SCHEME AND SYLLABUS

Doctor of Philosophy
in
Computer Science and Engineering

(w.e.f. Session Oct-2024)

DEPARTMENT OF ENGINEERING AND TECHNOLOGY

Gurugram University, Gurugram, Haryana

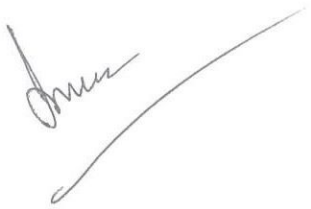
Ph.D. Course work guidelines

As per UGC Regulations 2016: Minimum Standards and procedure for Award of Ph.D. Degree, after admission in Ph.D., a research scholar shall be required to undertake course work for a minimum period of one semester.

COURSE STRUCTURE:

Subject Code	Name of course	Credits	Marks		
			External	Internal	Total
	RESEARCH METHODOLOGY	4	70	30	100
	RESEARCH AND PUBLICATION ETHICS	2	35	15	50
	SUBJECT SPECIFIC	4	70	30	100
	SEMINAR	4	--	100	100
Total		**14**	175	175	350

All scholar enrolled in the course work must choose one subject-specific course must be from the Subject-Specific Course List provided by the department.



Department of Engineering & Technology
Gurugram University, Gurugram

Ph.D. Coursework Syllabus- Oct-2024 onwards

Research and Publication Ethics (RPE)

Course Id: 24/PHD/COM01:

Total Marks : 50 (External = 35 Marks + Internal = 15 Marks) Credit : 02 (30 hrs)

Overview: This course as total 6 units focusing on basic of philosophy of science and ethics. Research integrity, publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, h-index, impact factor, etc.) and plagiarism tools will be introduced in this course.

Pedagogy: Classroom teaching, guest lectures, group discussion and practical sessions.

Learning Outcome

By the end of the course, students will be able to understand the importance of being ethical in carrying out research and publication activities. They will be able to differentiate the quality publication practices and how to cognisant about dubious publishing practices/publishers. More importantly, there will be an increased awareness about 'open access' and contribution of research output to open access publishing platforms. The learners will also get acquainted with the software/databases which are necessary for carrying out research work.

Detailed Syllabus

Instructions for q.paper setter:

The question paper shall comprise eight questions of Seven Marks each (at least one questions from each unit). The students will be required to attempt five questions.

The internal assessment will be done through tutorials, assignments, quizzes and Group discussion. Weightage will be given for active participation.

Unit 1: Philosophy and Ethics (3hrs)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions.

Unit 2: Scientific Conduct (5 hrs)

1. .Ethics with respect to science and research
2. Intellectual honest and research integrity
3. Scientific misconducts: falsification, fabrication, and plagiarism
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

Unit 3: Publication Ethics (7 hrs)

1. Publication ethics: definition, introduction and importance
2. Best practices/standard setting initiatives and guidelines: COPE, WAME, etc.
3. Conflictes of interest
4. Publication misconduct: deifinition, concept, problems that lead to unethical behavior and vice verse, types
5. Violation of publication ethics, authorship and contributor ship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE:

Unit 4: Open Access Publishing (4hrs)

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies.
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/journal suggestion tool viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

Unit 5: Publication Misconduct (4 hrs)

A. Group Discussions (2hrs)
   1. Subject specific ethical issues, FFP, authorship
   2. Conflicts of interest
   3. Complaints and appeals: examples and fraud from India and abroad

B. Software Tools (2hrs):
   1. Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Unit 6: Databases and Research Metrics (7hrs)

A. Databases (4hrs)
   1. Indexing databases
   2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3hrs)
   1. Impact Factor of journal citation report, SNIP, SJR, IPP, Cite Score
   2. Metrics : h-index, g index, i10 index, altmetrics.

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Ph.D. Coursework Syllabus- Oct-2024 onwards

RESEARCH METHODOLOGY

Total Marks: 100 (External =70 Marks + Internal =30 Marks) **Credit: 4**

Exam Time: 3Hours

OBJECTIVES

The course objectives are:

- **To introduce the fundamental concepts and scope of research**, including its objectives, characteristics, types, and the systematic process involved in formulating a research problem and hypothesis.
- **To design effective research methodologies**, including variable identification, instrument construction, sampling techniques, and data collection methods with attention to validity and reliability.
- **To develop analytical skills for data processing and interpretation**, using statistical techniques and software tools for both qualitative and quantitative research.
- **To equip students with academic writing and documentation skills**, emphasizing ethical practices, technical report writing, and the use of LaTeX for preparing research papers and theses.

LEARNING OUTCOMES

- Identify and explain the fundamental principles of research, including types, processes, and characteristics, as well as the formulation of research problems and hypotheses.
- Design and validate appropriate research instruments (e.g., questionnaires, scales) and select suitable data collection and sampling techniques based on research objectives.
- Perform and interpret statistical data analysis using tools such as Excel or statistical software, applying univariate to multivariate techniques appropriately.
- Produce well-structured research reports or theses using LaTeX, adhering to academic writing standards, ethical guidelines, and proper documentation methods.

COURSE OUTCOMES

Upon Completing the Course, Students will able:

CO1: **Describe** the fundamental concepts, types, and components of research, including the research process, characteristics of good research, and formulation of research problems and hypotheses.

