PhD

Syllabus

Department of Information Technology

Tripura University

(A Central University)

Suryamaninagar, Tripura, India -799022

The basic eligibility and selection procedure of PhD and PG programmes under the department of Information Technology along with syllabi are listed here:

1.1. Minimum Eligibility for admission to obtain PhD in Information Technology

Applicant must be an Indian national and must have passed any of the following:

M. Tech/M.E. degree in Information Technology/ Computer Science &Engineering/ Computer Engineering/ Electronics and Communication Engineering / Software Engineering or equivalent with first class and not less than 55% aggregate marks (of all the years) or equivalent CGPA of 6.5 (in case of SC/ST and Physically Challenged (PC) candidates 50% aggregate marks or equivalent CGPA of 6.0 is the eligibility requirement), with/without a valid GATE score. GATE qualified candidates will get preference.

1.2. Minimum Eligibility for Admission in PG course in Information Technology

Applicant must be an Indian national and must have passed any of the following:

a) B. Tech/B.E. degree in Information Technology/ Computer Science &Engineering/ Computer Engineering/ Electronics and Communication Engineering / Software Engineering or equivalent.
b) MCA or its equivalent or
c) M.Sc. in Computer Science/Information Technology/ Electronics

with first class and not less than 60% aggregate marks (of all the years) or equivalent CGPA of 6.5 (in case of SC/ST and Physically Challenged (PC) candidates 55% aggregate marks or equivalent CGPA of 6.0 is the eligibility requirement), with/without a valid GATE score. GATE qualified candidates will get preference.

1.3. Selection Procedure for admission for PhD in Information Technology

Selection for admission into Ph.D (IT) Programme will be strictly on the basis of merit. However, policy of reservation (and/or quota if any) will be applicable as per central Govt rule. Moreover, there should be available slots under the faculty supervisors of the department as per UGC norms.The Rules and Regulations are in connivance with the UGC (Minimum Standards and Procedure for Awards of M.Phil/Ph.D Degree) Regulations, which are modified and as clarified time to time.

The University shall allow a candidate to get admission in the Ph.D. Program when he /she qualifies in RET (Research Eligibility Test) conducted by the Tripura University. The RET shall be conducted through a Written Test as per Syllabi of the department listed in Section 1.5 followed by Viva-Voce Examinations.

A candidate seeking Admission in the Ph.D. Program in the Dept of IT must have a eligibility as per Section 1.1.

The basic eligibility criteria for appearing in RET shall be the successfulcompletion of the earlier Post-Graduate Program (fulfilling the norms stated in sub clause3.IV & 3.V of the lateset Ph. D Rules & Regulations of the University) or a professional degree declaredequivalent by thecorresponding

statutory regulatory body recognized byUGC or AICTE.

1.4. Selection Procedure for PG course in Information Technology

Selection for admission into M. Tech(IT) Programme will be strictly on the basis of merit. However, policy of reservation (and/or quota if any) will be applicable as per central Govt rule. The detailed selection criterion for admission is as follows:

a) First preference will be given to candidates who have passed any of the above specified examinations in Section 1.2 AND have valid GATE score in Information Technology or Computer Science & Engineering. The selection will be made on the basis of valid GATE score.

b) Second preference will be given to candidates who have passed any of the above specified examinations in Section 1.2. The selection will be merit basis. The department may also conduct a written test centrally like TUET (Tripura University Eligibility Test) or individually in the department for the aspiring candidates.

1.5. Syllabus for Research Eligibility Test (RET) for admission for obtaining PhD in Information Technology

As per current UGC norms RET has to be of 100 marks of which 50% weightage is to be given to research methodology and rest 50% to Subject specific knowledge. The RET question paper of the Department of Information Technology shall be within the following guidelines:

Part I: Research Methodology 50%

Research Preparation and Planning: Objectives, goals. Critical thinking. Topic selection and justification. Development of a research proposal.Research Resources: Sources of information. Literature, Citation indices –Impact factor, Ethical and Moral Issues in Research, Plagiarism, IPR– Copy right laws – Patent rights.Academic Writing and Presentation: Organization of proposals, Basic knowledge of funding agencies, Research report writing, Communication skills, Publication to Reputed journals, Thesis and Research report writing. Presentation Elements, Oral Communication skills and Oral defense.Data Collection, Analysis and Inference: Basic Statistics. Sample size determination & sampling Techniques- Tests and their applications in research studies. Correlation and Regression Analysis-Time series Analysis-Forecasting methods. Mathematical Modelling: Basic concepts– static and dynamic model – Model for prediction and its limitations. System simulation – validation and use of optimization techniques.

Part II: Information Technology 50%

Basic Mathematical Foundations of Engineering Mathematics and Discrete Mathematics: Graphs, Combinatorics, Linear Algebra, Calculus and Probability. Digital Logic Boolean algebra. Combinational and sequential circuits. Digital Design. Assembly Language programming.Computer Organization and Architecture Machine instructions and addressing modes, memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).Programming and Data Structures Programming in C, Algorithms Searching, sorting, hashing, Algorithm design techniques. Theory of Computation Regular expressions and finite automata. Compiler Design Lexical analysis, Operating System Processes, File systems.Databases ER-model. Relational model: SQL. Integrity constraints, normal forms. Database Management Systems, File organization, Computer Networks Concept of

layering. LAN technologies (Ethernet), Basics of Wi-Fi. Network security. Basics of Cloud computing, Soft Computing and IoT.

1.6. Course work Syllabus for students admitted for obtaining PhD in Information Technology

The students shortlisted and selected via section 1.4 need to undergo mandatory course work which shall be in accordance to PhD norms prescribed by the university and UGC. The minimum Credits required to pass the course-work is 16 credits. The candidates have to obtain the minimum credits via:

- Mandatory Research methodology course under Dean Faculty of Science: **4 Credits**
- A minimum of three (03) papers of 4 credits each from the list of course work subjects listed by the department (as suggested by supervisor) from list in Section 1.8 : 3x4= **12 Credits**

1.7. Mandatory Research methodology course under Dean Faculty of Science

PHD-9001Research Methodology I. The whole paper is divided into four units as follows:

- 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, drawing inferencesfrom 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 andstatistical 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 andacknowledgement - 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 ResearchReport, Types of Report: research papers, thesis, Research proposal, Research Project Reports,Pictures and Graphs, citation styles, writing a review of paper, Bibliography.

PHD-9004: Seminar/Practical/ Project and Assignment. 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.

1.8. List of 4 credit Electives for PhD Course work (select any two)

Course Code	Course Title	L-T-P	Credits	Availability as MOOC
PIT0001E	Adhoc and Sensor Networks	4-0-0	4	Yes
PIT0002E	Advanced Graph Theory	4-0-0	4	Yes
PIT0003E	Advanced Microprocessor	4-0-0	4	
PIT0004E	Artificial Intelligence	4-0-0	4	Yes
PIT0005E	Bioinformatics	4-0-0	4	Yes
PIT0006E	Cloud Computing	4-0-0	4	Yes
PIT0007E	Compiler Design	4-0-0	4	Yes
PIT0008E	Computational Geometry	4-0-0	4	Yes
PIT0009E	Computational Systems Biology	4-0-0	4	Yes
PIT0010E	Computer Architecture	4-0-0	4	Yes
PIT0011E	Cryptography and Network Security	4-0-0	4	Yes
PIT0012E	Data Mining	4-0-0	4	Yes
PIT0013E	Data Science	4-0-0	4	Yes
PIT0014E	Deep Learning	4-0-0	4	Yes
PIT0015E	Digital Signal Processing	4-0-0	4	Yes
PIT0016E	Distributed System	4-0-0	4	Yes
PIT0017E	Embedded Systems	4-0-0	4	Yes
PIT0018E	Image Processing	4-0-0	4	Yes
PIT0019E	Information Theory and Coding Techniques	4-0-0	4	Yes
PIT0020E	Internet of Things	4-0-0	4	Yes
PIT0021E	Knowledge Representation and Reasoning	4-0-0	4	Yes
PIT0022E	Machine Learning	4-0-0	4	Yes
PIT0023E	Medical Electronics	4-0-0	4	
PIT0024E	Mobile Computing	4-0-0	4	Yes
PIT0025E	Modern Digital Communication Techniques	4-0-0	4	Yes
PIT0026E	Modern Digital System Design	4-0-0	4	Yes
PIT0027E	Multimedia Processing	4-0-0	4	Yes
PIT0028E	Natural Language Processing	4-0-0	4	Yes
PIT0029E	Pattern Recognition	4-0-0	4	Yes
PIT0030E	Social Network	4-0-0	4	Yes
PIT0031E	Soft Computing	4-0-0	4	Yes
PIT0032E	Software Engineering	4-0-0	4	Yes
PIT0033E	Computer Networks and Internet Protocol	4-0-0	4	Yes
PIT0034E	Theory of Computation	4-0-0	4	Yes
PIT0035E	Data Structures and Algorithm	4-0-0	4	Yes

