Department of Computer Science and Engineering Tripura University (A Central University) Suryamaninagar-799022



Syllabus for Ph.D. Coursework (Academic Session: 2024-25)

Syllabus for Ph.D. Coursework

(As Pre-Requisite for Ph.D. Registration)

Course Code	Course Name	Course Contents	Credit
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PRM1-3011	Research	Common for all disciplines	4
	Methodology I		
PRPE-3012	Research and	Common for all disciplines	2
	Publication Ethics		
PCSE-3013	Discipline Specific	As decided by the	4
	Advanced Research	concerned DRC	
	Methodology		
PCSE-3014	Discipline Specific	Discipline specific	4
	Research Analytical	Literature Survey, Review	
	Skill	of Research Papers and	
		Presentation as per need of	
		RAC	

As per Notification No. F.TU/Admission/Ph.D/01/2024, Dated: 23/01/2025

Detailed Syllabus for Ph.D. Coursework

<u>Course-I:</u>

PRM1-3011: Research Methodology I

Marks: 100

Credit: 4

Unit 1: Introduction to Research and Research Process

- Concept of Research: Definition, types of research, significance in academia and industry.
- **Research Process:** Steps in the research process, formulation of research questions and hypotheses.
- **Research Design:** Concept, importance, and types (descriptive, exploratory, experimental, etc.).

Unit 2: Research Methods and Methodology

- Qualitative and Quantitative Research: Definitions, methods, and approaches.
- **Sampling Techniques:** Types of sampling methods probability vs. non-probability sampling.
- Data Collection Methods: Surveys, interviews, questionnaires, case studies, focus groups, observation, Laboratory, ethnographic, etc.
- Data Analysis and Interpretation: Overview of statistical tools and methods.

Unit 3: Literature Review and Research Question Formulation

- Literature Review: Purpose, techniques for conducting a literature review, evaluating sources.
- **Developing a Research Question:** From literature, identifying gaps, formulating clear, researchable questions.
- **Theoretical Framework:** Understanding and formulating theoretical perspectives and models.

Unit 4: Writing and Presentation of Research

- **Research Paper Writing:** Structure, components (Abstract, Introduction, Literature Review, Methodology, Results, Discussion).
- Citations and References: Importance of proper citation styles (APA, MLA, Chicago).
- Thesis Writing: Organizing and presenting a doctoral thesis.
- Oral Presentation Skills: Preparing for research defense, presenting research results effectively.

Unit 5: Future Trends

- Emerging Research Tools: Artificial Intelligence generative tools, Digital resources
- Role of Inter-disciplinary/ Multidisciplinary/ Trans-disciplinary research.

- 1. Bell, J. (2010). Doing Your Research Project.
- 2. Berg, Bruce L. Qualitative Research Methods for the Social Sciences.
- 3. Bernard, H.R. (2017). *Research Methods in Anthropology: Qualitative and Quantitative Approaches.*

