including logic, reasoning, and knowledge representation (Knowledge, Comprehension).
- Apply heuristic search, optimization, and learning algorithms to solve complex problems (Application).
- Analyze AI models in areas such as planning, natural language understanding, and multi-agent coordination (Analysis).
- Evaluate AI system performance and ethical considerations (Evaluation).
- Design intelligent agents and AI systems integrating multiple AI techniques (Synthesis,

Application).

- Critically review current research and propose innovations in AI (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.        Knowledge Representation and Logical Reasoning**

Logic, ontologies, and description logics support reasoning, while non-monotonic reasoning handles belief updates and revisions.

### **Unit 2.        Search and Optimization Algorithms**

Search strategies, CSPs, and optimization methods like genetic algorithms support problem-solving, while reinforcement learning enables decision-making from experience.

### **Unit 3.        Machine Learning and Probabilistic Models**

Supervised, unsupervised, and reinforcement learning cover key AI methods, with Bayesian networks and Markov models for probabilistic reasoning. SVMs and ensembles enhance performance, while deep learning integrates these for complex tasks.

### **Unit 4.        Multi-Agent Systems and Planning**

Agent architectures enable communication and coordination in distributed problem solving, supported by automated planning and scheduling, with game theory guiding negotiation strategies.

### **Unit 5.        Ethics, Explainability, and Emerging Trends**

Explainable AI ensures transparency, addressing ethics, bias, and fairness, while focusing on safety and robustness. Emerging trends include neurosymbolic AI, causal reasoning, and AI for social good.

### **Recommended books/reference material**

1. He, G., Li, Z., Zhu, Z., Han, T., Cao, Y., Chen, C., ... & Ni, D. (2025). CLP-Net: an advanced artificial intelligence technique for localizing standard planes of cleft lip and palate by three-dimensional ultrasound in the first trimester. *BMC Pregnancy and Childbirth*, 25(1), 10.
2. Farhadi Nia, M., Ahmadi, M., & Irankhah, E. (2025). Transforming dental diagnostics with artificial intelligence: advanced integration of ChatGPT and large language models for patient care. *Frontiers in Dental Medicine*, 5, 1456208.
3. Koller, D., & Friedman, N. (2020). *Probabilistic graphical models: Principles and techniques*. MIT Press.
4. Sutton, R. S., & Barto, A. G. (2018). *Reinforcement learning: An introduction* (2nd ed.). MIT Press.
5. Dhal, S. B., & Kar, D. (2025). Leveraging artificial intelligence and advanced food processing techniques for enhanced food safety, quality, and security: a comprehensive review. *Discover Applied Sciences*, 7(1), 1-46.

## **Advanced Deep Learning**

### **PhD. Computer Science**

#### **Course Code: CS-832**

#### **Credit Hours: 03**

### **Objectives**

This course provides an in-depth study of advanced deep learning techniques, architectures, and optimization strategies. It focuses on cutting-edge models such as generative adversarial networks, transformers, graph neural networks, and self-supervised learning. Students will develop skills to design, implement, and evaluate state-of-the-art deep learning solutions across diverse domains.

### **Learning Outcomes**

- Demonstrate advanced understanding of deep learning theory and architecture design (Knowledge, Comprehension).
- Implement and optimize complex neural networks including GANs, transformers, and graph neural networks (Application).
- Analyze the training dynamics and generalization properties of deep models (Analysis).

- Evaluate deep learning models using rigorous quantitative and qualitative metrics (Evaluation).
- Design innovative deep learning solutions tailored to real-world challenges (Synthesis, Application).
- Critically assess recent research literature and contribute original ideas to the field (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.      Advanced Neural Network Architectures**

Generative Adversarial Networks (GANs) and variants (DCGAN, CycleGAN, StyleGAN) Transformer architectures and attention mechanisms, Graph Neural Networks (GNNs) and applications, Capsule Networks and recurrent network advances

### **Unit 2.      Optimization and Regularization Techniques**

Advanced optimizers: AdamW, Ranger, Lookahead, Learning rate scheduling and warm restarts, Batch normalization, layer normalization, and dropout variants

Techniques to avoid overfitting and improve generalization

### **Unit 3.      Self-Supervised and Unsupervised Learning**

Contrastive learning (SimCLR, MoCo) and autoencoders (VAEs) advance representation learning, alongside clustering methods and emerging self-supervised techniques.

