

ಬೆಂಗಳೂರು
ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ



BENGALURU
CITY UNIVERSITY

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No.BCU/Ph.D-Syllabus / 97 /2025-26

Date. 15.04.2025

NOTIFICATION

Sub: Computer Science Ph.D Course Work Syllabus of Bengaluru City University

Ref: 1. The recommendations of the Board of Studies in Computer Science and Applications (PG & UG)
2. Approval of the Vice-Chancellor dated.09.04.2025

In pursuance to the recommendations of the Board of Studies in Computer Science and Applications (PG & UG) and pending approval of the Academic Council, the Syllabus for Computer Science Ph.D Course Work of Bengaluru City University with is hereby notified for information of the concerned. Effective from the academic year 2025-26

The copy of the Syllabus is notified in the University Website: www.bcu.ac.in for information of the concerned.


REGISTRAR


To,

1. The Dean, Faculty of Science, BCU.
2. The Chairman & Members of BOS in Computer Science & Applications (PG & UG), BCU.
3. The Principals of the concerned affiliated Colleges of BCU – through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
5. Office copy / Guard file.

Bengaluru City University, Bengaluru
Department of Computer Science

Syllabus for PhD Coursework
in
Computer Science

With Effect From
2024-2025

Dr Ramesh B Kudenatti
Chairman (I/c)

07 April 2025

Structure of PhD Coursework

SN	Name of the Course	Hours/ Week	Exam duration	Maximum Marks			Credits
				CA	Exam	Total	
1	Paper I: Research Methodology in Computer Science	03	03	30	70	100	04
2	Paper II: Advanced Algorithms	03	03	30	70	100	04
3	Paper III: A. Digital Image Processing B. Artificial Intelligence and Machine Learning	03	03	30	70	100	04
4	Paper IV: Research and Publication Ethics	1.5	1.5	15	35	50	02
		Comprehensive Viva			50	50	02
		Total			295	400	16

Paper I: Research Methodology in Computer Science

Unit I: Introduction to research

12 Hours

What is Research?, Types of research, Why research? Significance and Status of research in computer science, Steps in research: having grounding in computer science, major journals and publication in computer, Major research areas of computer science, identification, selection and formulation of research problem, hypothesis formulation, developing a research proposal, planning your research, the wider community resources and tools, how engineering research differs from scientific research, the role of empirical studies.

Unit II: Statistics for computer science research

12 Hours

Basics of statistics-probability theories, conditional probability, Poisson distribution. Binomial distribution, Properties of normal distributions, estimates of means and proportions; Principal component and factor analysis. Standard deviation coefficient of variations. Correlation and regression analysis.

Unit III: Research methods for computer science

12 Hours

Formal specification, algorithm, and complexity; building artifacts: proof of performance, concept, existence; process methodology: human-computer interaction, cognitive processes, interactive games, social networks and web analytics

Unit IV: Research papers and thesis presentation

12 Hours

Literacy survey: finding out about your research area, literature search strategy writing critical reviews, identifying venues for publishing your research. Writing papers and the review process: preparing and presenting paper, the conference review process, making use of the referee's reports, the journal review process, group exercise in reviewing research papers.

Thesis writing: Planning the thesis, writing the thesis, thesis structure, writing up schedule, the Oral examination and viva voce.

Reference books:

1. Francis C Dane, Research Methods, Brooks/ Cole publishing company, California, 1990.
2. Juliet Corbin, Anselm Strauss, Basic of Qualitative Research, 3rd Edition, Sage Publication, California, 2008.
3. Chandan, J. S. Statistics for Business and Economics, 1st Edition, Vikas Publishing, 2021
4. Angela Brew, The nature of research: Inquiry in Academic Context, 1st Edition, Routledge, London, 2002.
5. Kothari C.R. and Gaurav Garg Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi, 2019.

Paper II: Advanced Algorithms

Unit I: Review of analysis techniques

10 Hours

Review of Analysis Techniques: Growth of Functions: Asymptotic notations; Standard notations and common functions; Recurrences and Solution of Recurrence equations- The substitution method, The recurrence – tree method, The master method; Amortized Analysis: Aggregate, Accounting and Potential Methods.

