# Computer Science and Engineering, Tripura University (A Central University) Suryamaninagar-799022

# Syllabus for Course Work

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# (As prerequisite for Ph.D. registration)

| Course Code | Course Name | Course Contents | Credit |
|---|---|---|---|
| PHD-9001 | Research Methodology I | Quantitative Methods, Computer Application and Research Ethics | 4 |
| PHD-9002 | Research Methodology II | Review and Critique of Published Research in the relevant field, training, field work, Communication skill etc. | 4 |
| PHD-9003 | Advanced area of research in the subject | To be decided according to need of the RAC | 4 |
| PHD-9004 | Seminar / Practical / Project and Assignment etc. | To be decided according to need of the RAC | 4 |

# Detailed Syllabus for Course Work

**Course-I:**

**PHD-9001: Research Methodology I**                      **Credit: 4**

***Basic Computer Applications, Quantitative methods, Statistics and application of Computer in statistics, Research Ethics and IPR, Documentation and scientific writing***


## Unit-1: Basic Computer Applications
Basic computer knowledge, Features and applications related to presentation of text in suitable format and saving the data for future applications. Use of word processing, Practical knowledge of MS Word to type the script, insert tables, figures and graphs, plotting of graphs in excel, Preparation of power point presentations based on the topic of research. Insertion of figures, graphs, charts in presentation. Use of spreadsheet and database software, Preparation of scientific posters for presentations Internet and its application: Email, WWW, Web browsing, acquiring technical skills, dra wing inferences from data, Cloud computing.

## Unit-2: Quantitative methods, Statistics and application of Computer in statistics
Measures of Central tendency and Dispersion. Probability distribution- Normal, Binomial and Poisson distribution. Parametric and Non-parametric statistics. Confidence interval, Errors. Quantitative Techniques: Levels of significance, Regression and Correlation coefficient. Statistical analysis and fitting of data; Chi- Square Test, Association of Attributes t- Test Anova, Standard deviation, Co- efficient of variations. Open source software for quantitative and statistical analysis.

## Unit-3: Research Ethics and IPR
Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

## Unit-4: Documentation and scientific writing:
Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research proposal, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography

**Course-II:**

**PHD-9002: Research Methodology II**                    **Credit: 4**

*Review and critique of published research in the relevant field, training, field work, communication skill etc*

A research paper is based on original research. A review article or review paper will be based on other published articles. It will not support original research. Review articles will summarize the existing literature on a topic in an attempt to explain the current state of understanding on the topic. Training and field work will be based on different hand on experiments and measurement results on research topics. Communication skill will be improved for betterment of research paper and thesis writing.

**Course-III:**

**PHD-9003: Advanced area of research in the subject**          **Credit: 4**

[Choose any one from a, b, c, d, e and f]

    *a.* **Image Processing and Computer Vision**

Digital Images, Fundamental steps in Digital Image Processing, Components of Digital Image Processing system. Digital Image Fundamentals-Neighborhood, Connectivity, boundaries, Relations, Distance Measures, Arithmetic/Logic Operations, Image Acquisition and Representation: Fundamental of visual perception, Image acquisition, Fundamentals of CCD Camera, Scanner, visual and other domains. Image sampling and quantization. Representation in different file formats. Different image categories.

Image Enhancement : Gray Level transformations, Histogram processing.

Spatial Domain Methods- Mean and median filters, Image Sharpening.

Enhancements in the frequency domain – Fourier transform, Low pass filtering, High pass filtering, Ideal, Butterworth and Gaussian Filters.

Image Restoration : Differences in noise removal and restoration, noise models, degradation Model, Different spatial and frequency domain filters, Estimation of degradation function, Inverse filters; Wiener Filtering, Geometric Transformation-Spatial Transformation, Gray Level Interpolation.

