Department of Computer Science

Vidyasagar University

Syllabus for Ph.D. Coursework in Computer Science

Course Code	Course Name	Full Marks	Credit	No. of Lectures (in hrs.)
PHDCS-1	RESEARCH METHODOLOGY AND RESEARCH PUBLICATION ETHICS (RPE) AND COMPUTER APPLICATIONS	50 [Written: 40 (Exam Hours: 2) + One Assignment: 10]	4	16
PHDCS-2	DOCUMENT PREPARATION TOOLS AND STATISTICAL METHODS	50 [Written: 40 (Exam Hours: 2) + One Assignment: 10]	4	16
PHDCS-3	REVIEW OF RESEARCH WORK	50	4	-
PHDCS-4	EMERGING ISSUES IN CORE AREAS OF RESEARCH	50 [Written: 40 (Exam Hours: 2) + One Assignment: 10]	4	16

PHDCS-4: ELECTIVE (One paper is to be chosen as directed by supervisor)

A. Image processing and data security
B. Deep learning
C. Audio processing
D. Internet on Things
E. Natural Language Processing

Details Syllabus

PHDCS-1: RESEARCH METHODOLOGY AND RESEARCH PUBLICATION ETHICS (RPE) AND COMPUTER APPLICATIONS

UNIT-I

Research Aptitude: Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done.

Research Process: Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis - meaning, types, development of hypothesis and its testing, Meaning & Functions of Research Design

UNIT-II

Data Analysis: Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with database statistical functions, using correlation, Multiple Regression, Using Sampling to Analyze Data

UNIT-III

Significance of Report Writing: Different Steps in writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Art of scientific writing-Steps to better writing, flow method, organization of material and style, Drawing figures, graphs, tables, footnotes, references etc. in a research paper

UNIT-IV

Publication Ethics: Introduction, Definition, & Importance; Scientific Research Misconduct; Falsification, Fabrication & Plagiarism/Self-plagiarism, Kinds & Remedies; Intellectual Property; Reasonable & Fair Use; Copyright and related IPR Issues ; Violation of Publication Ethics; Authorship/Co-authorship, Joint research/ Contributorship& Patentable Inventions- Extent of Rights & Claims ; Best Practices/Standards Setting Initiatives and guidelines; COPE, WAME, UGC-CARE list etc.; Publication Misconduct; Concept; Definition & Kinds of Problems & Unethical Behaviour; Identification of Publication Misconduct, Complaints & Appeal Provisions.

Use of internet in research work : Use of internet networks in research activities in searching material, paper downloading, submission of papers, relevant websites for

journals and related research work. Introduction to Patent laws etc., process of patenting a research finding, Copy right, Cyber laws.

References:

1. Research Methodology Methods and Techniques, Kothari, C. R., Wiley Eastern Ltd.
2. Microsoft Excel Data Analysis and Business Modeling, Wayne L. Winston, Microsoft Press, ISBN: 0735619018
3. Research Methodology: a step-by-step guide for beginners, Kumar, Pearson Education.
4. Practical Research Methods, Dawson, C., UBSPD Pvt. Ltd. 5. Research Methodology, Sharma, N. K., KSK Publishers, New Delhi.

PHDCS-2: DOCUMENT PREPARATION TOOLS AND STATISTICAL METHODS

Writing scientific report, project proposal, and thesis.Preparing conference presentation: preparation of slides withtables, pictures, graphs etc.Preparing references and bibliography for any research paper.Checking the similarities of any report and addressing the same. Tool for document writing: Latex.

Collection of data: classification and tabulation, Permutation and Combination, Binomial Series, Polynomial, Frequency distribution, Measures of central tendency: mean, median, and mode, Standard Deviation, Correlation and regression, Interpolation.Probability: Bayes theorem, conditional probability, independence events, randomvariable.Theoretical distributions: Binomial, Poisson, Normal.Statistical tools for analysis and interpretation of data: Python, MATLAB, Microsoft Excel

References:

1. LaTeX Beginner's Guide: Create visually appealing texts, articles, and books for business and science using LaTeX, 2nd Edition Kindle Edition
2. More Math IntoLaTeX: A Guide for Documentation and Presentation Paperback – Import, 8 October 2007
3. Statistical Methods (Combined edition volume 1 & 2) Paperback – 1 July 2017
4. Fundamentals of Statistics Paperback – 1 May 2018

PHDCS-3: REVIEW OF RESEARCH WORK

Review Work Written to be submitted by each scholar duly signed and recommended by the supervisor.

