RESEARCH AND PUBLICATION ETHICS
(PHD-OE1)

Module-1: PHILOSOPHY AND ETHICS (3 hrs.)

1. **Introduction to philosophy:** Definition, Nature and Scope, concept, branches
2. **Ethics:** Definition, moral philosophy, nature of moral judgments and reactions.

Module-2: SCIENTIFIC CONDUCT (5 hrs.)

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. **Scientific misconducts:** Falsification, Fabrication, and Plagiarism (FFP)
4. **Redundant publications:** duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

Module-3: PUBLICATION ETHICS (7 hrs.)

1. **Publication ethics:** Definition, introduction and importance
2. **Best practices/ Standards setting initiatives and guidelines:** CO PE, WAME, etc.
3. Conflicts of interest
4. **Publication misconduct:** Definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

Module-4: OPEN ACCESS PUBLISHING (4 hrs.)

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & 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 Suggester, etc.

Module-5: PUBLICATION MISCONDUCT (4 hrs.)

A. **Group Discussion (2 hrs)**
   1. Subject specific ethical issues, FFP, authorship
   2. Conflicts of interest
   3. Complains and appeals: example and fraud from India and abroad

B. **Group Discussion (2 hrs)**
   Use of plagiarism software like Turnitin, Urkund and other open-source software tools

Module-6: DATABASES AND RESEARCH METRICS (7 hrs.)

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

B. Research Metrics (3 hrs)

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics

Text Book (s)

1. Bird, A. (2006) *philosophy of Science.* Routledge.
2. MacIntyre, Alasdair (1967) *A short History of Ethics*, London.
3. Bcall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179.

ADVANCED MACHINE LEARNING TECHNIQUES AND APPLICATIONS (PHD-OE2)

Unit 1:
Supervised Learning (Regression/Classification)
Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Nave Bayes
Linear models: Linear Regression, Logistic Regression, Generalized, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Unit 2:
Unsupervised Learning: Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)

Unit 3:
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit 4:
Advanced Topics in Machine Learning: Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning.

Unit 5:
Machine Learning for IoT and Emerging Applications: Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications. Scalable Machine Learning (Online and Distributed Learning): A selection from some other advanced topics, e.g., Semi-Supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Text Book (s):

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Toshigami, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

Aurelien Geron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, 2nd Edition, O’Reilly Media, 2019.

RESEARCH METHODOLOGY
(PHD-CSE1)

Unit 1: Introduction to Research
Definition and Objectives of Research, Types of Research: Basic, Applied, Descriptive, Analytical, Quantitative, Qualitative, Steps in Research Process, Characteristics of Good Research, Identification of Research Problem, Formulation of Research Hypotheses, Significance of Research in Computer Science and Engineering.

Unit 2: Research Design and Methodology
Research Design: Exploratory, Descriptive, Experimental, Cross-sectional and Longitudinal Studies, Sampling Techniques, Probability and Non-Probability Sampling, Data Collection Methods: Primary and Secondary Data, Questionnaire Design, Interviews, Surveys, Observation Techniques, Case Studies, Selection of Appropriate Methodology in Computer Science and Engineering Research.

Unit 3: Data Analysis and Interpretation
Data preparation and description, exploratory data analysis, Cross tabulation, Univariate analysis, Test of significance. Large sample tests(z-test), Small sample test (t-test), Bivariate analysis, F-test, x^2 –test, Analysis of variance, (ANOVA), One way ANOVA, Two-way ANOVA, Multivariate analysis.

Unit 4: Research Ethics and Scholarly Communication
Data Screening and Transformation, Correlation, t Test, Analysis of Variance, Factor Analysis, Cluster Analysis, Multidimensional Scaling, Multiple Regression, Non-Parametric Tests of Significance, Analysis of examples from different disciplines.

Unit 5: Advanced Topics in Research Methodology
Systematic Review and Meta-Analysis, Experimental Design in Computer Science, Mixed Methods Research, Action Research, Case Study Research, Software Tools for Research Management and Writing (e.g., EndNote, LaTeX, Mendeley), Emerging Trends in Research Methodology for Computer Science and Engineering, Collaborative Research and Networking.