- 4. Booth, W.C., Colomb, G.G., & Williams, J. M. (2008). The Craft of Research.
- 5. Braun, V., & Clarke, V. (2006). Using Thematic Analysis in Psychology.
- 6. Bryman, A. (2016). Social Research Methods. New York: OUP.
- 7. Burns, R.B. (2000). Introduction to Research Methods.
- 8. Cooper, H., & Hedges, L. V. (Eds.). (2009). Handbook of Research Synthesis and Meta-Analysis.
- 9. Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.*
- 10. Creswell, J.W., & Poth, C.N. (2018). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches.*
- 11. Davis, Gordon B. Writing the Doctoral Dissertation: A Systematic Approach.
- 12. Denscombe, M. (2014). *The Good Research Guide: For Small-Scale Social Research Projects.*
- 13. Field, A. (2017). Discovering Statistics Using IBM SPSS Statistics.
- 14. Flick, U. (2018). An Introduction to Qualitative Research.
- 15. Gerring, J. (2012). Social Science Methodology: A Unified Framework.
- 16. Gravetter, F.J., & Wallnau, L.B. (2017). Essentials of Statistics for the Behavioral Sciences.
- 17. Gupta, S. C. Fundamental of Statics, Himalaya Publishing.
- 18. Gupta, S. P. Statistical Methods, Sultal Chand & Sons
- 19. Jupp, V. (2006). The Sage Dictionary of Social Research Methods.
- 20. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Delhi: New Age International,
- 21. Kumar, R. (2011). Research Methodology: A Step-by-Step Guide for Beginners.
- 22. Marcoulides, G. A. (Ed.) Modern methods for Business Research. Psychology Press.
- 23. Machi, Lawrence & McEvoy, Deborah A. The Literature Review: Six Steps to Success.
- 24. McKinney, K., & Hargrove, T. (2018). The Interdisciplinary Handbook of Research Design.
- 25. Melville, Stuart & Wayne, Goddard. Research methodology : an introduction for science & engineering students.
- 26. Neuman, W.L. (2014). Social Research Methods: Qualitative and Quantitative Approaches.
- 27. Pallant, J. (2013). SPSS Survival Manual.
- 28. Patton, M.Q. (2002). Qualitative Research & Evaluation Methods.
- 29. Ranjit Kumar. Research Methodology: A Step-by-Step Guide for Beginners.
- 30. Saunders, Mark, et al. Research Methods for Business Students.
- 31. Schutt, R. K. (2019). Investigating the Social World: The Process and Practice of Research.
- 32. Sekaran, U., & Bougie, R. (2016). Research Methods for Business: A Skill-Building Approach.
- 33. Silverman, D. (2016). Qualitative Research.
- 34. Silvia, Paul J. How to Write a Lot: A Practical Guide to Productive Academic Writing.
- 35. Strunk, William Jr. & White, E. B. The Elements of Style.
- 36. Tabachnick, B.G., & Fidell, L.S. (2013). Using Multivariate Statistics.
- 37. Turabian, K. L. (2018). A Manual for Writers of Research Papers, Theses, and Dissertations.
- 38. Walliman, N. (2017). Your Research Project: Designing and Planning Your Work.
- 39. Wayne, Goddard & Melville, Stuart. Research Methodology: An introduction
- 40. Zikmund, W. G. Babin, Carr, J.C. & Gri, M. Business Research methods. Mason: Cengage Learning.

Suggested Tools/Software:

- SPSS, R, Excel for data analysis.
- Zotero, Mendeley, RefWorks, EndNote for reference management.

<u>Course-II:</u>

PRPE-3012: Research & Publication Ethics

Marks: 50

Credit: 2

Philosophy and Ethics: Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgements and reactions

Scientific Conduct: Ethics with respect to science and research; Intellectual honesty and researchintegrity; Scientific misconducts: falsification, fabrication and plagiarism(FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data, falsification of images

Publication Ethics: Definition, introduction and importance of publication ethics; Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.; Publication misconduct: Unethical behavior and vice versa; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals

Open Access Publishing: Open access publications and initiatives; SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies; Software tool to identify predatory publications developed by SPPU; (Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester)

Publication Misconduct: Group discussions on - (i) Subject specific ethical issues, FFP, authorship; (ii)Conflicts of interest; (iii) Complaints and appeals: examples and fraud from India and abroad; Using Software tools - (iv) Anti-plagiarism tools like Turnitin, Urkund, Drill Bit and i-Thenticate and other open sources software tools

Databases and Research Metrics: (i) Databases - Indexing databases, Citation databases: Web of Science, Scopus etc.; (ii) Research Metrics - Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, h-index, g index, i10 index, altmetrics; (iii) Citation of bibliography using Mendeley

Recommended Books/Journals

- 1. Bird. (2006), Philosophy of Science, Routledge
- 2. P. Chaddah. (2018) Ethics in Competitive Research: Do not get scooped: donot get plagiarized: ISBN: 9789387480865
- National Academy of Science, National Academy of Engineering and Institute of Medicine. (2009). On Beinga Scientist: A Guide to Responsible Conduct in Research, 3rd Edition, National Academies Press.
- D. B Resnik. (2011) What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https: www.niehs nih.gov/research/resources/bioethics/whatis/index.cfm

- 5. J. Beall, (2012). Predatory publishers are corrupting open access. Nature 489(7415), 179-179 https://doi.org/10.1038/489179a
- Indian National Science Academy (INSA), Ethics in Science Education, Researchand Governance (2019), ISBN 978-81-939482-1-7 http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Course-III:

PCSE-3013: Discipline Specific Advanced Research Methodology Marks: 100 Credit: 4

[Choose any one from A, B, C, D, and E]

A: Advances of Machine Learning

Pre-requisites: Course logistics and overview, Linear Algebra Primer, Vector Calculus Review, Brief review of concepts from Linear Algebra and Vector Calculus.