### **Unit 4.      Interpretability, Robustness, and Fairness**

Explainability tools like LIME and SHAP reveal model decisions, while adversarial defenses improve robustness against attacks and distribution shifts. Fairness focuses on detecting and mitigating bias in deep learning.

### **Unit 5.      Applications and Research Trends**

Deep learning advances NLP, vision, speech, and bioinformatics, with neural architecture search and AutoML optimizing models. Federated learning enhances privacy, while ongoing research tackles emerging challenges.

### **Recommended books/reference material**

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press.
2. Su, Z., Gu, S., Wang, J., & Lund, P. D. (2025). Improving ultra-short-term photovoltaic power forecasting using advanced deep-learning approach. Measurement, 239, 115405.
3. Bronstein, M. M., Bruna, J., LeCun, Y., Szlam, A., & Vandergheynst, P. (2017). Geometric deep learning: Going beyond Euclidean data. IEEE Signal Processing Magazine, 34(4), 18-42.
4. Zhou, S., Yang, D., Zhang, Z., Zhang, J., Qu, F., Punetha, P., ... & Li, N. (2025). Enhancing autonomous pavement crack detection: Optimizing YOLOv5s algorithm with advanced deep learning techniques. Measurement, 240, 115603.
5. Molnar, C. (2020). Interpretable machine learning. Lulu.com.

## **Advanced Natural Language Processing**

### **PhD. Computer Science**

**Course Code: CS-833**

**Credit Hours: 03**

### **Objectives**

This course provides a comprehensive study of advanced natural language processing (NLP) techniques, emphasizing deep learning methods, linguistic theory, and state-of-the-art applications. Topics include semantic parsing, language modeling, machine translation, and dialogue systems. Students will critically analyze recent research and develop sophisticated NLP systems for complex language understanding tasks.

### **Learning Outcomes**

- Demonstrate deep understanding of linguistic fundamentals and advanced NLP models (Knowledge, Comprehension).
- Apply neural architectures such as transformers and recurrent models for language processing tasks (Application).
- Analyze syntactic and semantic representations and their role in NLP systems (Analysis).
- Evaluate the performance of NLP models using appropriate metrics and error analysis (Evaluation).
- Design and implement advanced NLP solutions including dialogue systems and machine

translation (Synthesis, Application).

- Critically review current literature and propose research directions in NLP (Evaluation, Synthesis).

### **Course Outline**

#### **Unit 1.        Foundations of NLP and Linguistic Theory**

Language understanding involves syntax, semantics, and pragmatics, using morphological analysis, POS tagging, parsing, and word embeddings.

#### **Unit 2.        Language Modeling and Sequence Learning**

Statistical models and RNNs evolved to transformers with attention, powering pre-trained models like BERT and GPT.

#### **Unit 3.        Semantic Parsing and Understanding**

Semantic role labeling and frame semantics analyze meaning, while named entity recognition and coreference resolution track entities. Word sense disambiguation improves understanding, supported by knowledge graphs and ontologies.

#### **Unit 4.        Machine Translation and Dialogue Systems**

Machine translation uses statistical and neural methods with sequence-to-sequence models and attention. Dialogue systems can be retrieval-based or generative, evaluated by specialized metrics.

#### **Unit 5.        Advanced Topics and Research Trends**

Multilingual and low-resource NLP focus on fairness and explainability, leveraging few-shot and zero-shot learning. Emerging areas include prompt engineering, large language models, and ethics.

### **Recommended books/reference material**

1. Jurafsky, D., & Martin, J. H. (2022). Speech and language processing (3rd ed. draft). Pearson.

2. Goldberg, Y. (2022). Neural network methods for natural language processing (2nd ed.). Morgan & Claypool.
3. Manning, C. D., & Schütze, H. (2020). Foundations of statistical natural language processing. MIT Press.
4. Vaswani, A., et al. (2017). Attention is all you need. Advances in Neural Information Processing Systems.
5. Zhang, Y., & Yang, Q. (2021). A survey on multi-task learning. IEEE Transactions on Knowledge and Data Engineering, 34(12), 5586-5609.

**Advanced Machine Learning**  
**PhD. Computer Science**  
**Course Code: CS-834**  
**Credit Hours: 03**

**Objectives**

This course covers advanced machine learning concepts, algorithms, and theoretical foundations. It delves into supervised, unsupervised, and reinforcement learning, emphasizing probabilistic models, kernel methods, ensemble techniques, and recent deep learning advancements. Students will critically evaluate models and design scalable machine learning solutions for complex data-driven problems.