CO2: **Classify and differentiate** among various research types and methodologies and evaluate appropriate use-cases for each.

CO3: **Develop and design** research instruments such as questionnaires and scales by applying principles of measurement, validity, and reliability, along with appropriate sampling and data collection methods.

CO4: **Analyze** research data using univariate, bivariate, and multivariate statistical techniques and interpret outputs from tools such as Excel and statistical software.

CO5: **Formulate and write** a structured research report or thesis by applying principles of technical writing, audience engagement, and ethical standards in research.

CO6: **Utilize** LaTeX for academic writing, including formatting research papers and theses, while understanding its significance in scholarly communication and reproducibility.

SYLLABUS

Unit I

Meaning, objectives and motivations in research, Characteristics and limitations of research, Components of research work, Criteria of good research, Research process, Types of Research, Fundamental, Pure or Theoretical Research, Applied Research, Descriptive Research, Evaluation Research, Experimental Research, Survey Research, Qualitative Research, Quantitative Research, Historical Research; Research problem: Selecting and analyzing the research problem, problem statement formulation, formulation of hypothesis, Literature review: purpose, sources, and importance - literature review procedure. Objectives: Learning Objectives; Definitions; Formulation of the research objectives.

Unit II

Variables in Research, Measurement and scaling, Different scales, Construction of instrument, Validity and Reliability of instrument. Data Collection methods: primary and secondary data, Construction of questionnaire and instrument, validation of instruments. Sample size determination, Sample design and sampling techniques. Processing of Data: Editing of Data, Coding of Data, Classification of Data, Statistical Series.

Unit III

Qualitative vs Quantitative data analyses: Univariate, Bivariate and Multivariate statistical techniques, Introduction to Excel, Data handling and plotting in Excel, Plotting software (at least one), Measures of Central Tendency, Dispersion, correlation and Regression, Chi-square test: Applications, Steps, characteristics, limitations, Analysis of Variance and Covariance, Factor analysis, Discriminant analysis, cluster analysis, multiple regression and correlation, multidimensional scaling, Conjoint Analysis, Application of statistical software for data analysis.

Unit IV

Research report: Different types, Contents of report, executive summary, contents of chapter, report writing, the role of audience, readability, comprehension, tone, final proof, report format, title of the report, Ethical issues in research: Code of Ethics in Research: Ethics and Research Process, Importance of Ethics in Research; Formal Methods: Formal Specification, Algorithm, and Complexity; Building Artefacts: Proof of Performance, Proof of Concept, and Proof of Existence; Process Methodology: Methods for Software Engineering and Human-Computer Interaction, Cognitive Processes, Interactive Games, Social Networks, and Web Analytics.

Introduction to Latex, Elementary Latex syntax, Paper and thesis writing using Latex

TEXTBOOKS

1. **Kothari, C. R., & Garg, G.** *Research Methodology: Methods and Techniques* (4th Edition), New Age International Publishers
2. **Creswell, J. W.** *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th Edition), SAGE Publications
3. **Cooper, D. R., & Schindler, P. S.** *Business Research Methods* (12th Edition), McGraw-Hill Education
4. **Saunders, M., Lewis, P., & Thornhill, A.** *Research Methods for Business Students* (7th Edition), Pearson Education
5. **Leedy, P. D., & Ormrod, J. E.** *Practical Research: Planning and Design* (12th Edition), Pearson

REFERENCE BOOKS

1. **Montgomery, D. C., & Runger, G. C.** *Applied Statistics and Probability for Engineers,* Wiley
2. **Trochim, W. M. K.** *Research Methods: The Essential Knowledge Base,* Cengage Learning
3. **Best, J. W., & Kahn, J. V.** *Research in Education,* Pearson
4. **Bell, J.** *Doing Your Research Project: A Guide for First-Time Researchers,* McGraw-Hill Education
5. **Lamport, L.** *LaTeX: A Document Preparation System,* Addison-Wesley

RELEVANT MOOC/SWAYAM/NPTEL COURSES:

1. **Research Methodology** – by Prof. A. K. Tripathi (IIT Roorkee) https://nptel.ac.in/courses/121105007
2. **Data Analysis and Decision Making** – by Prof. G. Srinivasan (IIT Madras) https://nptel.ac.in/courses/110106064
3. **Technical Writing** – by Prof. S. S. Dash (IIT Madras) https://nptel.ac.in/courses/109106094

Paper Setting Instruction: The examiner will set nine questions in total. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit. Question one will have seven parts from all units and the marks of first question will be of 14 (1Q * 2 Marks). The remaining eight questions to be set by taking two questions from each unit and the marks of each question 14.