Introduction to Machine Learning: Supervised and Unsupervised, Generative and Discriminative models, Classification and Regression problems; Feature selection, dimensionality reduction using PCA; Bayesian classification, Discriminative classifiers: Perceptrons, Multi-layer perceptron, RBF Networks, Decision Trees, Support Vector Machines; Unsupervised learning: EM Algorithm; K-Means clustering, DBSCAN, Hierarchical Agglomerative Clustering, Density estimation in learning, Mean-shift clustering; Classification performance analysis; Ensemble methods: Ensemble strategies, boosting and bagging; Sequence Models: Hidden Markov Models, Probabilistic Suffix Trees; Applications and Case studies.

Advanced Topics in Machine Learning: Kernel Methods: Review of SVM, Classification and Regression using SVM, Properties of Kernels, Non-Mercer Kernels, Kernel Selection, Multiple Kernel Learning, Kernel PCA; Probabilistic Graphical Models: Bayesian networks, Undirected models, Bayesian learning, structure learning, Inference on graphical models, exponential families; Deep Learning: Review of Multi-layer Perceptrons, Backpropagation Algorithms, Stochastic Gradient Descent, Loss and Activation functions, Regularization strategies, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory Units (LSTM), Auto encoders; Reinforcement Learning: Introduction to Reinforcement Learning, Multi-armed Bandit Problem, Finite Markov Decision Processes, Dynamic Programming, Eligibility Traces, Policy Gradient Methods, Deep-Q Learning; Applications and Case Studies.

Advances of Convolutional Neural Network (CNN): ConvNets, ConvNet Architectures and Dropout/Regularization/Batchnorm ConvNets: Basic concepts of Convolutional Neural Networks starting from filetering. Convolution and pooling operation and arithmatics of these. ConvNet Architectures: Discussions on famous convnet architectures - AlexNet, ZFNet, VGG, C3D, GoogLeNet, ResNet, MobileNet-v1, MobileNet-v2, EfficientNet, GhostNet. Discussion on regularization, Dropout, Batchnorm, Optimizers, etc.

Applications of CNN in Detection and Segmentation: Discussion on detection, segmentation problem definition, challenges, Evaluation, Datasets and Localization by regression. Discussion on detection as classification, region proposals, RCNN family, SSD, and YOLO architectures,

fully convolutional segmentations, Mask-RCNNs, Encoder-Decoder Frameworks (Seg-Net and U-Net), Recurrent Architectures, Transformers, NLP Applications, Vision Transformers, Discussion on Recurrent Neural Networks (RNNs), Long-Short Term Memory (LSTM) architectures, Discussion on Attention, Transformers, Few Shot/Zero Shot Learning Algorithms.

Recommended Books/References:

- 1. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall (India) 2015.
- 2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, 2nd Edn., Wiley India, 2007.
- 3. C. M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer, 2006.
- 4. S. O. Haykin, Neural Networks and Learning Machines, 3rd Edition, Pearson Education (India), 2016.
- 5. J. Shawe-Taylor and Nello Cristianini, Kernel Methods for Pattern Analysis, Cambridge University Press, 2004.
- 6. D. Koller and N. Friedman, Probabilistic Graphical Models Principles and Techniques, MIT Press, 2009.
- 7. I. Goodfellow, Y. Bengio , A. Courville, Deep Learning, MIT Press, 2017.
- 8. R. Sutton, Reinforcement Learning An Introduction, MIT Press, 1998.
- 9. Iddo Drori, "The Science of Deep Learning", Cambridge University Press
- 10. Simon O. Haykin, "Neural Networks and Learning Machines", Pearson Education India
- 11. Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press
- 12. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep learning, In preparation for MIT Press, Available online: http://www.deeplearningbook.org, 2016
- 13. S. Haykin, Neural Networks and Learning Machines , Prentice Hall of India, 2010
- 14. Satish Kumar, Neural Networks A Class Room Approach, Second Edition, Tata McGraw-Hill, 2013
- 15. B. Yegnanarayana, Artificial Neural Networks, Prentice- Hall of India, 1999
- 16. C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

B: Digital Forensics

Introduction to Digital Forensics: Definition of digital forensics and computer forensics and its principles, Cyber-crime and computer based crime, Evolution of computer forensics, Stages of computer forensics process, Benefits of computer forensics, Uses of computer forensics, Objectives of computer forensics, Role of forensics investigator, Forensics readiness its goals, benefits and steps for effective Forensic Readiness Planning, Understanding the legal and ethical considerations in digital forensics.