**Learning Outcomes**

- Comprehend advanced theoretical concepts in machine learning including probabilistic modeling and kernel methods (Knowledge, Comprehension).
- Apply sophisticated machine learning algorithms to real-world datasets (Application).
- Analyze model behavior, convergence, and generalization performance (Analysis).
- Evaluate machine learning models with rigorous metrics and validation techniques (Evaluation).
- Design innovative and efficient machine learning solutions integrating multiple approaches (Synthesis, Application).
- Critically review current research and contribute novel ideas to machine learning (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.      Advanced Supervised Learning**

Support vector machines and kernel tricks, Ensemble methods: boosting, bagging, random forests, Probabilistic classifiers and Bayesian methods

Model selection and hyperparameter optimization

### **Unit 2.      Unsupervised Learning and Dimensionality Reduction**

Clustering algorithms: spectral clustering, DBSCAN, hierarchical, Manifold learning and nonlinear dimensionality reduction, Latent variable models and mixture models Autoencoders and representation learning

### **Unit 3.      Probabilistic Graphical Models**

Bayesian networks and Markov random fields, Inference algorithms: exact and approximate, Structure learning and parameter estimation, Applications in vision, NLP, and bioinformatics

### **Unit 4.      Reinforcement Learning and Sequential Decision Making**

Markov decision processes (MDPs), Value iteration, policy iteration, Q-learning

Function approximation and deep reinforcement learning, Exploration-exploitation trade-offs and policy gradients

### **Unit 5.      Scalability, Robustness, and Research Frontiers**

Large-scale machine learning and distributed algorithms, Model interpretability and fairness, Robustness to adversarial examples, Recent advances: meta-learning, few-shot learning, causal inference

## **Recommended books/reference material**

1. Bishop, C. M. (2021). Pattern recognition and machine learning. Springer.
2. Murphy, K. P. (2023). Machine learning: A probabilistic perspective (adaptive ed.). MIT Press.
3. Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction (2nd ed.). MIT Press.
4. Mukesh, V. (2025). A Comprehensive Review of Advanced Machine Learning Techniques for Enhancing Cybersecurity in Blockchain Networks. Journal ID, 8736, 2145.

**Evolutionary Computing and Swarm Intelligence**  
**Computer Science**  
**Course Code: CS-835**  
**Credit Hours: 03**

**Objectives**

The course on Evolutionary Computing & Swarm Intelligence aims to equip PhD/MS students with a deep understanding of bio-inspired optimization techniques such as genetic algorithms, particle swarm optimization, ant colony optimization, and other evolutionary strategies. It focuses on the theoretical foundations, algorithm design, and practical applications in complex problem-solving. Students will explore convergence analysis, hybridization techniques, and real-world use cases in engineering, AI, and data science. The course also encourages critical evaluation and research in emerging trends within the domain.

**Learning Outcomes**

- Design and implement algorithms such as Genetic Algorithms, Particle Swarm Optimization, and Ant Colony Optimization.
- Critically analyze the performance of evolutionary and swarm-based methods compared to traditional optimization techniques.
- Apply EC and SI algorithms to solve real-world problems in machine learning, optimization, robotics, and complex systems.

**Course Outline**

**Unit 1.        Foundations of Evolutionary Computing**

Covers the principles of natural evolution, genetic algorithms, selection, crossover, mutation, and population-based optimization techniques.

**Unit 2.        Swarm Intelligence Techniques**

Introduces swarm-based methods like Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), focusing on decentralized behavior and collective learning.

**Unit 3.        Hybrid and Advanced Evolutionary Strategies**

Explores hybrid algorithms combining EC/SI with local search or machine learning techniques, along with advanced strategies like Differential Evolution and Evolution Strategies.

**Unit 4.      Applications in Real-World Domains**

Focuses on applying EC and SI algorithms to problems in machine learning, scheduling, robotics, and multi-objective optimization.

**Unit 5.      Performance Evaluation and Research Trends**

Covers convergence analysis, performance metrics, benchmarking, and current research directions including adaptive and parallel implementations.