N.B. : If available in the form of MOOC course under the UGC/AICTE SWAYAM or NPTEL Initiative, these courses can be taken online as well, subject to University approving a proper Credit Transfer via MoU and Controller Examination doing the mapping of MOOC 75-25 (Exam-Internal) to University format of 70-30. Else the department can appoint a mentor for the courses for doing the same.

DETAILED SYLLABI

Adhoc and Sensor Networks	**PIT0001E**
Prerequisites: Basic concepts on Data Communications and Networking	4 - 0 - 0

Course Outcomes:

At the end of the course the student will be able to

CO1: Identify the major issues associated with ad-hoc/sensor networks.

CO2: Explore current ad-hoc/sensor technologies by researching key areas such as algorithms, protocols, hardware, and applications.

CO3: Gain hands-on experience through real-world programming projects on ad-hoc/sensor hardware.

CO4: Implement or develop algorithms involved in MAC/ Routing/ Transport Layers of ad-hoc/sensor systems.

Course Content:

MANET - Introduction, Self-organizing behavior, Co-operation, MAC, Routing;
Multicast routing, Mobility model, Transport layer,
Opportunistic Mobile Networks, UAV networks, Wireless Sensor;
Networks (Introduction)- WSN (Coverage, Topology management), Mobile Sensor Networks;
MAC, Congestion control, Routing; Underwater WSN;
Security, Structure of sensor nodes;

References:

1. Carlos D Corderio and Dharma P. Aggarwal, "Ad Hoc and Sensor Networks: Theory and Applications", 2nd Edition, World Scientific Publications, 2011.
2. 1. C. Siva Rama Murthy and B.S. Manoj , "Ad Hoc Wireless Networks: Architecture and Protocols", 2nd Edition , Pearson Education, 2009.
3. 2. Sudip Misra, Isaac Woungang and Subhas Chandra Misra, "Guide to Wireless Ad Hoc Networks" , 1st Edition, SpringerVerlag London Limited, 2009.

Advanced Graph Theory	**PIT0002E**
Prerequisites: Discrete Mathematics	4 - 0 - 0

Course Outcomes:

Students by the end of the course will be able to

CO1: Describe common graph algorithms including graph traversals, pathfinding, greedy algorithms, recursion, and dynamic programming.

CO2: Model and solve real world problems using graph algorithms.

CO3: Implement graph algorithms in code.

CO4: Develop algorithmic thinking skills to expand on common graph algorithms and improve problem solving approaches.

Course Content:

Introduction to Graphs & its Applications, Basics of Paths, Cycles, and Trails, Connection, Bipartite Graphs, Eulerian Circuits, Vertex Degrees and Counting, Degree-sum formula, The Chinese Postman Problem and Graphic Sequences.
Trees and Distance, Properties of Trees, Spanning Trees and Enumeration, Matrix-tree computation, Cayley's Formula, Prufer code.
Matchings and Covers, Hall's Condition, Min-Max Theorem, Independent Sets, Covers and
Maximum Bipartite Matching, Augmenting Path Algorithm, Weighted Bipartite Matching, Hungarian Algorithm;
Stable Matchings and Faster Bipartite Matching, Factors & Perfect Matching in General Graphs, Matching in General Graphs: Edmonds' Blossom Algorithm
Connectivity and Paths: Cuts and Connectivity, k-Connected Graphs, Network Flow Ford-Fulkerson

Labeling Algorithm, Max-Flow Min-cut Theorem, Menger's Proof using Max-Flow Min-Cut Theorem.
Vertex Coloring and Upper Bounds, Brooks' Theorem and Color-Critical Graphs, Counting Proper Colorings.
Planar Graphs, Characterization of Planar Graphs, Kuratowski's Theorem, Wagner's Theorem.
Line Graphs and Edge-coloring, Hamiltonian Graph, Traveling Salesman Problem and NP-Completeness, Dominating Sets.

References:

1. D.B. West, Introduction to Graph Theory, Prentice Hall, 2001
2. Jon Kleinberg and Eva Tardos, Algorithm Design, Addison-Wesley, 2005
3. J.A.Bondy and U.S.R.Murty: Graph Theory, Springer, 2008.
4. R.Diestel: Graph Theory, Springer(low price edition) 2000.
5. F.Harary: Graph Theory, Narosa, (1988)
6. C. Berge: Graphs and Hypergraphs, North Holland/Elsevier, (1973

Advanced Microprocessor	**PIT0003E**
Prerequisites: Basic 8085 or any 8 bit microprocessor	4 - 0 - 0

Course Outcomes:

At the end of the course, the students should be able to
CO1. Understand the necessity, features and architecture of 8086.
CO2. Analyse the addressing modes and understand the functions of 8086 instructions.
CO3. Write simple assembly language programs.
CO4. Understand the need and handling of interrupts in 8086 and features of peripheral ICs.

Course Content:

Evolution of 16 bit 32 bit microprocessors from the 8 bit 8085. Introduction to Intel 8086/8088 microprocessor architecture. Concepts of pipelining, parallel and co-processing. Concept of segmentation and computation of physical addresses. The maximum and minimum mode of operation of 8086 processor.
Architecture, Addressing Modes, Data Movement, Arithmetic and Logic operations, Program control, hardware specifications, memory and basic I/O interfaces, Interrupts, Direct memory access and DMA controlled I/O, Bus Interface, Arithmetic Co-processor, MMX and SIMD technologies of x86 family
The Protected mode operation via selectors and descriptors of 16 bit 80286 and its up gradation for 32 bit of 80386 and 80486 processors
The Pentium, Pentium Pro, P-II and P-III micro-processors
Overview of the new 64 bit architecture and Multi core operations along with the multi-threading technologies; Other high end microprocessors, Motorola, AMD, Power PC, etc

References:

1. Intel Microprocessors (8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium-II, Pentium-III, and Pentium 4) Architecture, Programming and Interfacing, 7th Edition, Barry B Bray, PHI, New Delhi 2006
2. Introduction to Microprocessors, 3rd Ed., A.P. Mathur, Tata McGraw Hill, New Delhi.
3. Microprocessors and Programmed Logic, 2nd Ed., Kenneth L.Short, Prentice Hall of India, New Delhi, 1988.
4. Microprocessor Architecture Programming Applications with the 8085/8080A – R.S. Gaonkar, 3rd Ed., PHI.
5. Intel Microprocessors (8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium-II, Pentium-III, and Pentium 4) Architecture, Programming and Interfacing, 7th Edition, Barry B Bray, PHI, New Delhi 2006
6. Introduction to Microprocessors, 3rd Ed., A.P. Mathur, Tata McGraw Hill, New Delhi.
7. Microprocessors and Programmed Logic, 2nd Ed., Kenneth L.Short, Prentice Hall of India,

New Delhi, 1988.
8. Microprocessor Architecture Programming Applications with the 8085/8080A – R.S. Gaonkar, 3rd Ed., PHI.

