Department of Artificial Intelligence and Data Science

Scheme & Syllabi for Pre-Ph.D.

Computer Science (Artificial Intelligence and Data Science)

w.e.f. 2023-2024

Paper No.	Nomenclature	Credits
PPD-101	Research Methodology	04 Credits
PPD-102	Review of Literature and Seminar	04 Credits
PPD-103	Departmental Elective Course Option - I : Computational Intelligence (PPD-103(i)) Option - II : Intelligent Wireless Communication (PPD-103(ii)) Option - III : Network Security (PPD-103(iii))	04 Credits
PPD-104	Research and Publication Ethics (RPE)	02 Credits

Course Work

i) The duration of the Ph.D. course work will be of one semester. It will be offered in the first semester. It will consist of 04 papers.

ii) Each paper of the course work except PPD-104 will be of 4 credits. PPD-104 is of 02 credits. Each paper will of 100 marks.

iii) The scheme for Ph.D. course work is as under:

PPD-101: Research Methodology

PDS-102: Review of Literature and Seminar - It includes review of literature, presenting a seminar on review of published state of art research or on own published review / survey paper in the relevant area of research etc.

PPD-103: Departmental Elective Course

It includes an elective course related to the relevant field of research and it will be offered by the respective department/school.

PPD-104: Research and Publication Ethics (RPE)

This course is for awareness about the publication ethics and publication misconducts. It includes basics of philosophy of science, technology, ethics, research integrity, publication ethics etc.

Research Methodology

General Course Information

Course Code: PPD-101 Course Credits:4 Contact Hours: 4 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods:** **Max. Marks: 100 (Internal: 30; External: 70)** Two minor tests, each of 20 marks, will be conducted. For the purpose of internal assessment, the average of the marks obtained by a student in these two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (6 marks) Assignments (2 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. All questions carry equal marks. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. The remaining eight questions are to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt five questions in all, one compulsory and any other four questions by selecting one from each unit.

Course content

Unit I

Research Methodology: Nature, Objectives, and of research , type of research , research approaches, significance of research , scope and formulation of hypothesis, research and scientific encountered by researchers in India, benefits to the society in general, defining the research problem: definition of research problem, problem formulation, necessity of defining the problem, technique involved in defining a problem

Unit II

Statistical analysis an probability distribution: Measure of central tendency and dispersion mean, median, mode, range, mean deviation, standard deviation, discrete continuous and mixed random variables, definition of probability, addition rules and conditional probability, binomial, poisson sampling and geometric distribution, sample test,chi-square test.

Unit III

Research design and modeling: meaning of research design, need of research design, features of a good design, important concept related to research design, different research design, basic principles of experimental design, developing a research plan, design of experimental set-up, Use of standards and codes, types of models, model building and stages, need and type of simulation.

Unit IV

Research report writing: Format of the research report, Synopsis dissertation thesis its differentiation , references/bibliography, technical paper writing/general report writing , making presentation ,use of visual aids, research proposal preparation: writing a research proposal and research report, writing research grant proposal, Computer application for presentation : basic presentation skills for documentation and presentation tools: power point, Microsoft office and Knowledge tools.

Text and Reference Books:

1. C.R. Kothari & Gaurav Garg (2014), Research Methodology, Third Edition, New Age International Publishers.
2. R. Ganeshan, Research Methodology for Engineers, MJP Publisher, 2011
3. Ratan khananabis and Suvasis Saha,Research Methodology, University Press, Hyderabad, 2005

4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Comptation, Sterling Publisher Pvt. Ltd., New Delhi, 2004.
5. Vijay Upagade and Arvind Shende , Research Methodology, S. Chand and Company Ltd., New Delhi, 2009.
6. Y.K. Singh, Fundamental of Research Methodology and Statistics, New Age international Pvt. Ltd, 2006.