**Recommended books/reference material**

1. "An Introduction to Genetic Algorithms" by Melanie Mitchell
2. "Swarm Intelligence: From Natural to Artificial Systems" by Eric Bonabeau, Marco Dorigo, and Guy Theraulaz

**Advanced Topics in Computer Networks**

**PhD. Computer Science**

**Course Code: CS-841**

**Credit Hours: 03**

**Objectives**

This course offers an advanced study of computer networking concepts, protocols, and architectures. It covers topics such as network design, performance analysis, security, and emerging technologies like software-defined networking and network function virtualization. Students will analyze complex networking problems and develop innovative solutions for scalable and secure networks.

**Learning Outcomes**

- Understand advanced concepts and protocols in computer networking (Knowledge, Comprehension).
- Apply network design principles and protocols for efficient communication (Application).
- Analyze network performance, reliability, and security issues (Analysis).

- Evaluate emerging network technologies and their impact on modern infrastructures (Evaluation).
- Design and implement advanced network architectures and security mechanisms (Synthesis, Application).
- Critically assess research literature and propose advancements in networking (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.        Advanced Network Architectures and Protocols**

TCP/IP and OSI models underpin networking, with QoS and MPLS managing traffic, while SDN offers flexible network control.

### **Unit 2.        Wireless and Mobile Networks**

Wireless communication includes mobile IP, ad hoc, and sensor networks, advancing toward 5G and beyond.

### **Unit 3.        Network Security and Privacy**

Cryptographic protocols and VPNs secure networks, while intrusion detection, DoS mitigation, and secure routing protect against attacks.

### **Unit 4.        Network Performance and Management**

Network monitoring tools analyze traffic and manage congestion, using protocols like SNMP for resource allocation and control.

### **Unit 5.        Emerging Trends and Research Topics**

NFV, IoT challenges, and edge computing drive research in automated, AI-powered networks.

## **Recommended books/reference material**

1. Tanenbaum, A. S., & Wetherall, D. J. (2022). Computer networks (6th ed.). Pearson.

2. Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson.
3. Kreutz, D., Ramos, F. M. V., Verissimo, P. E., Rothenberg, C. E., Azodolmolky, S., & Uhlig, S. (2015). Software-defined networking: A comprehensive survey. *Proceedings of the IEEE*, 103(1), 14-76.
4. Stallings, W. (2020). Network security essentials: Applications and standards (6th ed.). Pearson.
5. Misra, S., & Obaidat, M. S. (Eds.). (2021). Smart and resilient networks. Springer.

## **Advanced Security Management and Cryptography**

**PhD. Computer Science**

**Course Code: CS-842**

**Credit Hours: 03**

### **Objectives**

This course explores advanced concepts in security management and cryptography. It covers cryptographic algorithms, protocols, key management, security policies, risk assessment, and compliance. Students will learn to design secure systems, manage security infrastructure, and evaluate emerging threats and defenses in cybersecurity.

### **Learning Outcomes**

- Understand fundamental and advanced cryptographic principles and security management frameworks (Knowledge, Comprehension).
- Apply cryptographic algorithms and protocols to secure data and communications (Application).
- Analyze security policies, risk factors, and threat models (Analysis).
- Evaluate security mechanisms and compliance with standards and regulations (Evaluation).
- Design secure architectures and strategies for enterprise-level security management (Synthesis, Application).
- Critically review current research and emerging trends in cryptography and security management (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.      Foundations of Cryptography**

Cryptography uses symmetric/asymmetric encryption, hash functions, and digital signatures for security.

### **Unit 2.      Cryptographic Protocols and Key Management**

Key distribution, PKI, and protocols like SSL/TLS ensure secure communication, with quantum cryptography as a future approach.

### **Unit 3.      Security Management and Governance**

Security policies, risk management, incident response, and auditing ensure compliance with standards like ISO 27001 and NIST.

### **Unit 4.      Network and System Security**

Firewalls and IDS/IPS protect networks; access control manages identities, securing cloud and virtualization against malware.

### **Unit 5.      Emerging Trends and Research in Cryptography**

Post-quantum cryptography and blockchain enhance security, addressing privacy and IoT cyber-physical system challenges.