Department of Engineering & Technology
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Ph.D. Coursework Syllabus- Oct-2024 onwards
Computer Science and Engineering

SUBJECT SPECIFIC COURSE:

S.No	Subject Code	Name of Subject
1		Advanced Computer Architecture
2		Advanced Computer Networks
3		Internet of Things- Principles and Applications
4		Machine Learning
5		Cloud Computing
6		Data Analytics and Visualization
7		Advanced Web Intelligence Techniques
8		System Software and Compiler Design

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Ph.D. Coursework Syllabus- Oct-2024 onwards
Computer Science and Engineering

Advanced Computer Architecture

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3Hours

Course Outcomes:

CO1 Explain the fundamental concepts of computer architecture including logic design, instruction sets, CPU design, and memory systems.
CO2 Apply architectural principles and techniques to design and analyze components of modern processors and memory hierarchies.
CO3 Analyse the performance of computer systems using standard metrics, performance equations, and advanced architectural features.
CO4 Design and develop solutions for processor and memory subsystems using advanced techniques such as pipelining, ILP, and multicore architectures.
CO5 Evaluate contemporary computer architectures and emerging trends for their effectiveness in various applications.

Course Contents:

Unit 1: Basics of Logic Design: Combinational logic, finite state machines. Computer Arithmetic: Binary number systems, floating-point numbers, operations on binary numbers, implementations, ALU design, fast adder design.

Unit 2: Performance: Metrics and calculations, performance equations, Amdahl's law, Instruction Set Architecture: Influence of Technology and Software on the instruction set. Instruction set classifications, addressing modes, instruction encoding, impact of high-level language and compilers, Microprogramming. CPU Design and Architecture: Instruction pipeline, stages of execution, basic CPU organization, single-cycle and multiple-cycle designs, microprogramming vs.hardwired control, interrupts.

Unit 3: Pipelining and parallelism: Pipeline dependencies, data and control hazards, resolving hazards, forwarding, exceptions, multiple-functional-unit pipelines. Advanced Pipelining and Instruction Level Parallelism: Dynamic scheduling, branch prediction, superscalar issue, compiler and architectural support for Instruction Level Parallelism ILP, branch prediction and speculative execution. Advanced ILP. Out of order execution and register renaming. Advanced Superscalar Architecture.

Unit 4: Memory Hierarchy: caches and cache hierarchies, cache organizations, cache performance, compiler support for cache performance, main memory organization, virtual memory, TLBs Synchronization and Sequential consistency. Cache coherency, Snoopy Protocol, MESI protocol, Relaxed Memory models.

Unit 5: Recent Trends: VLIW / EPIC Architectures, Vector Computers, Introduction to Multi-Core Architectures: Tiled Multi-core processors, General purpose multi-core processors, speculative multi- threaded architecture. Introduction GPU-GPU Computing.

Textbooks

1. K.HWANG, "Advanced Computer Architecture, Parallelism, Scalability, Programmability", McGraw Hill, New York, 1993

2. Hennessy and Patterson, "Computer Architecture: A Quantitative Approach," Second Edition, Morgan Kaufmann Publishers, 1995

Reference Books

1. Patterson and Hennessy, "Computer Organization and Design: The Hardware/Software Interface," Morgan Kaufmann Publishers, 1994

2. Multi-core Processors and Systems (Google eBook), Stephen W. Keckler, Kunle Olukotun, H. Peter Hofstee, Springer Science & Business Media.

Instruction for Paper Setter: The question paper must be divided into two parts. Part-1 must contain 5 questions comprising of 2 marks each which covers all the units. Part-2 must contain 10 questions comprising of 12 marks each which covers all the units. Part-1 is compulsory. Students have to attempt any 5 questions from part-2.

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Ph.D. Coursework Syllabus- Oct-2024 onwards
Computer Science and Engineering

Advanced Computer Networks

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3Hours

Course Outcomes:

CO1 Explain the fundamental principles, architectures, and protocols of computer networks.
CO2 Apply networking concepts to configure and manage network devices, protocols, and addressing schemes for both wired and wireless networks.
CO3 Analyse the operation and performance of various routing, congestion control, and resource allocation mechanisms in internetworking environments.
CO4 Design and evaluate solutions for modern networks using technologies for wired and wireless networks.
CO5 Assess and compare emerging networking trends, protocols, and architectures for their suitability in different application scenarios.

Course Content:

Unit 1: Foundation of Networking Protocols: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing, Equal-Sized Packets Model: ATM - Networking Devices: Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure. Link Layer: Introduction and Services, Error- Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization.

Unit 2: Routing and Internetworking: Network–Layer Routing, Least-Cost-Path algorithms, Non- Least- Cost-Path algorithms, Intra-domain Routing Protocols, Inter-domain Routing Protocols, Congestion Control at Network Layer, IPv4 Addresses, IPv6 Addresses, Internet Protocol, Internetworking,IPv4, IPv6, Transition from IPv4 to IPv6, Multicasting Techniques and Protocols, Basic Definitions and Techniques, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, Node-Level Multicast algorithms.

Unit 3: Transport and End-to-End Protocols: Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control , Principles of Network Applications, The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System(DNS), P2P File Sharing, Socket Programming with TCP and UDP. Congestion Control and Resource Allocation, Congestion- Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance.

Unit 4: Wireless Networks and Mobile IP: Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standards, Cellular Networks, Mobile IP, Wireless Mesh

Networks (WMNs) ,Overview of Optical Networks, Basic Optical Networking Devices, Large-Scale Optical Switches, Optical Routers, Wavelength Allocation in Networks, Case Study: An All-Optical Switch.