Review of Literature and Seminar

General Course Information

Course Code: PPD-102 Course Credits:4	**Course Assessment Methods:** **Max. Marks: 100 (Internal: 30; External: 70)** The candidates shall review 25 to 35 research papers under the guidance of supervisor (s) concerned and shall submit the report (a copy of Review of Literature) as well as to present their work in the form of seminar before the evaluation committee constituted (including supervisor (s) concerned) by chairperson of the department. The performance will be evaluated on the basis of submitted literature and the presentation given by the candidate before the evaluation committee. The internal evaluation is done by supervisor (s) concerned on the basis of critical understanding of review of literature for given topic by the candidate. The external evaluation is done by the evaluation committee constituted (including supervisor (s) concerned) by chairperson of the department on the basis of critical understanding of review of literature for given topic by the candidate as well as presentation given by the candidate before the evaluation committee.

Computational Intelligence

General Course Information

Course Code: PPD-103(i) Course Credits:4 Contact Hours: 4 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods:** **Max. Marks: 100 (Internal: 30; External: 70)** Two minor tests, each of 20 marks, will be conducted. For the purpose of internal assessment, the average of the marks obtained by a student in these two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (6 marks) Assignments (2 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. All questions carry equal marks. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. The remaining eight questions are to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt five questions in all, one compulsory and any other four questions by selecting one from each unit.

Course content

Unit I

Introduction: Computational Intelligence, Soft Computing, Learning, Types of Learning, Fuzzy Systems, Rough Sets, Evolutionary Search Strategies.

Unit II

Artificial Neural Networks: Introduction, Mc Culloch-Pitts Neuron Model, Learning Rules, Perceptron, Neural Network Architectures, Associative Memory Networks, Feed forward Networks, Backpropogation Network. Deep Neural Network, Training Deep Neural Network.

Unit III

Classification: Introduction, Decision Tree Induction, Bays Classification Methods, Rule based Classification, Support Vector Machine, Model Evaluation and Selection, Techniques to Improve classification accuracy.

Unit IV

Cluster Analysis: Introduction, Partitioning Methods, Hierarchical Methods, Density Based Methods, Evaluation of Clustering, Outlier and outlier Analysis, Outlier Detection Methods, Outlier detection in High dimensional Data.2024

T**ext and Reference Books:**

1. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, Margon Kaufman Publishers, Waltham, USA, Third Edition, July 2011.
2. Samir Roy, Udit Chakraborty, Introduction to Soft Computing, Pearson India Education, First Edition, 2013.
3. Charu C Aggarwal, Neural Networks and Deep Learning, Springer International Publishing, Second Edition, 2023.
4. Russell Stuart, Norvig Peter, Artificial Intelligence: A Modern Approach, Pearson Education, Fourth Edition, 2022

Intelligent Wireless Communication

General Course Information

Course Code: PPD103(ii) Course Credits:4 Contact Hours: 4 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods:** **Max. Marks: 100 (Internal: 30; External: 70)** Two minor tests, each of 20 marks, will be conducted. For the purpose of internal assessment, the average of the marks obtained by a student in these two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (6 marks) Assignments (2 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. All questions carry equal marks. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. The remaining eight questions are to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt five questions in all, one compulsory and any other four questions by selecting one from each unit.

Course content

Unit I

Introduction Intelligent Wireless Communication, Roadmap and Pillars for nest generation networks, Small Cells for Mobile Networks, Cooperation for Next Generation Wireless Networks

Unit II

Machine type communication, intelligent resource allocation and interference management, Edge intelligent, machine learning and deep Learning for next generation wireless networks, Generative Learning for wireless communication.

Unit III

Software Defined Networks, Self-organization and self-Optimization networks, Cloud based network, Big Data and wireless networks, Fog and IoT computing, Front Haul and Backhaul Network, Ultra Dense networks modeling analysis and application.