Artificial Intelligence	**PIT004E**
Prerequisites: Data structures, Programming and an ability to discuss algorithms.	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Understand the basics of artificial intelligence and neural networks.

CO2: Develop algorithms based on search, knowledge representation.

CO3: Develop applications based on NLP Concepts, to develop a Cognitive Agent

CO4: Understand and perform numerical analysis for various model networks to solve various optimization problems.

Course Content:

Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of Symbolic AI, Agents; State Space Search: Depth First Search, Breadth First Search, DFID;

Heuristic Search: Best First Search, Hill Climbing, Beam Search; Traveling Salesman Problem, Tabu Search, Simulated Annealing;

Population Based Search: Genetic Algorithms, Ant Colony Optimization; Branch & Bound, Algorithm A*, Admissibility of A*;

Monotone Condition, IDA*, RBFS, Pruning OPEN and CLOSED in A*; Problem Decomposition, Algorithm AO*;

Game Playing: Algorithms Minimax, AlphaBeta, SSS*; Rule Based Expert Systems, Inference Engine, Rete Algorithm; Planning: Forward/Backward Search, Goal Stack Planning, Sussman's Anomaly; Plan Space Planning, Algorithm Graph plan;

References:

1. Russell, S. J., &Norvig, P. (2013). Artificial Intelligence: A ModernApproach (3rd ed.). PHI Learning.

2. Vernon, D. (2014). Artificial Cognitive Systems: A Primer. MIT Press.60

3. Rich, E., & Knight, K. (2011). Artificial Intelligence (3rd ed.). TataMcGraw-Hill.

4. Patterson, D. W. (1990). Introduction to Artificial Intelligence andExpert Systems. PHI Learning.

5. Barr, A., Cohen, P. R., & Feigenbaum, E. A. (1982). The Handbook ofArtificial Intelligence. Addison-Wesley.

6. Allen, J. (1995). Natural Language Understanding (2nd ed.). PearsonEducation India.

7. Nilsson N.J., (1991). Principles of Artificial Intelligence. NarosaPublishing.

8. Nilsson, N. J. (1998). Artificial intelligence: A New Synthesis. MorganKaufmann Inc.

9. Luger, G. F. (2002). Artificial intelligence: Structures and Strategiesfor Complex Problem Solving. Addison-Wesley.

10. Charniak E., & McDermott D. (1985). Introduction to ArtificialIntelligence. Addison-Wesley.

Bioinformatics	**PIT0005E**
Prerequisites: Basic knowledge of Biology and any computer language.	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.

CO2: Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.

CO3: Explain about the methods to characterise and manage the different types of Biological data.
CO4: Classify different types of Biological Databases.

Course Content:

Introduction, DNA sequence analysis, DNA Databases
Protein structure and function, protein sequence databases, sequence alignment
PAM matrix, Global and local alignment, BLAST: features and scores
Multiple sequence alignment, Conservation score, phylogenetic trees
Protein sequence analysis, hydrophobicity profiles, non-redundant datasets
Protein secondary structures, Ramachandran plot, propensity, secondary structure prediction
Protein tertiary structure, Protein Data Bank, visualization tools, structural classification, contact maps
Protein structural analysis, protein structure prediction
Protein stability, energetic contributions, database, stabilizing residues, stability upon mutations
Protein folding rates, proteins interactions, binding site residues
Computer aided drug design, docking, screening, QSAR
Development of algorithms, awk programming, machine learning techniques, applications using WEKA

References:

1. M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, Academic Press,
2. D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, Pearson Education Inc. 2006

Cloud Computing	**PIT0006E**
Prerequisites: Basics of Computer Architecture and Organization and Networking	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to
CO1: Apply cloud computing model in real application.
CO2: Use programming paradigms like MapReduce to create applications.
CO3: Operate cloud by installing virtual machines and apply migration.
CO4: Understand of challenges of cloud

Course Content:

Introduction to Cloud Computing
Cloud Computing Architecture
Service Management in Cloud Computing
Data Management in Cloud Computing
Resource Management in Cloud
Cloud Security
Open Source and Commercial Clouds, Cloud Simulator
Research trend in Cloud Computing, Fog Computing

References:

1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley,2011
2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010

Compiler Design	**PIT0007E**

Prerequisites: Automata theory basics	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Specify and analyze the lexical, syntactic and semantic structures of advanced language features.

CO2: Separate the lexical, syntactic and semantic analysis into meaningful phases for a compiler to undertake language translation.

CO3: Write a scanner, parser, and semantic analyzer without the aid of automatic generators.

CO4: Turn fully processed source code for a novel language into machine code for a novel computer.

Course Content:

Overview of compilation, Run-Time Environments, Local Optimizations, Machine code generation

Global Register Allocation

Implementing Object-Oriented Languages, Introduction to Machine-Independent Optimizations

Data-Flow Analysis, Control-Flow Analysis, Machine-Independent Optimizations, Data-Flow Analysis: Theoretical Foundations

Partial Redundancy Elimination, The Static Single Assignment Form, Automatic Parallelization

Instruction Scheduling, Software Pipelining, Energy-Aware Software Systems

Just-In-Time Compilation, Garbage Collection

Inter-procedural Data-Flow Analysis, Worst Case Execution Time Estimation

References:

1. A.V. Aho, M.S. Lam, R. Sethi, and J.D. Ullman, Compilers: Principles, Techniques, and Tools, Pearson Education, 2007 (second ed.).
2. K.D. Cooper, and L. Torczon, Engineering a Compiler, Elsevier, 2004.

Computational Geometry	**PIT0008E**
Prerequisites: Null	4 - 0 - 0

Course Outcomes:

Upon completion of the course students will be able to:

CO1: Apply computational analysis techniques to solve practical computer aided design and drafting scenarios.

CO2: Understand and utilize measurement systems, precision and conversions as used in the computer aided design and drafting industry.

CO3: Perform tolerance study analysis for computer aided design and drafting scenarios.

CO4: Recognize manufacturing tolerances and their effect on a mechanical design.

Course Content:

Introduction using Basic Visibility Problems , The Maximal Points Problem , The Plane Sweep Technique and applications ,Convex Hull Different Paradigms and Quickhull , Dual Transformation and Applications , Lower Bounds on Algebraic tree model , Point Location and Triangulation , Voronoi Diagram and Delaunay Triangulation , Randomized Incremental Construction and Random Sampling , Arrangements and Levels , Range Searching , Clustering Point Sets using Quadtrees and Applications , Epsilon-Nets VC Dimension and Applications , Shape Analysis and Shape Comparison.

References:

1. Adobe Systems Inc., PostScript Language Tutorial and Cookbook, Addison-Wesley, 1985. (http://Www-cdf.fnal.gov/offline/PostScript/BLUEBOOK.PDF)
2. B. Casselman, Mathematical Illustrations: A Manual of Geometry and PostScript, Springer-Verlag, 2005. (http://www.math.ubc.ca/~cass/graphics/manual)
3. CGAL User and Reference Manual (http://www.cgal.org/Manual) T. Cormen, et.al.,

Introduction to Algorithms, 3rd ed., MIT Press, 2009.
4. E.D. Demaine and J. O'Rourke, Geometric Folding Algorithms: Linkages, Origami, Polyhedra, Cambridge University Press, 2007. (occasionally)
5. J. O'Rourke, Art Gallery Theorems and Algorithms, Oxford Univ. Press, 1987. (http://maven.smith.edu/~orourke/books/ArtGalleryTheorems/art.html, occasionally)
6. J. O'Rourke, Computational Geometry in C, 2nd ed., Cambridge Univ. Press, 1998. (definitely)
7. K. Mehlhorn and S. Näher, The LEDA Platform of Combinatorial and Geometric Computing, Cambridge University Press, 1999. (http://www.mpi-inf.mpg.de/~mehlhorn/LEDAbook.html, definitely)
8. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge Univ. Press, 1995. K. Mulmuley, Computational Geometry: An Introduction Through Randomized Algorithms, Prentice Hall, 1994. (occasionally)
9. F.P. Preparata and M.I. Shamos, Computational Geometry: An Introduction, SpringerVerlag, 1985. (occasionally)

Computational Systems Biology	**PIT0009E**
Prerequisites: Basic knowledge of Biology and any computer language.	4 - 0 - 0

Course Outcomes:

On successful completion of the course, the student will:

CO1: To introduce key concepts of mathematical modelling, in the context of different types of biological networks.