Image Segmentation : Point Detection, Line Detection, Edge Detection-first order and second order gradients. Thresholding-Global and/or optimal thresholding techniques; Region-based segmentation, Region growing, Region Splitting and Merging.

Colour Image Processing :Colour models, Colour transformations, Smoothing and

sharpening of colour images, colour Image segmentation.

Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-miss transformation, Boundary Extraction, thinning, Descriptors for binary regions. Extension of these operators to gray level images with applications.

Image Compression : Concept of redundancy, different redundancies, Fidelity criteria, Image compression models.

Lossless compressions: Huffman coding, Arithmetic coding, LZW coding, Lossless Predictive coding.

Lossy compressions: Lossy predictive coding, Transform coding, wavelet coding etc. Compression standards.

Shape detection: Least Mean Square error line fitting, Eigenvector line fitting, Straight line Hough Transform, Generalized Hough transform.

Image Understanding: Feature extraction techniques, Statistical Decision making techniques, Nearest Neighbour Clustering, Maxi-min Clustering, Discriminant functions, Artificial Neural Networks.

**Referred Books:**
1. Digital Image Processing, Gonzalez and Woods, Pearson
2. Digital Image Processing, Castlman, Pearson
3. Digital Image Processing, Jahne, Springer India
4. Digital Image Processing & Analysis, Chanda&Majumder, PHI
5. Fundamentals of Digital Image Processing, A.K. Jain, PHI
6. Pattern Recognition and Image Analysis, E. Gose, R. Johnsonbaugh, SteveJost, Prentice Hall India.

## *b.* **Pattern Recognition and Machine Learning**

Basics of pattern recognition, Problems in pattern Recognition, Pattern Recognition system Design, Template Matching, Decision Functions, Hyperplane and its Properties, Curse of Dimensionality, Dimensionality Reduction, Accuracy, Error Surface, Error rate and Error bound, Computational Complexity, Examples and Applications.

Feature Generation : Basic concepts, Basis Vectors, Principal Component Analysis, Singular Value Decomposition, Discrete Cosine and Sine Transform, Discrete Fourier Transform, Discrete Wavelet Transform, Regional Features, Features for Shape and Size Characterization.

Feature Selection :Preprocessing, Data Normalization, Feature Selection Based on Statistical Hypothesis Testing, Class Separability Measure, Feature Subset Selection.

Bayesian Decision Theory : Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features.

Parameter estimation methods : Maximum-Likelihood estimation, Bayesian estimation.

Non-parametric techniques for density estimation :Parzen-window method, K-Nearest Neighbour method.

Linear Classifier: Perceptron, Least Square Method, Support Vector Machines

Nonlinear Classifier: Multilayer Perceptron, Backpropagation Algorithm, Polynomial Classifier, Radial basis Function Networks, Nonlinear Support Vector Machines.

Context-Dependent Classification: Bayes Classifier, Markov Chain Models, Hidden Markov Model.

Clustering: Sequential and Hierarchical Clustering, k-means, c-means Algorithms, Vector Quantization, Cluster Validity.

Syntactic Pattern Recognition : Grammar based approach and applications, CYK parsing algorithm, Graphical approaches, Learning via Grammatical Inference.

Machine learning concepts and limitations : Learning theory, formal model of the learnable, sample complexity, learning in zero-bayes and realizable case, VC-dimension, PAC learning, fundamental algorithm independent concepts, hypothesis class, target class, inductive biasoccam's razor, empirical risk, limitations of inference machines, approximation and estimation errors, Tradeoff.

Machine learning assessment: Statistical model selection, structural risk minimization.

Ensemble learning methods: Voting, bagging, boosting.

Decision tree learning algorithms : Inference model, general domains, symbolic decisions trees, consistency, learning trees from training examples, entropy, mutual information, ID3 algorithm, handling continuous and missing attributes, confidence, overfitting, pruning, learning with incomplete data.