Unit IV

Wireless Systems Simulation and Evaluation Techniques, Evolution of Testing Technology, Software Simulation, Software Simulation Requirements, Link Level Simulation, System Level Simulation, Case study of various simulation approaches.

Text and Reference Books:

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks," John Wiley & Sons, Ltd., 2015
2. Yang Yang, "5G Wireless Systems Simulation and Evaluation Techniques," Springer, 2017.
3. Nobuyoshi Terashima, "INTELLIGENT COMMUNICATION SYSTEMS," ACADEMIC PRESS, 2002
4. Chu, Xiaoli; Duong, Trung Q.; Suraweera, Himal A, "Ultra-dense networks for 5G and beyond: modelling, analysis, and applications," Wiley, 2019.
5. Muhammad Ali Imran,Syed Ali Raza Zaidi, "Access, fronthaul and backhaul networks for 5G & beyond," Volume: Series:IET telecommunications series 74, The Institution of Engineering and Technology, 2017.
6. Balasubramanian, Bharath; Bonomi, Flavio; Chiang, Mung, "Fog for 5G and IoT," Fog for 5G and IoT, Wiley, 2017.
7. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen (eds.), "5G Mobile Communications", Springer, 2017

8. Amin Ebrahimzadeh, Martin MaierToward, 6G: A New Era of Convergence, John Wiley & Sons, Inc., Hoboken, New Jersey, 2021.
9. Yang Yang, Jing Xu, Guang Shi, Cheng-Xiang Wang, " 5G Wireless Systems Simulation and Evaluation Techniques," Springer International Publishing AG 2018.

Network Security

General Course Information

Course Code: PPD-103(iii) Course Credits:4 Contact Hours: 4 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods:** **Max. Marks: 100 (Internal: 30; External: 70)** Two minor tests, each of 20 marks, will be conducted. For the purpose of internal assessment, the average of the marks obtained by a student in these two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (6 marks) Assignments (2 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. All questions carry equal marks. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. The remaining eight questions are to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt five questions in all, one compulsory and any other four questions by selecting one from each unit.

Course content

Unit I

Wireless Ad hoc Networks, Routing protocols in Wireless Ad hoc networks, Wireless Sensor Networks, Applications and Challenges, Single-Node Architecture – Hardware Components, Basic Sensor Network Architectural Element, Security Requirements in Wireless Ad hoc Networks, Issues & challenges in security provisioning, Security attacks, Possible solutions for attacks, DoS and DDoS attacks, Secure information processing for sensor networks, State of art attack detection and mitigation techniques.

Unit II

IoT elements and Data Analytics for IoT Sensor Technology, Industrial IoT, Automotive IoT, IoMT, Data Communication Protocols, Data Analytics for IoT: Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Spark, Apache Storm, Structural Health Monitoring Case Study, Wireless Technologies for IoT/M2M, Security and Privacy Concerns in IoT Applications, Security Architecture in IoTs, Threats to Access Control, Privacy, and Availability, Specific Attacks to IoT, Vulnerabilities, Authentication/Authorization for Smart Devices, State of art cyber-attack detection and mitigation techniques in context of IoT.

Unit III

Cloud service and deployment models, Cloud vulnerabilities, Cloud Security Challenges, Cloud Information Security Objectives, Cloud Security Services, Secure Cloud Software Requirements, Cloud Security Policy Implementation, Infrastructure Security, Data Security and Storage, Privacy in Cloud, Threats and Vulnerabilities to Infrastructure, Data and Access Control, Trusted Cloud Computing, Identity Management and Access Control, State of art attack detection and mitigation techniques in in context of cloud computing.

Unit IV

Firewalls and types, Intrusion detection systems, techniques and types, limitations and open problems of intrusion detection systems, advanced persistent threats, case studies of intrusion detection systems against real-world threats and malware, statistical and machine learning approaches to detection of attacks - techniques for studying the Internet and estimating the number and severity of attacks, statistical pattern recognition for detection and classification of attacks, and techniques for visualizing network data, Network Security tool: Reconnaissance tools, attack and penetration tools, NMAP, TCPDUMP, Wireshark, SNORT, Reverse firewalling, securing honeypots, Honeywall, Botnets, tracking botnets, analysing malware, capturing malware using honeypots.