Text Book (s):

1. Creswell, J. W., Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications.
2. Kothari, C. R., Research Methodology: Methods and Techniques, New Age International Publishers.
3. Trochim, W. M. K., Research Methods: The Essential Knowledge Base, Cengage Learning.
4. Krishnaswamy, K. N., Research Methodology: Integration of Principles, Methods, and Techniques, Pearson Education.
5. Panneerselvam, R., Research Methodology, PHI Learning Pvt. Ltd.

DEPARTMENTAL ELECTIVE – I to VII
ADVANCED DATA SCIENCE
PHD-DCSE (I)

Unit 1:
Introduction to Data Science:- Big Data and Data Science, Datafication - Current landscape of perspectives, Statistical Inference - Populations and samples - Statistical modeling, probability distributions, fitting a model - Intro to R, Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA.

Unit 2:
The Data Science Process - Case Study: RealDirect (online real estate firm), Three Basic Machine Learning Algorithms - Linear Regression - k-Nearest Neighbors (k-NN) - k-means, Motivating application: Filtering Spam - Why Linear Regression and k-NN are poor choices for Filtering Spam - Naive Bayes and why it works for Filtering Spam - Data Wrangling: APIs and other tools for scrapping the Web.

Unit 3:
Feature Generation and Feature Selection (Extracting Meaning From Data) - Motivating application: user (customer) retention - Feature Generation (brainstorming, role of domain expertise, and place for imagination) - Feature Selection algorithms – Filters; Wrappers; Decision Trees; Random Forests Recommendation Systems: Building a User-Facing Data Product - Algorithmic ingredients of a Recommendation Engine - Dimensionality Reduction - Singular Value Decomposition - Principal Component Analysis - Exercise: build your own recommendation

Unit 4:
Mining Social-Network Graphs - Social networks as graphs - Clustering of graphs - Direct discovery of communities in graphs - Partitioning of graphs - Neighborhood properties in graphs.

Unit 5:
Data Visualization - Basic principles, ideas and tools for data visualization, Data Science and Ethical Issues - Discussions on privacy, security, ethics - A look back at Data Science.

Text Book (s):

1. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.
3. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
4. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009. (free online)
5. Mohammed J. Zaki and Wagner Miera Jr. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press. 2014.
6. Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011.
7. Carl Shan, Henry Wang, Max Song, and William Chen, The Data Science Handbook, Data Science Bookshelf, 2015.
8. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from The Frontline", O'Reilly. 2014.

ADVANCED CLOUD COMPUTING ARCHITECTURES AND SECURITY
PHD-DCSE (II)

Unit-I:

Cloud Computing: Cloud Computing in a Nutshell, Roots of Cloud Computing, Layers and Types of Clouds, Desired features of Cloud, Cloud Infrastructure Management. Infrastructure as Service Providers, Platform as Service Providers.

Migrating into a Cloud: Introduction, Broad Approaches to Migration into the Cloud, The seven-step Model of Migration into a Cloud, Conclusions.

Unit-II:

Virtual Machine Provisioning and Migration Services: Introduction and Inspiration, Background and Related Work, Virtual Machine Provisioning and Manageability, Virtual Machine Migration Services, VM Provisioning and Migration in Action, Provisioning in the Cloud Context.

Unit-III:

On the Management of Virtual Machine for Cloud Infrastructure: The Anatomy of Cloud Infrastructure, Distributed Management of Virtual Infrastructure, and Scheduling Techniques for Advanced Reservation of capacity, Capacity Management to meet SLA Commitments, Conclusions and Future Work.

Unit-IV

Fundamental Cloud Architectures: Work Load Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture.

Advanced Cloud Architecture: Hypervisor Clustering Architectures, Load Balanced VirtualServer Instance Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime architecture, Cloud Balancing architecture.