Support Vector Machines: Margin of a classifier, dual perceptron algorithm, learning non-linear hypotheses with perceptron kernel functions, implicit non-linear feature space, theory, zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, maximal margin classifier.

Assessing and comparing learning algorithms: bootstrapping, K-fold cross validation, hypothesis testing.

Reinforcement Learning : Control learning, Q-learning, Convergence.

**Referred Books:**
1. R.O. Duda, P.E. Hart and D.G. Stork, " Pattern Clasification," John Wiley, 2001
2. S. Theodoridisand K.Koutroumbas, "Pattern Recognition", 4th Ed., Academic Press, 2009
3. C.M. Bishop, "Pattern Recognition and Machine Learning", Springer,2006
4. R. Schalkoff, "Pattern Recognition", Wiley,2007
5. K. Fukunaga, "Introduction to Statistical Pattern Recognition", Academic press,1990
6. T.M. Mitchell, Machine Learning, McGraw-Hill, 1997

7. E. Alpaydin, Introduction to machine learning, Prentice Hall of India,2006
8. Vladimir N. Vapnik, Statistical Learning Theory, John Wiley and Sons, 1998
9. Shawe-Taylor J. and Cristianini N., Cambridge, Introduction to Support Vector Machines, University Press,2000

## c. Biometric Systems

Introduction to Biometric system : History, Definition, Characteristics, Applications. Signal processing and pattern recognition Fundamentals: Acquisition of biometric samples, Representational formats, Dimensionality reduction, Classification, Matching.

Biometric systems performance terminology: Performance assessment terminology, Testing methods used in biometrics, Graphical analysis of system performance.

Face recognition: Anatomy and discussion of face features, Feature extraction, Classification & Recognition, Evaluation.

Iris Recognition: Anatomy and discussion of iris features, feature extraction, Classification & Recognition, Evaluation.

Fingerprint Recognition: Anatomy and discussion of fingerprint features.

Feature extraction: Discussion of fingerprint features, Classification & Recognition, Evaluation.

Signature Recognition: Discussion of signature features, Feature extraction, Classification & Recognition, Evaluation.

Multi-biometric system: Introduction of multi-biometric systems, types of multi-biometric system, levels of fusion in multi biometric systems.

Biometric standard: Introduction of biometric standards, importance of biometric standards, privacy, interoperability of data, systems and applications.

**Referred Books:**
1. Biometric: Theory, Methods & Applications, N.V. Boulgouris, K.N. Plataniotis, E.Micheli-Tzanakou, IEEE Press,2009
2. Biometric System : Technology, Design& Performance Evaluation, J.Wayman, A.K. Jain, D.Maltoni, D.Maio, Springer Verlag, 2004
3. Handbook of Biometrics, Springer Verlag,2008, A.K. Jain, P.Flynn and A.A. Ross.
4. Samir Nanavati, Michael Thieme, Raj Nanavati, "Biometrics – Identity Verification in a Networked World", WILEY-Dreamtech
5. Paul Reid, "Biometrics for Network Security", Pearson Education.
6. John D. Woodward, Jr. "Biometrics-The Ultimate Reference", Wiley Dreamtech.


## d. Sensors and Systems

Universal Sensors and Transducer Interface (USTI), Optoelectronic Digital Sensors and Sensor Systems, Digital Temperature Sensors and Sensor system, Digital pressure

sensor and Transducers, Digital Humidity, Dew Point and Moisture Sensors, Digital Accelerometers, Inclinometers and Gyroscopes, Rotational Speed Sensors, Chemical Sensors and Biosensors, Capacitive Sensors Interfacing, resistive sensors interfacing, Resistive-Bridge Sensors Interfacing, DAQ Systems for Quasi-Digital Sensors and Transducers. Intelligent Sensor Systems.IEEE 1451 Standard Extension and Adaption for Quasi-Digital Transducers, Self-Adaptive Sensors and Sensor systems.