PHDCS-4: EMERGING ISSUES IN CORE AREAS OF RESEARCH

A. Image processing and data security

Image processing:

Introduction (Exposure to wide range of imaging applications), Image enhancement in spatial domain (intensity transforms, histogram processing, spatial filtering etc.), Image enhancement by transformation to a different space (fourier transform, wavelet transform etc.), Color Image Processing, Morphological Image Processing, Feature representation and description (point, line, edge, corner, SIFT), Image compression, Some basics on image segmentation and object detection.

Data security:

An Overview on Security and Data Security, Symmetric Ciphers: Classical Encryption Techniques (Substitution, Substitution). Data Encryption Standard, Advance Encryption Standard. Asymmetric Ciphering: Public Key Cryptography, RSA, Diffie-Hellman Key Exchange, Elgamal Cryptographic system, Elliptic Curve Cryptography, Diffie-Hellman Key Exchange, Data Integrity: Hash Function, Secure Hash Algorithm (SHA-3), Cryptography Data Integrity: Message Authentication Codes, Digital Signature: Elgamal Digital Signature Schame, Digital Signature: Schnorr Digital Signature Schame Digital Signature: Elliptic Curve Digital Signature Schame, Digital Signature: RSA-PSS Digital Signature Schame, Watermarking Schemes, Data Hiding Schemes, Stenographic Schemes.

References

1. Digital Image Processing (Gonzalez and Woods, 2nd and 3rd edition),
2. Fundamentals of Digital Image Processing (Anil K. Jain).
3. Cryptography and Network Security, Behrouz A. Forouzan.
4. Cryptography and Network Security Principles and Practices, Fourth, William Stallings

B. Deep Learning

Introduction: Basic concept of Deep Learning, Multi-layer Perceptrons, Backpropagation

Convolutional Neural Networks (CNNs): Basic concept of CNNs; CNN Architectures evolution: AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets; Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM, Grad-CAM, Grad-CAM++; Recent Methods (IG, Segment-IG, SmoothGrad)

CNNs in different applications: CNNs for Recognition and Verification (Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss); CNNs for Detection: Basic concept of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN

Recurrent Neural Networks (RNNs): Basic concept of RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition

Attention Models: Basic concept of Attention Models; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks; Vision Transformer

Deep Generative Models and its applications: Basic concept of Deep Generative Models: GANs, VAEs; Other Generative Models: PixelRNNs, NADE, Normalizing Flows, etc; Image Editing, Inpainting, Superresolution, 3D Object Generation, Security; Variants: CycleGANs, Progressive GANs, StackGANs, Pix2Pix, etc

Recent Trends: Few-shot, One-shot, Zero-shot Learning; Self-supervised Learning; Reinforcement Learning; Other Recent Topics

References

1. Deep Learning From Scratch: Building with Python from First Principles by Seth Weidman published by O`Reilley
2. Deep Learning with Python by Manning Publications
3. Deep Learning with PyTorch by Manning Publications
4. Grokking Deep Learning by Andrew W. Trask published by Manning Publications
5. Deep Learning by Ian Goodfellow, YoshuaBengio and Aaron Courville published by MIT Press

C. Audio Processing

UNIT-I Introduction

Audio signal & its properties, Types of audio signals, Audio processing system- brief outlines, Applications& recent development, History of audio processing.

UNIT-II Audio Processing & Analysis

Representation of digital audio signal, Analysis of audio signal components, Audio channels & its uses, Sampling, Analysis of amplitude, phase & frequency of audio, parameters for audio properties, Case studies.

UNIT-III Audio Watermarking

Basic principles of audio watermarking, Advantages & disadvantages, Watermarking Techniques, Applications, Quality measurement, Payload, Case studies.

UNIT-IV Audio Authentication

Challenges, Basic concepts, Procedures, measuring of authentication levels, Applications, Case studies.

UNIT-V Audio Compression

Basic principles, Challenges, Standard algorithms of audio compression, Benchmarks for audio compression, Case studies.

UNIT-VI IPR of Audio

Understanding and Overview of audio IPR, Basic concepts & procedures, Emerging Issues and Challenges, Advantages and Disadvantages, Patents, Trademarks, Copyrights, Future Aspects, Case studies.

References:

1. ZdoZoizen “Digital Audio Signal Processing” Wiley-Blackwell, 2nd Edition, 2008.
2. Ken C. Pohlmann, “Principles of Digital Audio”, McGraw-Hill Inc., US, 3rd Edition, 1995.
3. NedelikoCvejic&TapioSeppanen, “Watermarking Techniques and Technologies and Bench marks”, Idea Group, 2007.
4. Stephen J. Solari, “Digital Video and Audio Compression”, McGraw-Hill, 1997.

D. Internet on Things

Introduction to IoT: Sensing, Actuation, Networking basics, Communication Protocols,Sensor Networks, Machine-to-Machine, Communications, IoT Definition, Characteristics. IoTFunctional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs.