Unit 5: Mobile Ad-Hoc Networks: Overview of Wireless Ad-Hoc Networks, Routing in Ad-Hoc Networks, Routing Protocols for Ad-Hoc Networks, Wireless Sensor Networks, Sensor Networks and Protocol Structures, Communication Energy Model, Clustering Protocols, Routing Protocols, Wireless Mesh Networks, Network Architecture, Characteristics, Application Scenarios, Critical Design Factors.

Textbooks:

1. Computer Networking: A Top-Down Approach Featuring the Internet, James F. Kurose, Keith W.Ross, Third Edition, Pearson Education, 2007.
2. Computer Networks :A System Approach , Larry Peterson and Bruce S Davis 5th Edition,Elsevier -2014
3. Ad hoc Wireless Networks, 2nd Edition, C. Siva Ram Murthy & B. S. Manoj, Pearson Education, 2011
4. Jochen Schiller, "Mobile Communications", Pearson Addison-Wesley, 2/e, 2003.

Reference Books:

1. Wireless Mesh Networks, first edition, Ian F Akyildiz and Xudong Wang, WILEY Publications, 2009.

2. Behrouz A. Forouzan , "TCP/IP Protocol Suite", McGraw- Hill, 4/e, 2009.

Instruction for Paper Setter: The question paper must be divided into two parts. Part-1 must contain 5 questions comprising of 2 marks each which covers all the units. Part-2 must contain 10 questions comprising of 12 marks each which covers all the units. Part-1 is compulsory. Students have to attempt any 5 questions from part-2.

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Ph.D. Coursework Syllabus- Oct-2024 onwards
Computer Science and Engineering

Advanced Digital Image Processing

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04

Exam Time: 3Hours

Course Outcomes:

CO1 Explain fundamental concepts, models, and operations used in digital image processing.
CO2 Apply image processing techniques to enhance, restore, and transform images in various domains.
CO3 Analyze different image processing methods, their characteristics, and their impact on image quality.
CO4 Design image processing solutions for tasks such as compression, segmentation, and object representation.
CO5 Evaluate image processing algorithms and systems for their effectiveness in solving practical problems.

Course Content:

Unit 1: Introduction: What is Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System.

Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.

Unit 2: Image Enhancement in the Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Image Enhancement in the Frequency Domain: Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency- Domain Filters, Sharpening Frequency-Domain Filters, Homomorphic Filtering.

Unit 3: Image Restoration: A Model of the Image degradation/Restoration process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error

(Wiener) Filtering, Constrained Least Square Filtering, Geometric Mean Filter.

Unit 4: Color Fundamentals: Color Models, Pseudo color Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images, Color Image Compression.

Wavelets and Multi resolution Processing: Image Pyramids, Subband coding, The Haar Transform, Multi resolution Expansions, Wavelet Transforms in one Dimension, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets. Image Compression: Fundamentals, Image Compression Models, Error-free Lossless) compression, lossy Compression.

Unit 5: Morphological Image Processing: Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection, thresholding, Region-Based Segmentation, Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Textbooks

1. Rafael C Gonzalez and Richard E. Woods: Digital Image Processing, PHI 2nd Edition
2. A. K. Jain: Fundamentals of Digital Image Processing. Pearson.
3. Scott.E.Umbaugh: Digital Image Processing and Analysis, CRC Press.

Reference Books

1. S.Jayaraman, S.Esakkirajan, T.Veerakumar: Digital Image Processing, McGraw Hill.
2. Sid Ahmed, "Image Processing" McGraw -Hill

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Ph.D. Coursework Syllabus- Oct-2024 onwards
Computer Science and Engineering

Internet of Things- Principles and Applications

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3 Hours

Course Outcomes:

CO1 Explain the fundamental concepts, architecture, and design principles of Internet of Things systems and applications.
CO2 Apply appropriate networking, communication protocols, and connectivity solutions for IoT-based systems.
CO3 Analyse various IoT models, protocols, technologies, and system components to address specific application requirements.
CO4 Design and develop IoT solutions integrating sensors, actuators, devices, and communication technologies to meet functional and operational goals.
CO5 Evaluate IoT systems with respect to security, privacy, standards, and regulatory requirements for real-world deployment.

Course Contents:

Unit 1: Introduction: Definition, Characteristics of IOT, IOT Conceptual framework, IOT Architectural view, Physical design of IOT, Logical design of IOT, Application of IOT.Machine - to - machine (M2M), SDN (software defined networking) and NFV(network function virtualization) for IOT, data storage in IOT, IOT Cloud Based Services.

Unit 2: Design Principles for Web Connectivity: Web Communication Protocols for connected devices, Message Communication Protocols for connected devices, SOAP, REST, HTTP Restful and Web Sockets. Internet Connectivity, Internet based communication, IP addressing in IOT, Media Access control.

Unit 3: IoT Networking & Communication Protocols: Communication Models, Device-to-device, device-to-gateway, device-to-cloud, Gateway-to-cloud, back-end data sharing, IoT protocol stack (Link, Network, Transport, Application layers), IPv6, 6LoWPAN, RPL routing, Wireless Technologies, Wi-Fi, Bluetooth Classic/BLE, ZigBee, Z-Wave, LoRaWAN, NB-IoT, IoT Protocols, MQTT, CoAP, AMQP, XMPP.