Emerging Sensors : High speed imaging, 3D range sensors, Femto-second concepts, Front/back illumination, Diffraction issues.

Beyond visible Spectrum :Multispectral imaging and Thermal sensors, Fluorescent imaging.

Image reconstruction Techniques,Deconvolution, Motion and Defocus Deblurring, Tomography, Heterodyned Photography, Compressive Sensing.

Cameras for Human Computer Interaction (HCI):0-D and 1-D sensors, Spatio-temporal coding, Frustrated TIR, Camera-display fusion.

Useful techniques in Scientific and Medical Imaging: CT-scans, Strobing, Endoscopes, Astronomy and Long range imaging.

Case study : Microsoft Kinect, Nintendo 3DS, NVIDIA 3D Vision, Dual-stacked LCDs, 3D medical imaging displays, Range cameras, Retinal imaging devices, Thermal IR cameras, Light field cameras (5x5 camera array)

**Referred Books:**
1. Habib F. Rashvand and Jose M. AlcarazCalero, Distributed Sensor Systems : Practice and applications, John Wiley & Sons Ltd.
2. Sergey Y.Yurish, Digital Sensors and Sensors system : Practical design, International Frequency Sensor Association (IFSA) Publishing
3. Jon S. Wilson, Sensor Technology Handbook.

### e. Advanced Computer Networks and Communications

## Group-A

*Fundamentals of Networks, wireless networks, Satellite networks with basic communication principles. *Protocols and Standards: OSI Models, TCP/IP suit, X 25 protocol suit and their applications. *Sockets: Fundamental of Socket and socket based communications; Interposes communication in distributed and cloud environment. *Services: Flow control, congestions and error control in distributed and cloud environment. *Client server model: Client Server computing in distributed and cloud environment, Concurrency Control, Process management, System calls in TCP and UDP. *Web Administration and Management.

## Group-B

*Wireless network WLAN-architecture and Application, *Sensor Networks-architecture, protocols and applications, *RFID based communication and management, *Wireless

Ad-hoc Network: MANET architecture protocols in MANET-DSR, AODV, DSDV, TORA etc., *Mobile Agent, *Network Simulators: NS2, OMNET, QUALNET, *Case study of an wireless network Simulator-performance metrics, *VNC services: Principles of VNC services, updating of servers through VNC services in cloud environment, *VPN: Principles of VPN, Setting up wireless LAN, APN setting, *Internet Connectivity through APN mobile internet, APN as hotspot, SIM based internet, *Architecture and application of social networks.

## f. VLSI/FPGA

Introduction to VLSI design, MOS translator theory and CMOS logic and fabrication, CMOS combinational and sequential circuit design: Inverters, Tri-state Logic, Pass Translator, Multiplexer, Latches and Flip flops: Low power VLSI design: Static and dynamic power components, circuit design strategies for low power, Architectural Strategies for lower: Introduction to VLSI CAD, ASIC and FPGA Flow; VLSI physical Design: Layout, placement, Floor planning, Global and detailed Routing: Testing and Design for testability: Fault Models, Test Pattern Generation, Built in Self Test.

**Referred Books:**
1. Weste and Harris, CMOS VLSI Design.
2. Mead and Conway, Introduction to VLSI Systems.
3. N. Sherwani, Algorithms for VLSI Physical Design Automation.
4. G.DeMicheli, Synthesis and Optimization of digital circuits.
5. B. Preas&M.Lorenzetti, Physical, Design Automation of VLSI systems.
6. M. Abramovici, M.A. Breuer and A.D. Friedman, Digital Systems Testing and Testable Design
7. J.D. Ullman, Computational Aspects of VLSI
8. Breurer and Friedman, Diagnosis & Reliable Design of Digital Systems.

## Course-IV:

## PHD-9004: Seminar / Practical / Project and Assignment etc        Credit: 4

*A Term paper needs to be submitted on the Literature Survey done on the area of the research followed by proper presentation for the same.*