Text and Reference Books:

1. Murthy, C. S. R., & Manoj, B. S. (2004). Ad hoc wireless networks: Architectures and protocols, portable documents. Pearson education.
2. Tonguz, O. K., & Ferrari, G. (2006). Ad hoc wireless networks: a communication-theoretic perspective (Vol. 5). Hoboken: Wiley.
3. Cayirci, E., & Rong, C. (2008). Security in wireless ad hoc and sensor networks. John Wiley & Sons.
4. Chaki, N., & Chaki, R. (Eds.). (2014). Intrusion detection in wireless ad-hoc networks. CRC Press.
5. Olivier Hersent David Boswarthick & Omar Elloumi (2012) The Internet of Things: Key Applications and Protocols, Wiley.
6. Li, S., & Da Xu, L. (2017). Securing the internet of things. Syngress.
7. Buyya, R., Broberg, J., & Goscinski, A. M. (Eds.). (2010). Cloud computing: Principles and paradigms. John Wiley & Sons.
8. Krutz, R. L., & Vines, R. D. (2010). Cloud Security: A Comprehensive Guide to Secure Cloud Computing Wiley Publishing. Inc. Indianapolis, Indiana.
9. Mather, T., Kumaraswamy, S., & Latif, S. (2009). Cloud security and privacy: an enterprise perspective on risks and compliance. " O'Reilly Media, Inc.".
10. Roberto Di Pietro, Luigi V. Mancini (2008), Intrusion Detection System, Springer.
11. Anderson, James P. (1980), "Computer Security Threat Monitoring and Surveillance," Washing, PA, James P. Anderson Co.

Research and Publication Ethics (RPE)

General Course Information

Course Code: PPD-104 Course Credits: 2 Contact Hours: 2 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods:** **Max. Marks: 50 (Internal: 15; External: 35)** Two minor tests, each of 10 marks, will be conducted. For the purpose of internal assessment, the average of the marks obtained by a student in these two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (3 marks) Assignments (1 mark) and class performance (1 mark). The end semester examination will be of 35 marks. For the end semester examination, nine questions are to be set by the examiner. All questions carry equal marks. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. The remaining eight questions are to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt five questions in all, one compulsory and any other four questions by selecting one from each unit.

Course content

Course Structure:

The course comprised of six modules listed in table below. Each module has 4-5 units.

Modules	Unit Title	Teaching Hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE 05	Publication Misconduct	4
RPE 06	Database and Research Metrics	7
Total		30

Syllabus of "Research and Publication Ethics" (RPE)

I. Theory

RPE 01: Philosophy and Ethics (3 hours)

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

RPE 02: Scientific Conduct (5 hours)

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

RPE 03: Publication Ethics (7 hours)

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour andvice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

II. Practice

RPE 04: Open Access Publishing (4 hours)

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 tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

RPE 05: Publication Misconduct (4 hours)

A. Group Discussions (2 hours)

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 (2 hours)

1. Use of plagiarism software like Tumitin, Urkund and other open source software tools

RPE 06: Databases and Research Metrics (7 hours)

A. Databases (4 hours)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3 hours)

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

Reference:

1. Bird, A.(2006). Philosophy of Science.Routledge
2. Maclntyre, Alasdair (1967) A Short History of Ethics. London
3. P.Chaddah, (2018) Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN :978-9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to responsible conduct in Research: Third Edition, National Academies Press.
5. Resnik, D.B.(2011) What is ethics in research & why is it important. National institute of Environmental Health Science, 1-10 Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
6. Beall, J: (2012) Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. https://www.insaindia.res.in/pdf/Ethics_Book.pdf