Unit 4: **IoT system design and applications:** Sensor Technology , Participatory Sensing, Industrial IOT and Automotive IOT , Actuator, Sensor data Communication Protocols ,Radio Frequency Identification Technology, Wireless Sensor Network Technology. IOT Design methodology: Specification -Requirement, process, model, service, functional & operational view.IOT Privacy and security solutions, Raspberry Pi & arduino devices. IOT Case studies: smart city streetlights control & monitoring, smart agriculture, IoT for medical applications.

Unit 5: IoT Security, Privacy & Standards: Security Threats and Attacks: device spoofing, data interception, denial of service, physical attacks, IoT Security Mechanisms: Secure boot, data encryption, access control, PKI, Privacy Concerns: Data ownership, user consent, anonymization, Standards & Regulations: IEEE, IETF, oneM2M, ITU standards, Data protection regulations.

Textbooks:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of things (A Hands-on Approach)" 1st Edition ,Universal Press

2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols (2nd Edition), Wiley

References Books:

1. Rajkamal,"Internet of Things", Tata McGraw Hill publication

2. Hakima Chaouchi "The Internet of Things: Connecting Objects", Wiley P u blication.

3. Francis dacosta "Rethinking the Internet of things: A scalable Approach to connecting everything", 1st edition, Apress publications.

4. Donald Norris"The Internet of Things: Do It Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", McGraw Hill. .

Instruction for Paper Setter: The question paper must be divided into two parts. Part-1 must contain 5 questions comprising of 2 marks each which covers all the units. Part-2 must contain 10 questions comprising of 12 marks each which covers all the units. Part-1 is compulsory. Students have to attempt any 5 questions from part-2.

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Computer Science and Engineering

Machine Learning

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks)
Credit: 04 Exam Time: 3 Hours

Course Outcomes:

CO1 Explain fundamental concepts, principles, and types of machine learning and the challenges associated with building intelligent systems.
CO2 Apply machine learning techniques to solve problems involving classification, regression, clustering, and decision-making.
CO3 Analyze machine learning models and their performance using suitable evaluation measures and validation strategies.
CO4 Design and develop machine learning solutions using a variety of algorithms, models, and frameworks for real-world applications.
CO5 Evaluate machine learning systems considering performance, scalability, deployment, and ethical aspects.

Course Contents:

Unit 1: **Introduction to Machine Learning:** Definitions, real-world examples, Types of learning: supervised, unsupervised, semi-supervised, reinforcement learning, data preprocessing, feature engineering, model training, evaluation, deployment, Hypothesis space, inductive bias, capacity, generalization, Bias-variance tradeoff, Curse of dimensionality, No free lunch theorem.

Unit 2: Supervised and Unsupervised Learning: Regression: Linear regression, polynomial regression, Ridge, Lasso, Elastic Net, Classification: Logistic regression, k-NN, Decision trees (CART, ID3), Naïve Bayes, SVM (linear and kernel-based), Model evaluation metrics, Cross-validation: k-fold, stratified, leave-one-out, resampling, SMOTE, Clustering: k-means, hierarchical, DBSCAN, Gaussian Mixture Models (GMM), Dimensionality Reduction: PCA, LDA, t-SNE, UMAP, Association rule mining: Apriori, FP-Growth, Anomaly detection: distance-based, density-based (LOF), isolation forests.

Unit 3: Reinforcement Learning and Neural Networks: Markov decision process (MDP), HMM, Bellman equations, Value iteration and policy iteration, Linear quadratic regulation, Linear Quadratic Gaussian, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs. Ensemble learning: Bagging, Random Forests, Boosting (AdaBoost, Gradient Boosting, XGBoost, LightGBM, CatBoost), Stacking, Blending, Voting classifiers, Neural networks: perceptron, MLP, activation functions, back propagation, loss functions, Regularization in neural nets: dropout, batch normalization, early stopping.

Unit 4: Advanced & Emerging Topics in Machine Learning: Deep Learning: CNNs: convolution layers, pooling, architectures, RNNs: sequence modeling, vanishing gradient, GRU/LSTM (basic), Transfer learning: fine-tuning pre-trained models (VGG, ResNet, BERT), Probabilistic ML, Bayesian networks, Hidden Markov Models (HMMs), Variational inference (intro), Generative Models, Autoencoders (AE), Variational Autoencoders (VAE), Federated learning, Meta-learning / AutoML, Multi-task learning, Large Language Models (LLMs) (intro)

Unit 5: Machine learning Applications: Machine Learning for Big data: Big Data and MapReduce, Introduction to Real World ML, Choosing an Algorithm, Design and Analysis of ML Experiments, Common Software for ML.

Textbooks:

1. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited.

2. Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press.

3. Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC PresS 2009.

References Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville — Deep Learning, MIT Press.

2. Aurélien Géron — Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 3rd Edition.

3. Kevin P. Murphy — Machine Learning: A Probabilistic Perspective, MIT Press.

Instruction for Paper Setter: The question paper must be divided into two parts. Part-1 must contain 5 questions comprising of 2 marks each which covers all the units. Part-2 must contain 10 questions comprising of 12 marks each which covers all the units. Part-1 is compulsory. Students have to attempt any 5 questions from part-2.