## **Recommended books/reference material**

1. Stallings, W. (2022). Cryptography and network security: Principles and practice (8th ed.). Pearson.
2. Paar, C., & Pelzl, J. (2019). Understanding cryptography: A textbook for students and practitioners (2nd ed.). Springer.
3. Bishop, M. (2020). Computer security: Art and science (2nd ed.). Addison-Wesley.
4. Schneier, B. (2015). Applied cryptography: Protocols, algorithms, and source code in C (20th anniversary ed.). Wiley.
5. Conti, M., Dehghantanha, A., Franke, K., & Watson, S. (2018). Internet of things security and forensics: Challenges and opportunities. Future Generation Computer Systems, 78, 544-546.

## **Advanced Topics in Distributed Systems**

### **PhD. Computer Science**

**Course Code: CS-843**

**Credit Hours: 03**

## **Objectives**

This course provides an in-depth exploration of distributed systems principles, design, and implementation. Topics include distributed algorithms, synchronization, fault tolerance, consistency models, and distributed file systems. Students will learn to design and analyze robust and scalable distributed applications and evaluate cutting-edge research in the field.

## **Learning Outcomes**

- Demonstrate understanding of fundamental concepts and architectures of distributed systems (Knowledge, Comprehension).
- Apply distributed algorithms and protocols to solve synchronization and coordination problems (Application).
- Analyze fault tolerance, consistency, and replication techniques in distributed environments (Analysis).
- Evaluate distributed system design choices for scalability, reliability, and performance (Evaluation).
- Design and implement complex distributed applications addressing real-world challenges (Synthesis, Application).
- Critically review contemporary research and propose innovative distributed systems solutions (Evaluation, Synthesis).

## **Course Outline**

### **Unit 1.        Introduction to Distributed Systems and Models**

Distributed systems are characterized by resource sharing, scalability, and fault tolerance, but face challenges like latency and coordination. They follow architectural models like client-server or peer-to-peer and use communication methods such as RPC and message passing. Design goals focus on balancing performance, reliability, and complexity.

### **Unit 2.        Synchronization and Coordination**

Distributed systems use logical and vector clocks to track event ordering, while mutual exclusion and election algorithms manage resource access and coordination. Consensus protocols like Paxos and Raft ensure agreement among nodes, and distributed transactions rely on concurrency control to maintain consistency across the system.

**Unit 3. Fault Tolerance and Reliability**

Distributed systems rely on failure models and fault tolerance techniques to ensure reliability, using replication strategies and consistency models like strong or eventual consistency. Checkpointing, recovery protocols, and Byzantine fault tolerance further enhance system resilience against failures and malicious behaviors.

**Unit 4. Distributed File Systems and Storage**

Distributed file systems are designed for scalability, fault tolerance, and high availability, as seen in systems like Google File System and Hadoop Distributed File System. These, along with NoSQL databases, rely on effective data consistency and partitioning strategies to manage distributed storage efficiently.

**Unit 5. Advanced Topics and Emerging Trends**

Cloud computing and virtualization play a key role in distributed systems by enabling flexible resource management and on-demand services. Emerging paradigms like edge and fog computing bring computation closer to data sources, reducing latency. Technologies such as blockchain and distributed ledgers enhance trust and transparency, though challenges like scalability, security, and energy efficiency remain critical research areas.

**Recommended books/reference material**

1. Tanenbaum, A. S., & Van Steen, M. (2022). Distributed systems: Principles and paradigms (3rd ed.). Pearson.
2. Coulouris, G., Dollimore, J., Kindberg, T., & Blair, G. (2019). Distributed systems: Concepts and design (5th ed.). Addison-Wesley.
3. Lynch, N. (2022). Distributed algorithms. Morgan Kaufmann.
4. Shapiro, M., Preguiça, N., Baquero, C., & Zawirski, M. (2011). Conflict-free replicated data types. Symposium on Self-Stabilizing Systems.
5. Rodrigues, R., & Raynal, M. (2020). Distributed computing: Fundamentals, simulations, and advanced topics. Springer.

- **Understanding of Quran/ Fehm e Quran**

**Course Title: Understanding of Quran - I**

**Course Code: UHQ-101**

**Credit Hours: 1**

**Contact Hours: 3 per week**

**Weeks: 15-16 (45-48 hours)**

**Pre-Requisites: Nill**

**Course Objectives:**

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammar, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly—without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

**Learning Outcomes:**

This course will enable the students to:

- Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
- Acquire a strong foundation for understanding long verses of the Quran with clarity.
- Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plurals through hundreds of Quranic sentences.
- Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.
- Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
- Understand at least 30 to 40 % of each page of the Holy Quran.