Text Book (s):

1. Cloud Computing Concepts, Technology &Architecture by Thomas Erl. Pearson Publishers.
2. Cloud Computing Principles and Paradigms Edited by Rajkumar Buyya , James Broberg and Andrzej Goscinski.

SECURITY ENGINEERING
PHD-DCSE (III)

Unit-I

Security Attacks, Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking.

Unit-II:

ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks. Conventional Encryption Principles, Conventional encryption algorithms, cipher block modesof operation, location of encryption devices, key distribution Approaches of Message Authentication.

Unit-III:

Network Security Overview, Types of Security Attacks and Services, Internet Standards, Symmetric Encryption, Asymmetric Encryption, Kerberos, X.509, PGP, S/MIME, IP Security, Project Day, SSL, TLS, SNMP

Unit-IV:

Wireless Security, Cellular Security, DoS, DDoS, Firewalls, Database Security, Intrusion Detection and Identification, Obfuscation, Computer Forensics.

Unit-V:

Security in Cloud Computing, Blockchain Security, IoT Security, AI and Machine Learning in Security, Quantum Cryptography:

Text Book (s):

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.
2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn Ido Dubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech
3. Fundamentals of Network Security by Eric Maiwald (Dreamtech press)
4. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
5. Principles of Information Security, Whitman, Thomson.
6. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
7. Network Security: The complete reference, Robert Bragg, Mark Rhodes, TMH
8. Introduction to Cryptography, Buchmann, Springer.

ROBOTICS

PHD-DCSE (IV)

Unit-I:

Fundamental of Robotics: Robot anatomy, Co-ordinate system, Type and classification, speed of motion, Pay Load, Need of Robots, Different Applications.

Unit-II:

Elements of robots – links, joints, actuators, and sensors: Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters

Unit-III:

Examples of D-H parameters and link transforms, different kinds of actuators, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge-based force-torque sensors, proximity and distance measuring sensors, and vision.

Unit-IV:

Kinematics of serial robots- Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator. Other relevant topics.

Text Book (s):

1. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
2. Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence¸ McGraw- Hill, 1987.

NATURAL LANGUAGE PROCESSING
PHD-DCSE (V)

Unit-I:
Introduction, Level of Language Analysis, Organization of Natural language, Grammars: Grammars and sentence Structure, Transition Network Grammars.
Lexicon, Parsing with Features, Augmented Transition Networks, Various Lexicon Resource& Knowledge Source.

Unit-II:
Natural Language: Auxiliary Verbs and Verb Phrases, Movement Phenomenon in Language,Handling questions in Context-Free Grammars, Hold mechanisms in ATNs. Concept of parsing: Human preferences in Parsing, Encoding uncertainty, Deterministic Parser, POS Tagger, Stemmer, Ambiguity Resolution, Any other relevant topic.

Unit-III:
Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.
Words and Word Forms: Morphology fundamentals; Morphological Diversity of IndianLanguages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Unit-IV:
Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.
Meaning: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilingualism; Metaphors; Coreferences.
Web 2.0 Applications: Sentiment Analysis; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

Text Book (s):
1. JAMES ALLEN, Natural Language Understanding, 2/e, Pearson Education, 2003.
2. D. JURAFSKY, J. H. MARTIN, Speech and Language Processing, Pearson Education, 2002.
3. Christopher D. Manning, Hinrich Schütze, Foundations of Statistical Natural Language Processing, The MIT Press, Cambridge, Massachusetts.1999.
4. U. S. TIWARY, TANVEER SIDDIQUI, Natural Language Processing and Information Retrieval, Oxford University Press (2008).
5. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

HIGH SPEED NETWORKS

PHD-DCSE (VI)

Unit-I Frame Relay and High-Speed LANs

Covers Frame Relay Networks, Asynchronous Transfer Mode (ATM), ATM Protocol Architecture, ATM logical connection, ATM cell, ATM service categories, and AAL. Also includes high-speed LAN technologies such as Fast Ethernet, Gigabit Ethernet, Fibre Channel, and wireless LANs. Discusses WiFi and WiMax network applications, requirements, and the architecture of 802.11.