Cloud Computing

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3Hours

Course Outcomes:

CO1 Explain the evolution, models, architectures, and characteristics of cloud computing and distributed systems.
CO2 Apply concepts of virtualization, service models, and cloud infrastructure to design and manage cloud-based solutions.
CO3 Analyze cloud programming paradigms, cloud platforms, and resource management strategies for various applications.
CO4 Design secure, scalable, and interoperable cloud computing solutions considering standards, governance, and compliance requirements.
CO5 Evaluate cloud security, privacy, reliability, and performance aspects across different deployment scenarios.

Course Contents:

Unit 1: Foundations of Distributed and Cloud Computing: History and evolution of computing paradigms, Centralized computing, distributed computing, Cluster computing, Grid computing-principles, architectures and applications, Emergence of network-based systems, technologies for network-based systems, communication protocols, networked file systems, remote procedure calls, System models for distributed and cloud computing, layered models, virtualized resource models, service models, Middleware frameworks, resource management platforms, examples

Unit 2: Cloud Concepts and Virtualization: Introduction, Definitions, evolution, significance, Cloud issues and challenges, Cloud properties and characteristics, Cloud service models- IaaS, PaaS, SaaS, Cloud deployment models- Public, Private, Hybrid, Community, Cloud resources, Network resources and APIs, Virtual vs physical computational resources, Data storage options (block, file, object storage), Virtualization concepts, Hypervisors, Types examples :VMware, Hyper-V, KVM, Xen, High Availability (HA) and Disaster Recovery (DR) using virtualization, Virtual machine migration and dynamic resource management.

Unit 3: Cloud Service Models: Infrastructure as a Service (IaaS), Server, storage, network virtualization, Elastic compute, virtual machine provisioning, IaaS case studies : AWS EC2, OpenStack, Platform as a Service (PaaS), PaaS architecture, services for computation and storage, Development and deployment environments, PaaS case studies: Google App Engine, Microsoft Azure PaaS, Software as a Service (SaaS), Concepts, delivery models, multi-tenancy, SaaS case

studies: Salesforce, Google Workspace, Web technologies for SaaS, Web services, Web 2.0, Web OS, Anything as a Service (XaaS), Concept, examples: DBaaS, NaaS, CaaS

Unit 4: Cloud Programming and Software Environments: Parallel programming models (MapReduce, Hadoop, Spark), Distributed programming models (MPI, RPC, REST APIs), Programming on Amazon AWS, AWS SDKs, Lambda functions, EC2 scripting, Programming on Microsoft Azure, Azure functions, Azure App Service, Azure SDK,Google App Engine programming support, Application structure, deployment, APIs, Emerging cloud software environments, Kubernetes, Docker, OpenShift, serverless platforms

Unit 5: Cloud Access, Security, and Standards: Cloud access control mechanisms, Authentication, authorization, accounting (AAA), Cloud provenance and metadata management, Tracking data origin, changes, and ownership, Reliability and fault-tolerance, Redundancy, failover strategies, SLAs, Cloud security challenges and solutions, Data confidentiality, integrity, availability, Encryption, identity management, key management, Privacy, policy, and regulatory compliance, GDPR, HIPAA, PCI-DSS, Cloud federation and interoperability, Cross-cloud integration, data portability, Standards for cloud computing, IEEE, NIST, OGF, DMTF

Textbooks:

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing: Principles and Paradigms, Wiley.
2. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw-Hill.
3. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann.

Reference Books:

1. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Media.

2. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall / Pearson.

3. Arshdeep Bahga, Vijay Madisetti, Cloud Computing: A Hands-On Approach, Universities Press

Instruction for Paper Setter: The question paper must be divided into two parts. Part-1 must contain 5 questions comprising of 2 marks each which covers all the units. Part-2 must contain 10 questions comprising of 12 marks each which covers all the units. Part-1 is compulsory. Students have to attempt any 5 questions from part-2.

Data Analytics and Visualization

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3Hours

Course Outcomes:

CO1. Comprehend basics of data analytics and visualization.

CO2. Apply various regression models on given data set and perform prediction.

CO3. Demonstrate advance understanding of Time series concepts and analysis of data using Various time series models.

CO4. Analyze Text data and gain insights.

CO5. Experiment with different analytics techniques and visualization using R and Python

Course Content:

Unit 1: Introduction to Data analytics and life cycle : Data Analytics Lifecycle overview: Key Roles for a Successful Analytics, Background and Overview of Data Analytics Lifecycle Project, Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize

Unit 2: Regression Models: Introduction to simple Linear Regression, Introduction to Multiple Linear Regression: Assessing the Model, Cross-Validation, Model Selection and Stepwise Regression, Prediction Using Regression, Logistic Regression: Logistic Regression and GLM, Generalized Linear model, Predicted values from Logistic Regression, Interpreting the coefficients and odds ratios, assessing the models. Polynomial regression, Handling multi collinearity, regularization techniques.

Unit 3: Time Series: Overview of Time Series Analysis Box-Jenkins Methodology,ARIMA Model Autocorrelation Function (ACF) ,Autoregressive, Models ,Moving Average Models ,ARMA and ARIMA Models , Building and Evaluating an ARIMA Model, Reasons to Choose and Cautions, exponential smoothing, decomposition methods

Unit 4: Text Analytics: History of text mining, seven practices of text analytic, application and use cases for text mining, extracting meaning from unstructured text, summarizing text, text analysis steps, collecting raw text, ,representing text ,Term Frequency—Inverse Document Frequency (TFIDF),categorizing documents by topics, determining sentiments , gaining insights .