CO2: To cover important concepts from network biology, modelling of dynamic systems.

CO3: To cover important concepts from parameter estimation, as well as constraint-based metabolic modelling.

CO4: Hands-on component, emphasizing various software tools and computational methods for systems biology.

Course Content:

Introduction to Mathematical Modelling; Introduction to Static Networks
Network Biology and Applications; Reconstruction of Biological Networks
Dynamic Modelling of Biological Systems: Introduction, Solving ODEs & Estimation
Evolutionary Algorithms, Guest Lectures on Modelling in Drug Development
Constraint-based approaches to Modelling Metabolic Networks
Perturbations to Metabolic Networks; Elementary Modes, Applications of Constraint-based Modelling;
Constraint-based Modelling Recap, 13C Metabolic Flux Analysis
Modelling Regulation, Host-pathogen interactions, Robustness of Biological Systems
Advanced topics: Robustness and Evolvability, Introduction to Synthetic Biology, Perspectives & Challenges

References:

1. Voit E (2012) A First Course in Systems Biology. Garland Science, 1/e. ISBN 0815344678
2. Klipp E (2009) Systems biology: a textbook. Wiley-VCH, 1/e. ISBN 9783527318742
3. Newman MEJ (2011) Networks: an introduction. Oxford Univ. Press.

Computer Architecture	**PIT0010E**
Prerequisites: Computer Organization, Digital Circuits and Systems.	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Perform computer arithmetic operations.

CO2: Use the concepts and design of all type of sequential and combinational circuits.

CO3: Design and conduct experiments, as well as to analyze of the hardware of a computer system and its components such as control unit, arithmetic and logical (ALU) unit, input/output, and memory
unit.
CO4: Be able to design techniques such as pipelining and microprogramming in the design of the central processing unit of a computer system.

Course Content:
Introduction, Instruction Set Principles
Memory Hierarchy Design – Cache Memory Hierarchy, Main Memory Design
Fundamentals of Pipelining, Instruction Level Parallelism, Out-of-Order Execution
Thread-Level Parallelism – Multi-core Processors, Cache Coherency Problem, Synchronization, and Memory Consistency

References:

1. Advanced Computer Architecture by Kai Hwang
2. Computer Organization and Architecture by Moris Mano
3. D. Patterson and J. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann Publishers, Inc., Second edition, 1998.
4. Computer Architecture: A Quantitative Approach, John L. Hennessy & David A Patterson, Morgan Kaufmann, 1996.
5. Structure Computer Organization, 4th Edition, Andrew S. Tanenbaum, Prentice Hall, 1999.
6. Computer Architecture and Organization, J. Hayes, McGraw Hill, 1988. 5. Computer Organization and Architecture, 5th Edition, William Stallings, Prentice Hall, 1996.

Cryptography and Network Security	**PIT0011E**
Prerequisites: Computer Organization, Digital Circuits and Systems.	4 - 0 - 0

Course Outcomes:
On successful completion of the course students will be able to
CO1: To understand basics of Cryptography and Network Security.
CO2: To be able to secure a message over insecure channel by various means.
CO3: To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
CO4: To understand various protocols for network security to protect against the threats in the networks.

Course Content:
Introduction to Cryptography, Classical Cryptosystem, Cryptanalysis on Substitution Cipher, Play fair Cipher, Block Cipher;
Data Encryption Standard (DES), Triple DES, Modes of Operation, Stream Cipher, Pseudorandom Sequence;
LFSR based Stream Cipher, Mathematical background, Abstract algebra, Number Theory; Modular Inverse, Extended Euclid Algorithm, Fermat's Little Theorem, Eular Phi-Function, Eular's theorem, Quadratic Residue, Polynomial Arithmetic.
Advanced Encryption Standard (AES), Introduction to Public Key Cryptosystem, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem.
More on RSA, Primarily Testing, ElGamal Cryptosystem, Elliptic Curve over the Reals, Elliptic curve Modulo a Prime.
Generalised ElGamal Public Key Cryptosystem, Chinese Remainder Theorem, Rabin Cryptosystem, Legendre and Jacobi Symbol.
Message Authentication, Digital Signature, Key Management, Key Exchange, Hash Function. Universal Hashing, Cryptographic Hash Function, Secure Hash Algorithm (SHA), Digital Signature Standard (DSS), More on Key Exchange Protocol.
Cryptanalysis, Time-Memory Trade-off Attack, Differential Cryptanalysis, More on Differential Cryptanalysis, Linear Cryptanalysis.

Cryptanalysis on Stream Cipher, Algebraic Attack, Implementation Attacks, side channel attack. Internetwork Security, SSL, PGP, Cloud Security, Introduction to Blockchain and Bitcoin.

References:

1. William Stallings, "Crpyptography and Network security Principles and Practices", Pearson/PHI.
2. Wade Trappe, Lawrence C Washington, " Introduction to Cryptography with coding theory", Pearson.
3. W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education.
4. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India..
5. http://nptel.ac.in/courses/106105031/lecture by Dr. Debdeep Mukhopadhyay, IIT Kharagpur
6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-033- computer-system-engineering-spring-2009/video-lectures/ lecture by Prof. Robert Morris and Prof. Samuel Madden MIT.

Data Mining **PIT0012E**

Prerequisites: Nil 4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Identify the scope and necessity of Data Mining & Warehousing for the society.

CO2: Describe the designing of Data Warehousing so that it can be able to solve the root problems.

CO3: Understand various tools of Data Mining and their techniques to solve the real time problems.

CO4: Develop ability to design various algorithms based on data mining tools.

Course Content:

Introduction, Data Preprocessing;
Association Rule Mining, Classification Basics
Decision Tree, Bayes Classifier, K nearest neighbor
Support Vector Machine, Kernel Machine, Clustering, Outlier detection
Sequence mining, Evaluation, Visualization. , Case studies

References:

1. Introduction to Data Mining, Tan, Steinbach and Vipin Kumar, Pearson Education, 2016

Data Mining: Concepts and Techniques, Pei, Han and Kamber, Elsevier, 2011

Data Science	**PIT0013E**
Prerequisites: R.	4 - 0 - 0

Course Outcomes:

Students with a major in Data Science.

CO1: Students will execute statistical analyses with professional statistical software.

CO2: Students will develop relevant programming abilities.

CO3: Students will demonstrate proficiency with statistical analysis of data.

CO4: Students will develop the ability to build and assess data-based models.

Course Content:

Course philosophy and introduction to R

Linear algebra for data science: Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, solution of over-determined set of equations and pseudo-inverse) ; Geometric view - vectors, distance, projections, eigen value decomposition;

Statistics (descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to

hypothesis testing, confidence interval for estimates)
Optimization: Optimization; Typology of data science problems and a solution framework
Simple linear regression and verifying assumptions used in linear regression; Multivariate linear regression, model assessment, assessing importance of different variables, subset selection
Classification using logistic regression
Classification using KNN and k-means clustering

References:

1. Introduction to linear algebra - by gilbert strang
2. Applied statistics and probability for engineers – by douglas Montgomery

Deep Learning	**PIT0014E**
Prerequisites: Linear Algebra, Probability Theory	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to
CO1: Understand needs and fundamentals of Neural network along with its architecture.
CO2: Develop neural network algorithms like back propagation etc.
CO3: Understand advanced topics such as recurrent neural networks, long short term memory cells and convolutional neural networks.
CO3: Learn concepts of learning models for different applications.