M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics. Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT

M2M vsIoT An Architectural Overview–Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. Reference Architecture and Reference Model of IoT.

IoT Reference Architecture- Getting Familiar with IoT Architecture, Various architectural views of IoT such as Functional, Information, Operational and Deployment. Constraints affecting design in IoT world- Introduction, Technical design Constraints.

Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT application.

Developing IoT solutions: Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi Implementation of IoT with Arduino and Raspberry, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

References:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.

2. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-onApproach)”, 1st Edition, VPT, 2014

3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013
4. CunoPfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

E. Natural Language Processing

Introduction of NLP: Knowledge in Speech and Language processing,ambiguity and models and algorithm, language and understanding, brief history.

Regular Expressions, Automata, Similarity Computation: Regular Expressions,patterns,FA,FormalLanguage,NFSA,Regular Language and FSAs, Raw Text Extraction and Tokenization, Extracting Terms from Tokens, Vector Space Representation and Normalization, Similarity Computation in Text

Morphology and Finite-State Transducers: Inflection,Derivational Morphology, Finite-State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with FiniteState Transducers, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer, Human Morphological Processing.

Matrix Factorization and Topic Modeling: Introduction, Singular Value Decomposition, Nonnegative Matrix Factorization, Probabilistic Latent Semantic Analysis, Latent Dirichlet Allocation

Computational Phonology and Text-to-Speech: Speech Sounds and Phonetic Transcription, The Phoneme and Phonological Rules, Phonological Rules and Transducers, Advanced Issues in Computational Phonology, Machine Learning of Phonological Rules, Mapping Text to Phones for TTS, Prosody in TTS

Probabilistic Models of Pronunciation and Spelling: Dealing with Spelling Errors, Spelling Error Patterns, Detecting NonWord Errors, Probabilistic Models, Applying the Bayesian method to spelling, Minimum Edit Distance, English Pronunciation Variation, The Bayesian method for pronunciation and Weighted Automata, Pronunciation in Humans

grams: Counting Words in Corpora, Simple (Unsmoothed) N-grams, Smoothing, Backoff, Deleted Interpolation, N-grams for Spelling and Pronunciation, Entropy

HMMs and Speech Recognition: Speech Recognition Architecture, Overview of Hidden Markov Models, The Viterbi Algorithm Revisited, Advanced Methods for Decoding, Acoustic Processing of Speech, Computing Acoustic Probabilities
Training a Speech Recognizer, Waveform Generation for Speech Synthesis, Human Speech Recognition.

Word Classes and Part-of-Speech Tagging: Tagsets for English, Part of Speech Tagging, Rule-based Part-of-speech Tagging, Stochastic Part-of-speech Tagging, Transformation-Based Tagging

Lexicalized and Probabilistic Parsing: Probabilistic Context-Free Grammars, Problems with PCFGs, Probabilistic Lexicalized CFGs, Dependency Grammars, Human Parsing, The Chomsky Hierarchy, How to tell if a language isn't regular,Natural Language Context-Free or not, Complexity and Human Processing

Representing Meaning and Semantic Analysis: Computational Desiderata for Representations, Meaning Structure of Language, First Order Predicate Calculus, Some Linguistically Relevant Concepts, Alternative Approaches to Meaning, Syntax-Driven Semantic Analysis, Attachments for a Fragment of English, Integrating Semantic Analysis into the Earley Parser, Idioms and Compositionality, Robust Semantic Analysis

Lexical Semantics and Information Retrieval: Relations Among Lexemes and Their Senses, WordNet: A Database of Lexical Relations, The Internal Structure of Words, Creativity and the Lexicon, Selection Restriction-Based Disambiguation, Robust Word Sense Disambiguation, Information Retrieval, Other Information Retrieval Tasks, Named Entity Recognition.

Text Sequence Modeling and Deep Learning: Statistical Language Models, Kernel Methods, Word-Context Matrix Factorization Models, Neural Language Models, Recurrent Neural Networks[T]

References:

1. Daniel Jurafsky and James H.Martin Speech and Language Processing(2nd Edition),Prentice Hall:2 edition,2008.
2. Machine Learning for Text by Charu C.Aggarwal,Springer,2018 edition
3. Foundations of Statistical Natural Language Processing by Christopher D.Manning and HinrichSchuetze,MIT press, 1999
4. Steven Bird,Ewan Klein and Edward Loper Natural Language Processing with Python,O'Reilly Media;1 edition,2009
5. Roland R.Hausser, Foundations of Computational Linguistics:HumanComputer Communication in Natural Language,Paperback,MIT press,2011