Computer Crime Investigation & Different types of Acquiring Evidence or Crime Scene Management and Forensic Evidence: Introduction to digital evidence, Techniques for acquiring digital evidence from various sources (hard drives, USB drives, mobile devices, cloud storage), Initial decision making system, Chain of custody and preserving evidence integrity, Crime Scene Management: Introduction to the crime scene, Types of Crime Scene, Evaluation and processing of crime scene of crime, Documenting the crime scene (Note making, sketching, photography, videography of crime scene), role of the first arriving officer at the crime scene, Searching techniques of crime scene, processing of physical evidence-discovering, recognizing and examination of physical evidence, Preservation, packaging, sealing, labelling and forwarding of physical evidence, maintaining the chain of custody, probative value of physical evidence, reconstruction of scene of crime, Introduction to physical evidences, Types of physical evidences, classification and role of physical evidences in criminal investigations & Trails.

File Systems & Open-Source Forensic Tools: Understanding different file systems (NTFS, FAT, ext4, HFS+), File system analysis techniques for digital forensics, Introduction to popular open-source forensic tools (Autopsy, Sleuth Kit, Volatility, Wireshark, Photo forensics), Handson exercises with open-source tools for evidence analysis.

Malware Analysis: Understanding malware behavior and characteristics, Analyzing malware samples to determine their functionality and impact.

Audio Recognition and Video Analysis: Introduction to voice identification/speaker recognition, speech enhancement, Speaker Profiling: Segregation of speech samples, auditory analysis/listener's approach, spectographic approach or voiceprint analysis, Automatic speaker recognition technique, Video processing and enhancement, video authentication, hash value generation, Video Analysis: Frame Extraction, frame by frame analysis, shot by shot analysis, Technical aspects of the video, collection, handling and preservation of video files.

Image and Video Forensics/ Multimedia Forensics: Introduction to digital forgery, Taxonomy for digital forgery, Different challenges for forgery detection, Basic steps of the image/ video forensic investigation process, Challenges faced during forged content creation, Tools used by the research community for creation of forged media content, Encoder-decoder frameworks for forged object localization in images/ videos, Classification models for forged and authentic image classification, Performance evaluation metrics used for measuring the robustness of forgery detection (DCT, ELA, SRM, HOG, SIFT, CFA, NOI-I, NOI-II, etc.), Parameters used for analysis of the quality of the forged datasets, Generative Adversarial Network (GAN) for fake dataset generation, Some advanced architectures for face forgery dataset generation and their practical applications, Concept and need of metadata information for forgery detection in images/ videos, Photo-response non-uniformity (PRNU) based forgery localization, Long short-term memory (LSTM) networks for forgery detection, Domain adaptation models in context of forgery detection tasks, Quantum Neural Network in context of forgery detection tasks, Applications of forgery detection in social contexts.

- 1. Digital evidence and computer crime Forensic science, computers, and the internet. Third edition: E. Casey, 2011.
- 2. Digital image forensics: HT Sencar, N Memon, 2013.
- 3. Multimedia forensics: H. T. Sencar, L. Verdoliva, & N. Memon, 2022.
- 4. An introduction to criminalistics: C. E. O'hara, & J. W. Osterburg, (1952).
- 5. Dahiya M S, Crime scene management: a scientific approach; Shanti Sarvar Prakashan.
- 6. D. Shaw, Physics in the prevention and detection of crime. Contemporary Physics, 17(4), 307-330, 1976.
- 7. Practical digital forensics: R. Boddington, 2016.
- 8. Performing File Forensics on Windows 10 FAT 32 and NTFS File Systems using The Sleuth Kit (Autopsy Wrapper): U. Salter, 2023.
- 9. Malware analyst's cookbook and DVD: tools and techniques for fighting malicious code: M. Ligh, S. Adair, B. Hartstein, & M. Richard, 2010.
- 10. Practical malware analysis: the hands-on guide to dissecting malicious software: M. Sikorski & A. Honig, 2012.
- 11. Beigi, H., & Beigi, H. (2011). Speaker recognition (pp. 543-559). Springer US.