Course Content:

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm
Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks FeedForward Neural Networks, Backpropagation
Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis Principal Component Analysis and its interpretations, Singular Value Decomposition
Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders
Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout
Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization
Learning Vectorial Representations Of Words
Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks
Recurrent Neural Networks, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs
Encoder Decoder Models, Attention Mechanism, Attention over images

References

1. Deep Learning, An MIT Press book, Ian Goodfellow and YoshuaBengio and Aaron
2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc
3. https://onlinecourses.nptel.ac.in/noc20_cs62/preview, Prof. Prabir Kumar Biswas, IIT Kharagpur

Digital Signal Processing	**PIT0015E**
Prerequisites: Basic Signals and Systems	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Understand the analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.

CO2: Get familiarized with various structures of IIR and FIR systems.

CO3: Design and realize various digital filters for digital signal processing.

CO4: Understand the applications of DSP in speech processing and spectrum analysis.

Course Content:

Discrete Time Signals and Systems, DTFT, Relation between DTFT and Analog Fourier Transform

Rational Systems, Z-transform and Pole-Zero Models

IIR Filter Design, FIR Filter Design, Filter Structures

Basics of Multirate Signal Processing

Discrete Fourier Transform, Circular Convolution, Fast Fourier Transform

References

1. Digital Signal Processing, A. Oppenheim and R. Schafer
2. Discrete Time Signal Processing, A. Oppenheim and R. Schafer
3. Digital Signal Processing, J. G. Proakis and D. G. Manolakis
4. Digital Signal Processing, S. K. Mitra

Distributed System	**PIT0016E**
Prerequisites: Data Structures and Algorithms	4 - 0 - 0

Course Outcomes:

CO1: Understand the design principles in distributed systems and the architectures for distributed systems.

CO2: Apply various distributed algorithms related to clock synchronization, concurrency control, deadlock detection, load balancing, voting etc.

CO3: Analyze fault tolerance and recovery in distributed systems and algorithms for the same, analyze the design and functioning of existing distributed systems and file systems.

CO4: Implement different distributed algorithms over current distributed platforms.

Course Content:

Introduction to Distributed Systems, Message Passing, Leader Election, Distributed Models, Causality and Logical Time

Logical Time, Size of Vector Clock, Matrix Clocks, Virtual Time and Physical Clock Synchronization, Global State & Snapshot Recording Algorithms and Distributed Mutual Exclusion-Non-Token and Quorum based approaches

Distributed Mutual Exclusion-Token based approaches, Consensus & Agreement, Checkpointing & Rollback Recovery

Deadlock Detection, Distributed Shared Memory (DSM) and Distributed Minimum Spanning Tree

Termination Detection, Message Ordering & Group Communication, Fault Tolerance and Self-Stabilization

Distributed Randomized Algorithms, Distributed Hash Table & Peer to Peer Computing

Case Studies: GFS, HDFS, Map Reduce and Spark. Sensor Networks, Authentication & Security in DS: Introduction to Sensor Networks, Distributed Algorithms for Sensor Networks, Authentication in Distributed Systems, Security in Distributed Systems and Block Chain

Reference:

1. Distributed Computing: Principles, Algorithms, and Systems- Ajay D. Kshemkalyani and Mukesh Singhal
2. Distributed Computing: Fundamentals, Simulations and Advanced Topics-HagitAttiya and Jennifer Welch Distributed Algorithms-Nancy Lynch

Embedded Systems	**PIT0017E**
Prerequisites: Computer Organization, Basic of Microprocessors	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Acquire a basic knowledge about fundamentals of microcontrollers, programming and system control to perform a specific task.

CO2: Acquire knowledge about devices and buses used in embedded networking

CO3: Develop programming skills in embedded systems for various applications.

CO4: Acquire knowledge about basic concepts of circuit emulators, Life cycle of embedded design and its testing.

Course Content:

Introduction to Embedded System, ASICs and ASIPs

Designing Single Purpose Processors and Optimization

Introduction to FPGAs and Synthesis, Verilog Hardware Description Language (Verilog HDL)

Microcontrollers and Power Aware Embedded System Design

Real Time Operating System, Real Time Scheduling Algorithms

Modelling and Specification, Design Synthesis

Digital Camera Design and Hardware Software Partitioning, Design Optimization, Simulation and Verification.

Reference:

1. Wayne Wolf, "Computers as Components-principles of Embedded Computer system Design", 1st edition, Elseveir, 2009.
2. Labrosse, "Embedding system building blocks", 2rd edition, CMP Publishers, 2007.
3. Kenneth J. Ayala and Thomson, "The 8051 Microcontroller", 3rd edition, Thompson Delmar, Learning, 2008.
4. Frank Vahid, Tony Givargis and John Wiley, "Embedded System Design, Microcontrollers", 3rd edition, Pearson Education, 2008.
5. Michael J. Pont, "Embedded C", Addison Wesley, 2002

Image Processing	**PIT0018E**
Prerequisites: Concepts of Digital Signal Processing	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Understand the need for image transforms different types of image transforms and their properties. Develop any image processing application.

CO2: Understand the rapid advances in Machine vision. Learn different techniques employed for the enhancement of images.

CO3: Learn different causes for image degradation and overview of image restoration techniques. Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.

CO4: Learn different feature extraction techniques for image analysis and recognition

Course Content:

Introduction and signal digitization; Pixel relationship; Camera models & imaging geometry

Image interpolation; Image transformation; Image enhancement

Image restoration & Image registration

Colour image processing; Image segmentation

Morphological image processing; Object representation, description and recognition

Suggested reading:

1. Digital Image Processing by Rafael C Gonzalez & Richard E Woods, 3rd Edition

2. Fundamentals of Digital Image Processing by Anil K Jain
3. Digital Image Processing by William K Pratt.
4. J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006

Information Theory and Coding Techniques	**PIT0019E**
Prerequisites: Probability basics	4 - 0 - 0

Course Outcomes:

On completion of the course, student will be able to:

CO1: Perform information theoretic analysis of communication systems.

CO2: Design a data compression scheme using suitable source coding technique.

CO3: Design a channel coding scheme for a communication system.

CO4: Understand and apply fundamental principles of data communication and networking.

Course Content:

Introduction to Information Theory, Entropy, Mutual Information, Conditional and Joint Entropy, Measures for Continuous Random Variable, Relative Entropy

Variable Length Codes, Prefix Codes, Source Coding Theorem , Various source coding techniques: Huffman, Arithmetic, Lempel Ziv, Run Length

Optimum Quantizer, Practical Application of Source Coding: JPEG Compression, Introduction to Super Information, Models and Channel Capacity

Noisy Channel Coding Theorem, Gaussian Channel and Information Capacity Theorem, Capacity of MIMO channels

Introduction to Error Control Coding, Galois Field, Equivalent Codes, Generator Matrix and Parity Check Matrix

Systematic Codes, Error Detections and Correction, Erasure and Errors, Standard Array and Syndrome Decoding, Probability of Error, Coding Gain and Hamming Bound

Hamming Codes, LDPC Codes and MDS Codes, Cyclic Codes, Generator Polynomial, Syndrome Polynomial and Matrix Representation

Fire Code, Golay Code, CRC Codes and Circuit Implementation of Cyclic Codes

Introduction to BCH Codes: Generator Polynomials

Multiple Error Correcting BCH Codes, Decoding of BCH Codes

Reed Solomon (RS) Codes, Convolutional Codes , Trellis Codes: Generator Polynomial Matrix and Encoding using Trellis, Vitrebi Decoding and Known good convolutional Codes , Turbo Codes , Trellis Coded Modulation (TCM)