Unit 5: Data analytics and visualization with R: Introduction to R: data import and export, attribute and data type, descriptive statistics, exploratory data analysis: visualization before analysis, dirtydata, visualizing single variable, examining multiple variable, data exploration versus presentation, ggplot2 introduction, interactive visualization with plotly.

Unit 6: Data analytics and Visualization with Python: Essential Data Libraries for data analytics:Pandas, NumPy, SciPy, plotting and visualization with python: introduction to Matplotlib, Basic Plotting with Matplotlib, Create Histogram, Bar Chart, Pie chart, Box Plot, violin plot using Matplotlib, Introduction to seaborn Library, Multiple Plots, Regression plot, regplot.

Textbooks:

1. Discovering Knowledge in Data: An introduction to Data Mining, Daniel T. Larose, JohnWiley, 2nd Edition.
2. Data Mining: Concepts and Techniques, By Jiawei Han, Micheline Kamber, 3rd Edition, Morgan Kaufmann Series.
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data,EMC Education services Wiley Publication.
4. Practical Text Mining and statistical Analysis for non-structured text data applications,1st edition,Grey Miner,Thomas Hill.

Reference Books:

1. Practical Statistics for Data Scientists 50+ Essential Concepts Using R and Python, O'Reilly Publications 2nd Edition.

2. Data Analytics using R, Bharati Motwani, Wiley Publications

3. Python for Data Analysis: 3rd Edition, Wes McKinney ,Publisher(s): O'Reilly Media, Inc.

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Department of Engineering & Technology
Gurugram University, Gurugram

Ph.D. Coursework Syllabus- Oct-2024 onwards
Computer Science and Engineering

Advanced Web Intelligence Techniques

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3Hours

Course Outcomes:

CO1: Explain the principles, architectures, and advanced techniques of Web Intelligence, including web mining, semantic web, and social web technologies.
CO2: Apply data preprocessing, cleaning, and feature extraction techniques to prepare web data for mining and analysis.
CO3: Analyze web structure, content, and usage patterns using algorithms such as clustering, Markov models, and link analysis methods.
CO4: Design ontology-based solutions and semantic web applications for knowledge representation, integration, and reasoning.
CO5: Evaluate web mining models, social network analysis techniques, and ubiquitous web services for personalization, recommendation, and intelligent services.

Course Contents:

Unit 1: Foundations of Web Intelligence and Data Preprocessing : Introduction to Web Intelligence, Evolution, advanced techniques, key applications, Web data characteristics and quality issues, Web content, site structure, user sessions, privacy concerns, Quality measures in web data, Web data preprocessing and transformation, Hyperlink to graph representation, Crawler processing, large-scale storage, Cleaning and vector representation of content, Web session reconstruction: proactive, reactive sessionization, dynamic sessions, session outliers, Pattern extraction and storage, Feature selection/extraction, Supervised/unsupervised learning, ensemble algorithms, Model evaluation: classifiers, regression, clustering, association rules, Pattern Webhouse and PMML

Unit 2: Web Content and Structure Mining: Web content mining, MicroGenres, Pattrio method, usability and web design patterns, Recent analysis techniques (e.g. Nonnegative Matrix Factorization), Web structure mining, Web as a graph: properties, models, Link analysis: PageRank, HITS, spam detection algorithms, Structural clustering, community detection, Algorithmic challenges: streaming models, graph compression

Unit 3: Web Usage Mining and User-Centric Services: Characterizing and modeling user browsing behavior, Variables, statistics, amateur vs expert users, Representations: vectors, graphs, content valuation, Dimensionality issues, Pattern extraction from user behavior, Clustering, decision rules, Markov models (HMM, CRF, VLMC), ant colony models, matrix factorization, Applications, Adaptive websites, personalization, recommendations, User-centric web services in ubiquitous computing, Requirements: user centricity, context awareness, dynamicity, Research frameworks: Gaia, Aura, ABC, Amigo, Task-oriented service frameworks

Unit 4: Ontological Engineering and the Semantic Web: Knowledge representation and ontology engineering, methodologies: METHONTOLOGY, networked ontologies, reasoning, modularization, customization, ,ontology mapping, collaboration, applications of the Semantic Web, natural interaction, semantic web services, public administration, e-business, from semantic islands to semantic cloud

Unit 5: Web Intelligence on Social Web and Ubiquitous Services: Social web intelligence, online social networks, virtual communities, Social network analysis, community analysis, web mining on social web: basic and advanced applications, Ubiquitous intelligent services, interactive social network discovery, ontology-based context fusion, mobile services driven by social contexts, case studies and experimentation

Textbooks:

1. Juan D. Velásquez, Web Data Mining with R, Springer.

2□. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (2nd Edition) Springer.

3□. Gautam Soff, Enterprise Cloud Computing: Technology, Architecture, Applications, Cambridge University Press.