- 12. S. Singh, Forensic and Automatic Speaker Recognition System. International Journal of Electrical & Computer Engineering (2088-8708), 8(5), 2018.
- 13. Robustness-related issues in speaker recognition: T. F. Zheng, & L. Li, 2017.
- 14. Handbook of video databases: design and applications: B. Furht, & O. Marques 2003.
- 15. Schuld, Maria, Ilya Sinayskiy, and Francesco Petruccione. "The quest for a quantum neural network." Quantum Information Processing 13 (2014): 2567-2586.
- 16. Jia, Z. A., Yi, B., Zhai, R., Wu, Y. C., Guo, G. C., & Guo, G. P. (2019). Quantum neural network states: A brief review of methods and applications. Advanced Quantum Technologies, 2(7-8), 1800077.
- Beer, K., Bondarenko, D., Farrelly, T., Osborne, T. J., Salzmann, R., Scheiermann, D., & Wolf, R. (2020). Training deep quantum neural networks. Nature communications, 11(1), 808.
- 18. Verdoliva, L. (2020). Media forensics and deepfakes: an overview. IEEE Journal of Selected Topics in Signal Processing, 14(5), 910-932.

C: Wireless Ad Hoc And Sensor Networks

Introduction to Wireless Networks: History of Wireless Networks - DARPA, ALOHA, PRNET etc. Infrastructure based and Infrastructure less Wireless Networks. Homogeneous & Heterogeneous Wireless Networks. Enabling Technologies & their comparison - ZigBee, Bluetooth & IEEE 802.11, Networking Technologies. Classification of Wireless Ad Hoc Networks - WMNs, MANETs, VANETs & WSNs, Common Challenges, Device Heterogeneity, Introduction to Opportunistic Mobile Networks and UAV networks.

Wireless Ad Hoc Networks: Media Access Protocols, Routing Protocols - Periodic & On-Demand Routing, Fault Tolerant Routing, Multicast Routing - Flooding, Source Based Multicast Tree(SBT), Core Based Multicast Tree(CBT), Multicast Mesh, Group Based Multicast Forwarding. TCP over Ad Hoc Networks.

Mobile Adhoc Networks (MANET): Self-organized v/s Conventional Networking. Basic self organizing principles. Design Paradigms in self-organizing Networks, Self-organization Mechanisms – Neural Networks Based, Game Theory Based, Reinforcement Learning Based, Distributed Artificial Learning Based, Data Mining Based, Evolution Theory Based. Co-operation in Mobile Adhoc Networks: Characteristics & Challenges.

MAC Protocols in MANETs: Classification of MAC Protocols - Carrier Sense Multiple Access (CSMA) Protocol, Multiple Access with Collision Avoidance (MACA), Multiple Access with Collision Avoidance for Wireless (MACAW).

Routing in MANETs: Introduction, Challenges, Expected Properties. Proactive Routing Protocol - Wireless Routing Protocol (WRP), Fisheye State Routing Protocol(FSR), Optimized Link State Routing Protocol (OLSR). Reactive Routing Protocols - Dynamic Destination Sequenced Distance Vector (DSDV), Dynamic State Routing(DSR), Ad Hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing Protocols - Adaptive Distance Vector (ADV), Unicast Routing Protocols, Multicast Routing Protocols, Tree based Routing Protocols, Mesh based Routing Protocols, Mobility models, Transport layer, Transport Layer Protocols

Wireless Sensor Networks : Introduction, Coverage and Placement, Topology management, Mobile Wireless Sensor Networks, Medium Access Control, Congestion control, Flow Control, Routing in Wireless Sensor Networks, Underwater WSN.

Recommended Books/References:

- 1. Charles E. Perkins, Ad Hoc Networking, Addison Wesley; 1st edition, 2020.
- 2. Jing (Selena) He, Shouling Ji, Yingshu Li, Yi Pan, Wireless Ad Hoc and Sensor Networks: Management, Performance and Applications, CRC Press Publication, 1st edition, 2013.
- 3. Part of the syllabus will be covered through research papers.

D: Computer Network and Network Security

Network , Transport & Application Layer: Network Layer: Routing Algorithms: Shortest Path Routing, Flooding, Hierarchical Routing, Broadcast Routing, Multicast Routing, Distance Vector Routing. Congestion, Congestion Control Algorithms: General Principles, Prevention Policies, Congestion Control in Virtual-Circuit Subnets, Congestion Control in Datagram Subnets, Internetworking, The Network layer in the internet. Transport Layer: Transport Services, Transport Protocols, The Internet Transport Protocols: UDP, TCP; Application Layer: Domain Name System (DNS), Simple Network Management Protocol (SNMP), Electronic Mail, World Wide Web, Multimedia.

Computer Network Security: Computer Network Security, Security Challenges, Security Attacks, Security Threats, Security Threat Motives, Security Threat Management, Security Threat Correlation, Security Threat Awareness, Security Services and Mechanisms, Common Security components, Security Standards, Computer Network Vulnerabilities: Sources of Vulnerabilities, Vulnerability Assessment. Cyber Crimes and Hackers: Cyber Crimes, Hackers, Dealing with the Rising Tide of Cyber Crimes, A Model for Network Security.