Ungerboek's design rules and Performance Evaluation of TCM schemes,for fading channels and Space Time Trellis Codes (STTC), Space Time Block Codes (STBC)

Real Orthogonal Design and Complex Orthogonal Design, Generalized Real Orthogonal Design and Generalized Complex Orthogonal Design

Reference:

1. T.M. Cover and J. A. Thomas, Elements of information theory, John Wiley & Sons, 2012.
2. A. B. Robert, Information Theory, Dover Special Priced Titles, 2007.
3. R. M. Roth, Introduction to Coding Theory, Cambridge University Press, 2006.
4. S. Lin and D. J. Costello, Error Control Coding, 2 nd Edition, Prentice-Hall, 2004.
5. R. E. Blahut, Algebraic Codes for Data Transmission, Cambridge University Press, 2002.
6. T. K. Moon, Error Correction Coding: Mathematical Methods and Algorithms, Wiley, 2005.
7. R.H. Morelos-Zaragoza, The Art of Error Correcting Coding, Wiley and sons, 2006.
8. R. Johannesson and K.S. Zigangirov, Fundamentals of Convolutional Coding, 2 nd Edition, Wiley-IEEE Press, 2015.
9. E. Biglieri, D. Divsalar, P.J. McLane, M.K. Simon, Introduction to Trellis-Coded Modulation with Applications, Macmillan, 1991.

Internet of Things	**PIT0020E**
Prerequisites: Basic programming knowledge	4 - 0 - 0

Course Outcomes:

On successful completion of the course, the student will:

CO1: Understand the concept of IoT

CO2: Understand what constitutes an IoT design solution

CO3: Identify the sensors and basic electronic design needed for different IoT solutions

CO4: Analyze basic protocols of IoT.

Course Content:

Introduction to IoT; Sensing, Actuation, Basics of Networking;
Communication Protocols; Sensor Networks; Machine-to-Machine Communications
Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino;
Introduction to Python programming; Introduction to Raspberry Pi;
Implementation of IoT with Raspberry Pi;
Introduction to SDN; SDN for IoT;
Data Handling and Analytics; Cloud Computing; Sensor-Cloud;
Fog Computing; Smart Cities and Smart Homes;
Connected Vehicles; Smart Grid; Industrial IoT;

References:

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti (Universities Press)

Knowledge Representation and Reasoning	**PIT0021E**
Prerequisites: Basic formal languages, logic and programming	4 - 0 - 0

Course Outcomes:

On successful completion of the course, the student will:

CO1:has theoretical knowledge about principles for logic-based representation and reasoning.

CO2:has a basic understanding of Kripke models, production systems, frames, inheritance systems and approaches to handling uncertain or incomplete knowledge.

CO3:has a basic understanding of principles for reasoning with respect to explanation and planning.

CO4: has a broad understanding of how knowledge based systems work which provides a solid foundation for further studies and for assessing when knowledge based approaches to problem solving are appropriate

Course Content:

Introduction, Propositional Logic, Syntax and Semantics
Proof Systems, Natural Deduction, Tableau Method, Resolution Method
First Order Logic (FOL), Syntax and Semantics, Unification, Forward Chaining
The Rete Algorithm, Rete example, Programming Rule Based Systems
Representation in FOL, Categories and Properties, Reification, Event Calculus
Conceptual Dependency (CD) Theory, Understanding Natural Language
Deductive Retrieval, Backward Chaining, Logic Programming with Prolog
Resolution Refutation in FOL, FOL with Equality, Complexity of Theorem Proving
Semantic Nets, Frames, Scripts, Goals and Plans
Description Logic (DL), Structure Matching, Classification
Extensions of DL, The ALC Language, Inheritance in Taxonomies
Default Reasoning, Circumscription, The Event Calculus Revisited
Default Logic, Autoepistemic Logic, Epistemic Logic, Multi Agent Scenarios

References:

1. Language, Proof and Logic, Jon Barwise & John Etchemendy, CSLI Publications (1999); ch

9-11, 19.
2. Knowledge representation and Reasoning, Ronald J. Brachman & Hector J. Levesque, Elsevier (2004); ch 2- 5, 9, 11.
3. The Description Logic Handbook: Theory, implementation, and applications, Franz Baader, Deborah L. McGuinness, Daniele Nardi and Peter F. Patel-Schneider, Cambridge University Press(2010); ch 2, 5-6

Machine Learning	**PIT0022E**
Prerequisites: Basic programming, algorithm design, basics of probability & statistics	4 - 0 - 0

Course Outcomes:

On successful completion of the course, the student will:
CO1: Understand Machine Learning Techniques
CO2: Design Basic Practical Applications
CO3: Understand Model Based Prediction
CO4: To develop skills of using recent machine learning software for solving practical problems.

Course Content:

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation
Linear regression, Decision trees, overfitting
Instance based learning, Feature reduction, Collaborative filtering based recommendation
Probability and Bayes learning
Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM
Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network
Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning
Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model

References:

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. Introduction to Machine Learning Edition 2, by EthemAlpaydin.
3. Pattern Recognition and Machine Learning, Chris Bishop
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning Data Mining,Inference,and Prediction
5. Richard O. Duda, Peter E. Hart, David G. Stork. Pattern classification, Wiley, New York, 2001.
6. Course material available on Swayam platform and NPTEL, for the course on Introduction to Machine Learning, conducted by Prof. Sudeshna Sarkar, IIT Kharagpur.

Medical Electronics	**PIT0023E**
Prerequisites: Basic Electronics and biology	4 - 0 - 0

Course Outcomes:

On successful completion of the course, the student will:
CO1:Understanding biomedical signals and specifically cardiological signals like ECG
CO2:Analyzing biomedical signals in Frequency domain
CO3:Spectral Analyzing of biomedical signals
CO4:Understanding adaptive filtering of biomedical signals

Course Content:

Anatomy and physiology: Elementary ideas of cell structure, Heart and circulatory system, Central nervous system, Muscle action, Respiratory system, Body temperature and reproduction system
Overview of Medical Electronics Equipment, classification, application and specifications of diagnostic, therapeutic and clinical laboratory equipment, method of operation of these

instruments

Electrodes: Bioelectric signals, Bio electrodes, Electrode, Electrode tissue interface, contact impedance, Types of Electrodes, Electrodes used for ECG , EEG

Transducers: Typical signals from physiological parameters, pressure transducer, flow, transducer, temperature transducer, pulse sensor, respiration sensor,

Bio Medical Recorders and Patient Monitoring Systems: Block diagram description and application of following instruments, ECG Machine, EEG Machine, EMG Machine. Heart rate measurement, Pulse rate measurement, Respiration rate measurement, Blood pressure measurement.

References:

1. Handbook of biomedical Instrumentation by RS Khandpur
2. Biomedical Instrumentation by Cromwell,
3. Modern Electronics Equipment by RS Khandpur, TMMH, New Delhi
4. Introduction to BioMedical Electronics by Edward J. Perkstein; Howard Bj, USA

Mobile Computing	**PIT0024E**
Prerequisites: Java Programming and OS	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Have knowledge of fundamentals of mobile communicationsystems

CO2: Choose a system (TDMA/FDMA/CDMA) according to the complexity, installation cost, speed of transmission, channel properties etc.

CO3: Identify the requirements of mobile communication as compared to static communication

CO4: Identify the limitations of 2G and 2.5G wireless mobile communication and use design of 3G and beyond mobile communication systems.