Unit-II Queuing Analysis and Congestion Control

Focuses on queuing analysis and models, single server queues, effects of congestion, and congestion control. Includes traffic management and congestion control techniques in packet switching networks and Frame Relay congestion control.

Unit-III TCP and ATM Traffic Management

Examines TCP flow control, congestion control, retransmission, timer management, exponential RTO backoff, KARN's algorithm, window management, and TCP performance over ATM. Discusses traffic and congestion control in ATM, including requirements, attributes, traffic management framework, ABR traffic management, ABR rate control, RM cell formats, ABR capacity allocations, and GFR traffic management.

Unit-IV Integrated Services and Queuing Disciplines

Explores Integrated Services Architecture, including its approach, components, and services. Covers various queuing disciplines such as FQ, PS, BRFQ, GPS, WFQ, and Random Early Detection. Includes Differentiated Services and RSVP, focusing on goals and characteristics, data flow, RSVP operations, protocol mechanisms, and Multiprotocol Label Switching (MPLS), including operations, label stacking, and protocol details. Also addresses RTP protocol architecture, data transfer protocol, and RTCP.

Text Book (s):

1. William Stallings, High speed networks and internet, Second Edition, Pearson Education,2002.

2. Warland, Pravin Varaiya, –High performance communication networks‖, Second Edition, Jean Harcourt Asia Pvt. Ltd., 2001.

3. Irvan Pepelnjk, Jim Guichard, Jeff Apar, ―MPLS and VPN architecture‖, Cisco Press, Volume 1 and 2, 2003.

AD-HOC & SENSOR NETWORKS

PHD-DCSE (VII)

Unit-I: Introduction to Ad Hoc Networks and Routing

Introduction to Ad Hoc Networks, data transmission, basics of wireless, sensors and applications, data retrieval in sensor networks, sensor network platforms and tools. Routing topics include cellular and ad hoc wireless networks, issues of MAC layer and routing, proactive, reactive, and hybrid routing protocols, multicast routing, tree-based and mesh-based protocols, and multicast with Quality-of-Service (QoS) provision.

Unit-II: Quality of Service (QoS)

Real-time traffic support, issues and challenges in providing QoS, classification of QoS solutions, MAC layer classifications, QoS-aware routing protocols, and ticket-based and predictive location-based QoS routing protocols.

Unit-III: Energy Management in Ad Hoc Networks

Need for energy management, classification of energy management schemes, battery management and transmission power management schemes, network layer and data link layer solutions, and system power management schemes.

Unit-IV: Mesh Networks

Necessity for mesh networks, MAC enhancements, IEEE 802.11s architecture, opportunistic routing, self-configuration and auto-configuration, capacity models, fairness, heterogeneous mesh networks, and vehicular mesh networks.

Unit-V: Sensor Networks

Introduction to sensor networks, sensor network architecture, data dissemination, data gathering, MAC protocols for sensor networks, location discovery, quality of sensor networks, evolving standards, other issues, and recent trends in infrastructure-less networks.

Text Book (s):

1. Ad Hoc and Sensor Networks – Theory and Applications, *Carlos Corderio DharmaP.Aggarwal,* World Scientific Publications, March 2006, ISBN – 981-256-681-3

2.Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, LeonidasGuibas,Elsevier Science, ISBN – 978-1-55860-914-3 (Morgan Kauffman).

3. C. Siva Ram Murthy and B.S.Manoj, ―Ad hoc Wireless Networks – Architectures andProtocols', Pearson Education, 2004

4. Feng Zhao and Leonidas Guibas, ―Wireless Sensor Networks‖, Morgan Kaufman Publishers, 2004.

5. C.K.Toh, ―Adhoc Mobile Wireless Networks‖, Pearson Education, 2002.

6. ThomasKrag and SebastinBuettrich, _Wireless Mesh Networking ', O'ReillyPublishers, 2007.