Unit II: Graph algorithms

10 Hours

Graph Algorithms: Bellman - Ford Algorithm; Single source shortest paths in a DAG; Johnson's Algorithm for sparse graphs; Flow networks and Ford-Fulkerson method; Maximum bipartite matching. Polynomials and the FFT: Representation of polynomials; The DFT and FFT; Efficient implementation of FFT.

Unit III: Number-Theoretic algorithms

10 Hours

Elementary notions; GCD; Modular Arithmetic; Solving modular linear equations; The Chinese remainder theorem; Powers of an element; RSA cryptosystem; preliminary testing; Integer factorization

Unit IV: String-Matching algorithms

10 Hours

Naïve string Matching; Rabin - Karp algorithm; String matching with finite automata; Knuth-Morris-Pratt algorithm; Boyer – Moore algorithms.

Unit V: Probabilistic & Randomized Algorithms

08 Hours

Probabilistic and Randomized Algorithms: Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and Las Vegas algorithms; Probabilistic numeric algorithms.

Reference books:

1. Ellis Horowitz, Sartaj Sahni, S. Rajasekharan, Fundamentals of Computer Algorithms, 2nd Edition, Computer Science Press, New York, 2017.
2. Cormen T. H, Leiserson C. E, Rivest R. L., Stein C, Introduction to Algorithms 3rd Edition, MIT Press, Cambridge, 2022

Paper III (A)
Digital Image Processing

Unit I: Digital image fundamentals

12 Hours

Components of image processing system, Elements of visual perception, Steps in Digital Image Processing Systems, Image Sampling and Quantization, Basic Relationships between Pixels, Distance Transforms.

Frequency Domain: Introduction to Fourier Transform, Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT.

Unit II: Image enhancement and restoration

12 Hours

Spatial Domain: Basic Gray Level Transformation, Histogram Processing - Equalization and modification, Convolution Operation, Smoothing Spatial Filters - Averaging (Mean) Filter, Gaussian Filter, Sharpening Spatial Filters, Filtering in Frequency Domain: Smoothing and Sharpening Filters – Ideal, Gaussian, Butterworth Filters.

Image Restoration: Noise models, Model of Image Degradation/Restoration process, Restoration in the presence of Noise Only Spatial Filtering - Mean, and Order Statistics Filters. Periodic Noise Reduction by Frequency Domain Filtering – Band reject, Band pass and notch filters.

Unit III: Image segmentation and morphological processing

12 Hours

Image Segmentation: Detection of Discontinuities, Gradient and Laplacian based Edge Detection – Sobel, Prewitt Filters, and Roberts Cross Operator, Thresholding – Global and Adaptive Thresholding, Region Based Segmentation.

Image Morphology: Binary and Gray level morphology operations, Erosion, Dilation, Opening and closing operations.

Unit IV: Feature extraction and applications of image processing

12 Hours

Feature Extraction and Dimension Reduction: Image Features – Introduction to Color, Shape and Textures, HOG, Corner Detection, SIFT, SURF and Hough Transform, Principal Component Analysis (PCA).

Applications of Digital Image Processing – Object Detection and Medical Image Analysis. Neural Networks and Deep Learning Overview – Basic Architecture of Convolutional Neural Networks (CNN).

Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson Education, 2018.
2. S. Sridhar, "Digital Image Processing", Oxford University Press, 2011.
3. Jayaraman S, Veerakumar T, Esakkirajan S, "Digital Image Processing", Tata McGraw-Hill Education, 2011.
4. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT Press, 2016.

Paper III (B)
Artificial Intelligence and Machine Learning

Unit I: Introduction to AI

12 Hours

What is AI?, history, risks and benefits, agents and environments, the concept of rationality, the nature of environments, the structure of agents; problem-solving agents, search algorithms, uninformed search strategies, informed search strategies, heuristic functions, adversarial search and games, back tracking search for constraint satisfaction problems; knowledge representation issues and approaches.