References Books:

1. Juan D.Vel´asquez and Lakhmi C. Jain (Eds.): Advanced Techniques in Web Intelligence – 1, Springer, Sep-2010.
2. Richi Nayak,NikhiI chalkaranje, Lakhmi C.Jain: Evolution of the Web in Artificial Intelligence Environments,Springer,2008.
3. Ning Zhong: Web Intelligence Research and Development, Springer,2001.

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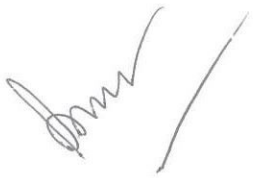

System Software and Compiler Design

Total Marks: 100 (External = 70 Marks + Internal = 30 Marks) Credit: 04
Exam Time: 3Hours

Course Outcomes:

CO1: Explain the design, functions, and implementation strategies of system software components such as assemblers, loaders, linkers, and compilers.

CO2: Apply lexical and syntax analysis techniques, including regular expressions, finite automata, and parsing methods, for analyzing programming language constructs.

CO3: Design intermediate code representations and apply semantic routines to generate and manipulate intermediate forms of code.

CO4: Analyze code optimization techniques and data flow analysis to improve efficiency and performance of compiled programs.

CO5: Develop code generation strategies using register allocation, DAG representations, and apply compiler construction tools such as lex and yacc.

Course Contents:

Unit 1: System Software: Assemblers, Basic Assembler Functions, Machine-dependent Assembler Features, Machine- Independent Assembler Features, Assembler Design Options, and Implementation examples. Loaders and Linkers: Basic Loader Functions, Machine-Dependent Loader Features, Machine-Independent Loader Features, Loader-Design Options, Implementation examples.

Unit 2: Introduction to compilers: Introduction, Theory of computer Languages, Design of a Language, Evolution of Compilers, stages of Compilation. Lexical analysis, alphabets and Tokens in Computer Languages, Representation of Tokens and Regular Expression, Token Recognition and Finite State Automata, Implementation, Error Recovery.

Unit 3: Syntax Analysis & semantic analysis: Introduction, Context-free Grammar and Structure of Language, Parser and its Types, Top-down Parsers, Bottom up-Parsers, Implementation, Parser Generator Tool (Yacc), Error Handling.

Unit 4: Intermediate Code generation: Introduction, Need for Intermediate Code, Types of Intermediate Code, Representations of All Language Constructs by Three-address code, Grammar Symbols and Attributes, Semantic Analysis, Semantic Routines for Intermediate Code Generation. Optimization, Hints on Writing optimized Code at User Level, Construction

of Basic Blocks and Processing, Data-flow Equations for Blocks with Backward Flow Control, Principal Sources of Optimization and Transformations, Alias, Procedural Optimization, Loops in Flow Graphs, Loop Optimization.

Unit 5: Code generation: Introduction, Issues in Code Generation, Target Machine Architecture, Subsequent Use Information, Simple Code Generator, Register Allocation, Directed Acyclic Graph Representation, Code Generation from Intermediate Code, Peephole Optimization. Compiler Writing tools, Introduction, Lexical Tools, Syntactic Tools.

Textbooks:

1. Compilers principles, Techniques and Tools: Alfred V. Aho, Ravi Sethi and Jeffrey D. Ullman, Pearson Education. 2013

2. Compiler Design: Muneeswaran, Oxford University Press, 2013
3. System Software, An Introduction to System Programming: Leland L. Beck and D. Manjula, Pearson Education, 3rd Edition, 2011

Reference Books:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman

Compilers: Principles, Techniques and Tools (2nd Edition) — also known as the "Dragon Book" ,Pearson Education.

2. D. M. Dhamdhere, System Programming and Operating Systems (2nd Edition), Tata McGraw Hill.

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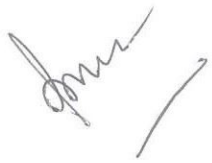

Department of Engineering & Technology
Gurugram University, Gurugram

Ph.D. Coursework Syllabus- Oct-2024 onwards

Seminar

Total Marks: 100 (Internal) Credit: 04

Objective:

The Seminar course aims to develop scholarly presentation skills, critical thinking, and familiarity with current research trends in the field of Computer Science and Engineering. Scholars are expected to explore, analyze, and present technical content from peer-reviewed sources and demonstrate command over their chosen topic.

Seminar Topics:

Topics must be research-oriented and aligned with the broad area of the scholar's Ph.D. thesis.
The topic must be approved by the assigned faculty member within the first two weeks of the course.

Seminar Deliverables:

Each scholar must:

1. **Prepare a Seminar Report** (Approx. 15–20 pages) including:
    - Introduction and motivation
    - Literature survey
    - Problem definition or key research issues
    - Methodologies/technologies discussed
    - Summary and future scope
    - References (in IEEE format)
2. **Deliver an Oral Presentation** (Duration: 25–30 minutes):
    - Presentation shcuild be prepared using PowerPoint or equivalent.
    - Question-and-answer session will follow.
3. **Submit a Plagiarism Report**:
    - Similarity index must be **below 15%.**
    - Plagiarism report (Turnitin/URKUND) must be submitted with the seminar report.

Evaluation Scheme : (Total Marks: 100) (Internal)

Component	Marks
Quality of Seminar Report	30
Depth of Literature Review	20
Content Delivery & Presentation	25
Response to Questions	15
Regularity and Participation	10
Total	**100**