**Course Outline:**

**Unit 1: Simple Quranic Words**

Muallim ul Quran: Book 1: Unit: Lesson 1-19

- Unit 2:**        **Words that comes before (The simple Quranic words)**  
 Muallim ul Quran: Book 1: Unit#2: Lesson 1-13
- Unit 3:**        **Quranic words in terms of their relationship and characteristics**  
 Muallim ul Quran: Book 1: Unit#3: Lesson 1-10
- Unit 4:**        **Singular Pronouns**  
 Muallim ul Quran: Book 2: Unit#4: Lesson 1-17
- Unit 5:**        **Singular pronouns & Demonstrative Pronouns**  
 Muallim ul Quran: Book 2: Unit#5: Lesson 1-23
- Unit 6:**        **Present Tense**  
 Muallim ul Quran: Book 3: Unit#6: Lesson 1-5

**Reference Books:**

1- بشير، دكتور. عبید الرحمن - معلم القرآن - اسلام آباد: دار العلم، ۲۰۲۴. جلد ۱، ۲ & ۳

- **Ethics (in lieu of Understanding of Quran)**

**Course Title: Ethics-I**

**Course Code: ETH-103**

**Credit hours: 1**

**Contact Hours: 3 per week**

**Weeks: 15-16 (45-48 hours)**

**Pre-Requisites: Nil**

**Objectives**

Upon successful completion of the course, students will be able to know the basics of ethics, & know how to develop an ethical approach. Also, analyze the importance of ethical and ethical values for a human being. And identify the Semitic & Non-Semitic Religions. Moreover, develop the concept of Ethics in Semitic & Non-Semitic religions. Also, analyze the similarities and differences between ethical teachings of various religions.

**Learning Outcomes:**

- Students will be able to demonstrate their understanding about the concept of ethics & ethical approach.

- Analyze the difference between the concept of Ethics in Sematic and Non-Sematic religions.

### **Course Outline:**

#### **Unit 1: Introduction and Importance of Ethics & Basic Ethical Principles**

Definition of Ethics, Importance of Ethics, Beneficence, Non-maleficence, Autonomy, Justice as basic Ethical behaviors.

#### **Unit 2: Theories of Moral Standards**

Moral Standards as Law, Moral Standards as Pleasure, Moral standards as Perfection. (Theories of Various Philosopher such as Kant, Spencer, John S. Mackenzie etc)

#### **Unit 3: The concept of Ethics in Major Religions- Christianity, Judaism**

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

#### **Unit 4: The concept of Ethics in Major Religions- Hinduism & Buddhism**

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

#### **Unit 5: The concept of Ethics in Major Religions- Islam**

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

### **References/Recommended Books:**

#### **Books**

1. Davis, N.K. (2023). Elements of Ethics, Legare Street Press.
2. Edmonds, D. (2019). Ethics and the Contemporary World, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). The Encyclopedia of Religion and Ethics, Creative Media Partners, LLC
4. Robinson, D. Garratt C. (2008). Introducing Ethics-a Graphic Guide, Icon Books Ltd.Uk.
5. اخلاق اور فلسفہ اخلاق، سیوہاروی، حفظ الرحمن، ندوة المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

#### **Websites & Articles**

1. Articles on Ethics [www.infotracs-college.com](http://www.infotracs-college.com)
2. Brown. (2017). The ethical dimensions of Global Environmental Issues. American Academy of Arts and Sciences. Retrieved July 7, 2017 from amacad.org
3. Business Ethics Magazine [www.business-ethics.com/annual.htm](http://www.business-ethics.com/annual.htm)
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July 2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>

7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics [www.globalethics.org](http://www.globalethics.org)
9. Klimes, Rudolf e. (2000). Ethical Problems.
10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). "Philosophical Foundations for Global Journalism Ethics"  
Journal of Mass Media Ethics:20(1)

- **Understanding of Quran/ Fehm e Quran**

**Course Title: Understanding of Quran - II**

**Course Code: UHQ-102**

**Credit Hours: 1**

**Contact Hours: 3 per week**

**Weeks: 15-16 (45-48 hours)**

**Pre-Requisites: Nill**

**Course Objectives:**

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammer, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly—without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

**Learning Outcomes:**

This course will enable the students to:

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently

and then comprehend their interpretation.