Cryptography: Introduction to Cryptography, Substitution Ciphers, Transposition Ciphers, Private key cryptography, Public key cryptography, Key Management and Distribution, OneTime i.e. End-to-End and Link Encryption, Basic Cryptographic Protocols: Key Exchange, Authentication, Analysis of Authentication and key Exchange Protocols, Secret splitting, Secret sharing, Secure elections, Electronic money. Symmetric-Key Algorithms, The Data Encryption Standard (DES), The Advanced Encryption Standard (AES), Cipher Modes, Other Ciphers, Cryptanalysis, Public-Key Algorithms, RSA Algorithm, Diffie-Hellman, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Digital Signatures & Security Management: Digital Signatures and Authentication Protocols, Symmetric Key Signatures, PublicKey Signatures, Message Digests, The Birthday Attack, Management of Public Keys: Certificates, X.509, Public Key Infrastructures, Authentication Protocols, Kerberos. Communication Security, IPsec, Firewalls, Virtual Private Networks, Wireless Security, E-Mail Security, Pretty Good Privacy, Privacy Enhanced Mail, S/MIME, IP Security Architecture, Web Security : Threats, Secure Naming, The Secure Sockets Layer, Transport Layer Security, Secure Electronic Transaction, Blockchain Technologies.

- 1. Andrew S. Tanenbaum, et al, "Computer Networks", Fifth Edition, Pearson Education India, 2013
- 2. William Stalings, "Foundation of Modern Networking", Pearson Education India, 2022.
- 3. Jeffery S. Beasley, "A Practical Guide to Advanced Networking", Third Edition, Pearson IT Certification, 2012.
- 4. Stalling, "Cryptography and Network Security: Principles and Practice", Sixth Edition, Pearson Education India, 2023.
- 5. C Siva Ram Murty & BS Manoj, "Ad HOC Wireless Networks: Architectures & Protocols" 2nd Ed, Pearson Education.

- 6. S. Keshav , "An Engineering Approach to Computer Networks", 2nd Edition, Pearson Education
- 7. Behrouz A. Forouzan, Data Communications and Networking, Third Edition TMH.
- 8. Asharaf S., Sivadas Neelima, Adarsh S., Franklin John, "Blockchain Technology: Algorithms and Applications", Wiley, 2023.
- 9. Part of the syllabus will be covered through research papers.

E: Recommender Systems

Introduction: Introduction and basic taxonomy of recommender systems (RSs). Traditional and non-personalized RSs. Recommender system functions, Applications of recommendation systems, Issues with recommender systems, Understanding ratings, Overview of data mining methods for recommender systems (similarity measures, clustering, SVMs, dimensionality reduction).

Collaborative Filtering RSs: User-based nearest neighbor recommendation, Item based nearest neighbor recommendation, Components of neighborhood methods (rating normalization, similarity weight computation, neighborhood selection), Model based and pre-processing based approaches, The cold-start problem, Long-tail principle. Attacks on collaborative recommender systems, Domain-specific challenges in recommender systems.

Content-based recommendation: Basic components of content-based RSs. Feature selection. Item representation Methods for learning user profiles, High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

Context-aware recommender systems: Contextual information models for RSs. Incorporating context in RSs.

Knowledge based recommendations: Knowledge representation and reasoning, Constraint based recommender systems, Case based recommender systems.

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design- Feature combination, Feature augmentation, Parallelized hybridization design- Weighted, Switching, Mixed, Pipelined hybridization design- Cascade Meta-level, Limitations of hybridization strategies.

Performance Evaluation of Recommender Systems: Evaluation metrics, Decision-Support metrics, User Centered metrics. Experimental settings, Rating prediction and accuracy. Working with RSs data sets.

Recommender Systems Applications: Real-time Recommender System like Social, Food, Music, Fashion along with their challenges.

- 1. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2022), 3rd ed.
- 2. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
- 3. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed.

- 4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed
- 5. J. Leskovec, A. Rajaraman and J. Ullman, Mining of massive datasets, 2nd Ed., Cambridge, 2012. (Chapter 9).
- 6. Part of the syllabus will be covered through research papers.

Course-IV:

PCSE-3014: Discipline Specific Research Analytical Skill Marks: 100 Credit: 4

Discipline Specific Literature Survey, Review of Research Papers and Presentation as per need of RAC