Course Content:

Introduction to mobile computing, installing of Android Studio and the latest SDK Tools and preparing the working environment, creating your first Android Application

Layouts, Views, Resources, Activities, Intents, Background tasks, connecting to the Internet Fragments, Preferences

User Interaction – input, menu items, custom views, User Experience – themes and styles, material design, adaptive layouts, accessibility, localization, debugging the UI

Storing Data, SQLite database, Sharing Data, content resolvers and providers, loaders to load data

Services, background work, alarms, broadcast receivers

Notification, widgets, transferring data efficiently, publishing app

Multiple form factors, sensors, Google cloud messaging, monetizing your app

References:

1. Android Programming (Big Nerd Ranch Guide), by Phillips, Stewart, Hardy and Marsicano
2. Android Programming – Pushing the limits by Hellman
3. Android Developer Training
4. Android Testing Support Library

Modern Digital Communication Techniques	**PIT0025E**
Prerequisites: Basic knowledge Analog and Digital Communication and signals and System	4 - 0 - 0

Course Outcomes:

CO1: Students will be able to understand and apply knowledge of human communication and language processes as they occur across various contexts, e.g., interpersonal, intrapersonal, small group, organizational, media, gender, family, intercultural communication, technologically mediated communication, etc. from multiple perspectives.

CO2: Students will be able to understand and evaluate key theoretical approaches used in the interdisciplinary field of communication. I.e., students will be able to explain major theoretical frameworks, constructs, and concepts for the study of communication and language, summarize the work of central thinkers associated with particular approaches, and begin to evaluate the strengths and weaknesses of their approaches.

CO3: Students will be able to understand the research methods associated with the study of human communication, and apply at least one of those approaches to the analysis and evaluation of human communication.

CO4: Students will be able to find, use, and evaluate primary academic writing associated with the communication discipline.

Course Content:

Introduction to digital communication systems, Source Coding, Characterization of Communication Signals & Systems

Signal space Representation, Representation of Memory less Modulation Methods, Nonlinear modulation methods

Optimal receivers of AWGN, Receiver for non-ideal channel

Probability of error of different modulation schemes

Fundamentals of estimation and detection theory used in digital communication

Carrier phase and symbol timing synchronization techniques

Channel estimation and equalization techniques, Power Adaptation methods for colored noise channel

References:

1. Digital Communications by John G. Proakis
2. Digital Communications by Bernard Sklar
3. Digital Communications by Robert Gallager
4. Digital Communications by Simon Haykin
5. Modern Digital and Analog communications by B.P. Lathi

Modern Digital System Design	**PIT0026E**
Prerequisites: Basic knowledge of digital electronics at UG level	4 - 0 - 0

Course Outcomes:

The goals of this laboratory course are:

CO1: To apply concepts and methods of digital system design techniques as discussed in the class (ESE170) through hands-on projects.

CO2: To analyze the results of logic and timing simulations and to use these simulation results to debug digital systems.

CO3: To learn to design combinational and sequential digital systems starting from a word description that performs a set of specified tasks and functions.

CO4: To develop skills, techniques and learn state-of-the-art engineering tools (such as VHDL, Xilinx ISE, etc.) to design, implement and test modern-day digital systems on FPGAs.

Course Content:

Memory Element: Review of Latch, R-S, J-K, D flip flops, Master Slave arrangement, Edge triggered flip flops, shift registers, asynchronous and synchronous counters.

Synchronous sequential finite state machines: Synchronous analysis process, design approaches, state reduction, design of next state decoder and output decoder, design of counters and decoders, code sequence detector, sequential code generators

ASM: ASM Chart, ASM block, Design using FFs. Design using separate FFs, Design using multiplexers, PLA and design of circuits using PLA

Asynchronous Sequential finite state machines: Need for asynchronous circuit, analysis, cycles and races, Hazards, map entered variable approaches to asynchronous Design.

Data Converters: Introduction to Analog to Digital and digital to Analog conversions, design and study of Register divider network, R-2R network, Circuits of DACs. ADCs: Flash Converters,

Counter type Converters, continuous type converter. Fast converters, Successive Approximation techniques. Split counter converter etc.

References:

1. An Engineering approach to Digital Design: William J. Fletcher PHI
2. Digital Design: Principles and Practices PHI
3. Fundamental of Digital Design CH Roth Jr. Jaico Pub House
4. Digital Design. Morris Mano. PHI
5. Digital Principles and Design Donald D. Givone TMH

Multimedia Processing	**PIT0027E**
Prerequisites: Digital Signal Processing	4 - 0 - 0

Course Outcomes:

CO1: Understand the concepts of image acquisition and digitization.

CO2: Classify image enhancement techniques and apply these techniques in both spatial and frequency domain.

CO3: Recognize the types of noise present in images and apply appropriate image restoration technique.

CO4: Categorize image segmentation techniques and apply these techniques.

Course Content:

Introduction to Multimedia, Elements of Image Compression System

Video Coding: Fixed-length and Variable-length Codes

Lossless and Lossy Compression, Discrete Cosine Transforms, Short-term Fourier Transform & Continuous and Discrete Wavelet Transform, Coding Techniques in 2 - D Wavelet Transforms

Motion Estimation: Matching Criteria, Generalized Matching, Generalized Deformation Model in Motion Estimation

Multimedia Standards, Still Image Compression Standards: JPEG, JPEG-2000

Video Compression Standards: An Overview, H.261 & H.263 Standards, MPEG-1 Standards: Specifications, Continuity & Synchronization, Synchronization of Media, Continuity Aspects of MPEG-1 Multimedia Streams

Multimedia Synchronization, MPEG-2 Standards, Scalable Profiles

MPEG- 4 Standards: Introduction, Audio Visual Objects, Multifunctional Coding Capabilities

MPEG- 1 Audio Standards, Audio Coder, Encoding, Bit Allocation and Psychoacoustic Model, Masking Effects and Layer-3 Encoding

Multimedia Content Representation and Retrieval, Video Content Representation, Motion Representation, Low to High-level Representation, Content Retrieval Schemes.

References:

1. Vaughan, V. Multimedia Making it Work. 8th ed., McGraw-Hill, New York, 2011.
2. N. Chapman, J. Chapman. Digital Multimedia 3th ed., John Wiley & Sons, New York, 2009.
3. Yun Qing Shi, Huifang Shu, Image and Video Compression for Multimedia Engineering, CRC Press, New York, 2008.
4. Z-N Li, M.S. Drew. Fundamentals of Multimedia
5. W. Sebesta, Programming the World Wide Web (2nd Ed.), Addison Wesley, Boston, 2003.
6. Manuals for working with the selected software tools for creating multimedia elements and systems

Natural Language Processing	PIT0028E
Prerequisites: Basic probabilities knowledge	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Develop algorithms based on NLP Concepts.

CO2: Develop applications based on Statistical Approaches of NLP

CO3: Create applications for Indian Language Processing.
CO4: To develop skills of using recent Natural Language Processing software for solving practical problems.

Course Content:

Introduction and Basic Text Processing, Spelling Correction, Language Modeling, Advanced smoothing for language modeling, POS tagging
Models for Sequential tagging – MaxEnt, CRF , Syntax – Constituency Parsing
Dependency Parsing , Lexical Semantics , Distributional Semantics
Topic Models , Entity Linking, Information Extraction
Text Summarization, Text Classification
Sentiment Analysis and Opinion Mining.