Unit II: Machine learning fundamentals and Supervised algorithms

12 Hours

Introduction to Machine Learning: Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Reinforcement Learning; Exploratory Analysis and Visualization, Performance Metrics. Supervised Learning Algorithms: Linear regression, logistic regression, support vector machines, K-Nearest Neighbors, Decision Trees, Random Forest, and Naïve Bayes.

Unit III: Unsupervised learning and Neural networks

12 Hours

K-Means Clustering, Hierarchical Clustering, Association Rule, Principal Component Analysis, Neural networks: introduction, ANN, MLP, Deep learning: CNN, RNN, and their applications.

Unit IV: Case studies of machine learning

12 Hours

Facebook alt application, voice assistants (Alexa, Siri), recommendation system (Netflix/Amazon), Google maps, self-driving cars-tesla, machine translation using Google translate, Gmail spam detection, face recognition.

Reference Books:

1. Russell, S. and Norvig, P., "Artificial Intelligence-A Modern Approach", Prentice Hall, 4th edition, 2020.
2. SaikatDutt, Subramanian C, Amit Kumar Das, "Machine Learning", Pearson; 1st edition, 2018.
3. Marc Peter Deisenroth, A. Aldo Faisal, Cheng SoonOng, "Mathematics for Machine Learning", Cambridge University Press, 2020.
4. V Susheela Devi, M NarasimhaMurty, "Pattern Recognition: An Introduction", Universities Press (India) Private Limited, 2021.
5. ShaiShaley-Schwartz and Shai Ben-David, "Understanding Machine Learning from Theory to Algorithms", Cambridge University Press, 2014.
6. Josh Starmer, "The StatQuest Illustrated Guide to Machine Learning", Qurate Books Pvt. Ltd., 2022.

Paper IV: Research and Publication Ethics

Unit I: Philosophy of Research

04 Hours

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

Unit II: Scientific Conduct

06 Hours

Ethics with respect to Science and research. Intellectual honesty and research integrity, scientific misconducts: falsification fabrication and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misinterpretation of data.

Unit III: Publication of Ethics

08 Hours

Definition, introduction and importance. Best practices/standards setting initiatives and guidelines, Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-versa types. Violation of publication ethics, authorship and contributorship, identification of publication misconduct, complaints and appeals. Predatory publishers and journals.

Unit IV: Practice-Open Access Publishing

04 Hours

Open access publications and initiatives. Journal finder/journal suggestion tools viz. Elsevier Journal finder, Springer Journal suggerter, etc.

Unit V: Publication misconduct

08 Hours

Group discussions- subject specific ethical issues, FFP, Authorship, Conflicts of interest, complaints and appeals: examples and frauds from India and abroad. Software tools. Use of plagiarism software by Open Source Software tools, grammar/spell check tools. Databases – Indenting databases. citation databases: Web Of Science , Scopus, UGC-CARE and other abbreviations, Mathematics Subject Classification, ORCID, other E-resources. Research Metrics – impact factor of journal as per Journal Citation Report, Copyrights, ISSN, ISBN, Cite Score. Metrics: h-index, g-index, i10 index, Alt metrics.

References:

1. Bird, A. Philosophy of science, Routledge. 2006.
2. Chaddah P., Ethics in Competitive Research: Do not get Scoped: Do not get plagiarized, ISBN: 978-9387480865, 2018.
3. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition, National Academic Press, 2009.
2. Resnik, D.B. What is ethics in research & why is it important. National Institute of Environmental Health Scienced, 1-10. Retrived form. 2011.
3. <http://www.nichs.nih.gov/researche/resources/bioethics.hatis.index.cfm>
4. Beall, J.(2012).Predatory publishers are corrupting open access, Nature, 489(7415), 179-179.<http://doi.org/10.1038/48919a>
5. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019).ISBN 978-81-99482-1-7.
http://www.insaindia.res.in/pdf/Ethics_Book.pdf