**Course Outline:**

**Unit 1: Past Tense**

Muallim ul Quran: Book 4: Unit#7: Chapter 1: Lesson 1-9

**Unit 2: Past Tense**

Muallim ul Quran: Book 4: Unit#7: Chapter 2: Lesson 1-7

**Unit 3: Past Tense**

Muallim ul Quran: Book 4: Unit#7: Chapter 3: Lesson 1-9

**Unit 4: Past Tense**

Muallim ul Quran: Book 5: Unit#7: Chapter 4: Lesson 1-5

**Unit 5: Past Tense & Passive Voice**

Muallim ul Quran: Book 5: Unit#7: Chapter 5 - 9

**Unit 6: imperative Verbs for Singulars**

Muallim ul Quran: Book 6: Unit#8: Lesson 1-8

**Reference Books:**

1- بشير، دكتور. عبید الرحمن - معلم القرآن - اسلام آباد: دار العلم، ۲۰۲۴. جلد ۳، ۴، ۵، ۶

- **Ethics (in lieu of Understanding of Quran)**

**Course Title: Ethics-II**

**Course Code: ETH-104**

**Credit hours: 1**

**Contact Hours: 3 per week**

**Weeks: 15-16 (45-48 hours)**

**Pre-Requisites: Nill**

**Objectives**

Upon successful completion of the course, students will be able to have better understanding of ethics in various walks of life like in workplace, in business, journalism etc. Moreover, they will be able to be familiarize with Contemporary World's Ethical Issues. And, try to develop answers about them.

### **Learning Outcomes:**

- Students will be able to demonstrate their understanding about the importance of ethics in their lives today.
- Identify Contemporary World's Ethical Issues.
- Create problem solving for these contemporary Ethical issues.

### **Course Outline:**

#### **Unit 1: Professional Ethics & Bioethics**

Meaning of Work/Professional Ethics, Professional Ethics and Human Values, Elements of professional Ethics: Person attitude, Beliefs about work, Positive Attributes (honesty, integrity, dedication, commitment, responsibility, interpersonal relationship) Genetic engineering, Organ Donation, Cloning, Head Transplant

#### **Unit 2: Ethical Conduct in Business Ethics & it's important**

Types of Business Ethics, Common Business Ethical Challenges  
Conflict of interest, honesty & integrity, whistle blowing, loyalty vs truth

#### **Unit 3: Journalism**

Principles of Ethical Journalism: Truth & Accuracy, Independence, Fairness & Impartiality, Humanity, Public Accountability

#### **Unit 4: Environmental Ethics**

Core Principles of environmental ethics: Justice & sustainability, Sufficiency & compassion, Solidarity & public participation, Pollution prevention. Current issues of environmental ethics: Pollution, The depletion of natural resources, Loss of biodiversity, Destruction of ecosystem, Global climate change

#### **Unit 5: Social Inequalities**

Meaning of Social Inequalities, Issues related to social inequality Difference in source of income, Health care, Freedom of speech, Gender inequality, Toxic workplace culture, Education, Political representation & participation

#### **Unit 6: Social Media Ethics**

Facebook, YouTube, WhatsApp, Instagram, TikTok, Snapchat, LinkedIn, X  
Current Ethical issues in social media: Plagiarism, Fake news, Harassment,

## **References/Recommended Books:**

### **Books**

1. Davis, N.K. (2023). Elements of Ethics, Legare Street Press.
2. Edmonds,D. (2019). Ethics and the Contemporary World, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). The Encyclopedia of Religion and Ethics, Creative Media Partners, LLC
4. Robinson, D.Garratt C. (2008). Introducing Ehics-a Graphic Guide, Icon Books ltd.Uk.
5. اخلاق اور فلسفہ اخلاق, سیوہاروی، حفظ الرحمن، ندوة المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

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1. Articles on Ethics [www.infotrac-college.com](http://www.infotrac-college.com)
2. Brown. (2017). The ethical dimensions of Global Environmental Issues. American Academy of Arts and Sciences. Retrieved July 7 ,2017 from amacad.org
3. Business Ethics Magazine [www.business-ethics.com/annual.htm](http://www.business-ethics.com/annual.htm)
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>
7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics [www.globalethics.org](http://www.globalethics.org)
9. Klimes, Rudolf e. (2000). Ethical Problems.
10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). “Philosophical Foundations for Global Journalism Ethics” Journal of Mass Media Ethics:20(1)