References:

1. Daniel Jurafsky and James H.Martin Speech and Language Processing(2nd Edition),Prentice Hall:2nd edition,2008.
2. Machine Learning for Text by CharuC.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

Pattern Recognition	**PIT0029E**
Prerequisites: Basic knowledge of Linear Algebra; Probability and Statistics	4 - 0 - 0

Course Outcomes:

CO1: Students will understand Bayesian Decision Theory, the canonical classifier model, and how different classification methods define decision boundaries. Evaluation: Assignments and projects
CO2: Students will be able to apply performance evaluation methods for pattern recognition. Evaluation: Projects
CO3: Students will be able to select appropriate techniques for addressing recognition problems. Evaluation: Assignments and projects
CO4: Students will be able to implement basic pattern recognition algorithms. Evaluation: Assignments and projects
CO5: Students will be able to summarize current pattern recognition research verbally and in writing. Evaluation: Assignments and research paper presentations

Course Content:

Introduction and mathematical preliminaries - What is pattern recognition? Clustering vs. Classification; Applications; Linear Algebra, vector spaces, probability theory, estimation techniques.
Classification: Bayes decision rule, Error probability, Error rate, Minimum distance classifier, Mahalanobis distance; K-NN Classifier, Linear discriminant functions and Non-linear decision boundaries.
Fisher's LDA, Single and Multilayer perceptron, training set and test sets, standardization and normalization.
Clustering: Different distance functions and similarity measures, Minimum within cluster distance criterion, K-means clustering, single linkage and complete linkage clustering, MST, medoids, DBSCAN, Visualization of datasets, existence of unique clusters or no clusters.
Feature selection: Problem statement and Uses, Probabilistic separability based criterion functions, interclass distance based criterion functions, Branch and bound algorithm, sequential forward/backward selection algorithms, (l,r) algorithm.
Feature Extraction: PCA, Kernel PCA.

Recent advances in PR: Structural PR, SVMs, FCM, Soft-computing and Neuro-fuzzy.

References:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
2. Statistical pattern Recognition; K. Fukunaga; Academic Press, 2000.
3. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.

Social Network	**PIT0030E**
Prerequisites: Basic programming, algorithm design, basics of probability & statistics	4 - 0 - 0

Course Outcomes:

On completion of the course students should be able to:

CO1: Use data communication vocabulary appropriately when discussing issues with other networking professionals.

CO2: Troubleshoot simple business network design errors.

CO3: Design simple business local, metropolitan and wide area networks using appropriate architectures, hardware and security.

Course Content:

Introduction; Handling Real-world Network Datasets
Strength of Weak Ties; Strong and Weak Relationships (Continued) & Homophily
Homophily Continued and +Ve / -Ve Relationships
Link Analysis ; Cascading Behaviour in Networks
Power Laws and Rich-Get-Richer Phenomena and Epidemics
Small World Phenomenon; Pseudocore (How to go viral on web)

References:

1. Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
2. Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010.

Soft Computing	**PIT0031E**
Prerequisites: Basic programming, algorithm design, basics of probability & statistics	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Develop NN network based application.

CO2: Differential between supervised, unsupervised and reinforcement learning.

CO3: Apply fuzzy logic on real life problems.

CO4: Design Hybrid Systems viz Neuro-Fuzzy, Neuro- Genetic, FuzzyGenetic systems.

Course Content:

Introduction to Soft Computing, Introduction to Fuzzy logic, Fuzzy membership functions, Operations on Fuzzy sets; Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences; Defuzzyfication Techniques, Fuzzy logic controller;
Concept of GA, GA Operators: Encoding, Crossover, Mutation
Introduction to EC, MOEA Approaches: Non-Pareto, Pareto;
Introduction to ANN, ANN Architecture; ANN Training, Applications of ANN

References:

1. An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press)
2. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer(Springer)
3. Fuzzy Logic with Engineering Applications Timothy J. Ross (Wiley)
4. Neural Networks and Learning Machines Simon Haykin (PHI)

Software Engineering	**PIT0032E**
Prerequisites: Basic programming	4 - 0 - 0

Course Outcomes:

On successful completion of the course students will be able to

CO1: Understand and implement the concept of SDLC

CO2: Understand the concept of project management

CO3: Apply software quality assurance practices to ensure that software designs, development, and maintenance.

CO4: Perform various testing techniques.

Course Content:

Introduction; Life Cycle Models

Requirements analysis and specification; Basics of software design; Procedural design methodology; Object-oriented concepts;

Introduction to UML: Class and Interaction Diagrams

Object-oriented analysis and design; Testing

References:

1. Software Engineering: A practitioner's approach by Roger S. Pressman, 7th edition, McGraw-Hill International edition
    1. Software Engineering by Ian Sommerville, 7th edition, Addison

Computer Networks and Internet Protocol **PIT0033E**

Prerequisites: Null 4 - 0 - 0

Introduction to Computer Networks – History, Circuit Switching and Packet Switching

TCP/IP Protocol Stack – Basic Overview

Application Layer Services (HTTP, FTP, Email, DNS)

Transport Layer Primitives – Connection Establishment and Closure

Flow Control and Congestion Control at the Transport Layer

Transmission Control Protocol – Basic Features, TCP Congestion Control

Network Layer Primitives – IP Addressing

IP Routing – Intra Domain Routing Protocols, Inter Domain Routing Protocols (BGP)

IP Services – SNMP, ARP

Data Link Layer Service Primitives – Forwarding, Flow Control, Error Control

Media Access Control - Channel Access Protocols, Framing, End to End Principles of Computer Networks

REFERENCES:

1. Computer Networking: A Top - Down Approach, by Ames Kurose, Keith Ross
2. Computer Networks - Andrew S Tanenbaum
3. Computer Networks: A Systems Approach Book by Bruce S. Davie and Larry L. Peterson
4. TCP/IP Tutorial and Technical Overview, (IBM Redbook) - Download From http://www.redbooks.ibm.com/abstracts/gg243376.html
5. TCP/IP Guide, Charles M. Kozierok, Available Online - http://www.tcpipguide.com
6. Request for Comments (RFC) - IETF - http://www.ietf.org/rfc.html

Theory of Computation **PIT0034E**

Prerequisites: Data Structures and Algorithms. 4 - 0 - 0

Finite Automata – deterministic and nondeterministic, regular operations

Regular Expression, Equivalence of DFA, NFA and REs, closure properties

Non regular languages and pumping lemma, DFA Minimization,

CFGs, Chomsky Normal Form

Non CFLs and pumping lemma for CFLs, PDAs, Equivalence of PDA and CFG

Properties of CFLs, DCFLs, Turing Machines and its variants

Configuration graph, closure properties of decidable languages, decidability properties of regular languages and CFLs
Undecidability, reductions, Rice's Theorem, introduction to complexity theory

REFERENCES:
1. Introduction to the Theory of Computation by Michael Sipser.

Data Structures and Algorithm **PIT0035E**

Prerequisites:Nil 4 - 0 - 0

Introduction to Computers and Programming, Pointers; Functions; Running time of a program; Computing time complexity, Polynomial evaluation and multiplication
Arrays and Multidimensional arrays, Searching: Binary Search, Linear;
Sorting: Insertion Sort, Merge Sort, Quick Sort, Heap Sort, Counting, Radix, Structures and User-defined data types
Links Lists: Operation – Creations, insertion, Deletion; Circular Lists; Doubly Linked List
Stacks: Operations and Applications; Queues: Operations and Applications; Circular Queues: Operations and Applications;
Tree: Binary Trees - Operations: Insert, Delete ; Traversal: Preorder, Inorder, Postorder; Search Trees - AVI-trees , B-tree , External Search;
Graphs: Representation: Matrix, Adjacency list; Traversal: Depth First Search, Breadth First Search; Minimum Spanning Tree , Shortest Path , All pairs Shortest Path, Transitive Closer;
Hashing Techniques; Sets : Representation , Operations: Union and Find;
String Algorithms : Pattern Matching , Text Editor;
Greedy algorithms; Dynamic programming; Matrix Chain Multiplication; Dijkstra's Algorithm
Boyer-Moore String Matching Algorithm

Text Books:

1. S.Lipschutz, " Theory and Problem of Data Structure" , Schaum's Outline Series, Tata McGraw-Hill
2. Tannenbaum, "Fundamentals of Data Structures", PHI
3. R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C" , PHI
4. Horowitz and Sahani, "Fundamentals of Data structures", Galgotia publications
5. "Data Structures Using C" - ReemaThareja
6. "Introduction to Data Structures in C" – Ashok N. Kamthane
7. Classic Data Structures - D Samanta