B.C.S.E FOURTH YEAR FIRST SEMESTER

Course code	CSE/PC/H/T/411
Category	Professional Core
Course title	Computer and Network Security
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction: Security Goals, Threat, Vulnerabilities and Attacks, Types of Attacks, Security Services and Mechanisms **[1L]**

2. Cryptographic Tools: Symmetric Key Cryptography, Asymmetric Key Cryptography, Message Integrity and Message Authentication, Cryptographic Hash Functions, Digital Signatures **[2L]**
3. User Authentication: Password Based Authentication, Token Based Authentication, Biometric Authentication, Remote User Authentication **[2L]**

4. Access Control: Access Control Principles, Subjects, Objects, and Access Rights, Discretionary Access Control, Role-Based Access Control **[2L]**

5. Database Security: Database Access Control, Inference, Statistical Database, Database Encryption **[2L]**
6. Internet Security Protocols and Standards: IPSec, SSL and TLS, PGP and S/MIME **[6L]**
7. Internet Authentication Applications: Kerberos, X.509, Public Key Infrastructure **[4L]**
8. Security Appliances: Intrusion Detection Systems, Firewalls and Intrusion Prevention Systems **[3L]**
9. Malicious Software: Types of Malicious Software, Viruses, Virus Countermeasures, Worms, Bots, Rootkits **[2L]**

10. Software Security: Buffer Overflow Attacks, Defense against Buffer Overflows, Handling Program Inputs, Writing Safe Program Codes, Interaction with Operating System and Other Software **[2L]**

11. *Blockchain Technology* **[2L]**
12. Operating System Security: Linux Security, Windows Security **[4L]**
13. IT Security Management Issues: IT Security Management, IT Security Standards, Organizational Context and Security Policy, Security Risk Assessment, IT Security Controls, Plans and Procedures, IT Security Audit, Cybercrime and Computer Crime, Intellectual Property, Privacy, Ethical Issues **[4L]**
14. Wireless Network Security: Authentication and Authorization in Wireless LANs, Data Protection in Wireless LANs **[4L]**

Books:

1. Computer Security: Principles and Practices, by William Stallings and Larry Brown, First Edition, 2008, Pearson Education
2. Network Security: Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Second Edition, 2003, Prentice Hall India
3. Cryptography and Network Security, by William Stallings, Fifth Edition, Prentice Hall, 2010
4. 4. Network Security Essentials: Applications and Standards, by William Stallings, Edition, Pearson Education
5. Cryptography and Network Security by Behrouz A. Forouzan and Debdeep Mukhopadhyay, Second Edition, 2010, Tata McGraw Hill
6. Security in Computing, by Charles P. Pfleeger, Shari Lawrence Pfleeger, 4th Edition, 2007, Prentice Hall

Course Outcomes (COs):

At the end of this course, each student should be able to:

CO1: Comprehend the concept of Security and related issues, different methods and techniques for providing security including authentication and access control.
CO2: Analyse Internet security protocols and standards.
CO3: Illustrate issues related to malicious software and ways to handle.
CO4: Assess overall security management in OS, IT, Wireless networks.

Course code	CSE/PC/H/T/412
Category	Professional Core
Course title	Machine Learning
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

Introduction: What is machine learning? Applications of Machine Learning, Types of machine learning with examples-supervised learning, unsupervised learning, semi-supervised learning, reinforcement learning, Learning as search [2L]

Learning from examples, training data representation, test data, output vector representation, hypothesis representation, hypothesis space, inductive bias, problem of generalization, more specific hypothesis and more general hypothesis, VC dimension, PAC learning, how noise affects learning. [4L]

Decision tree learning: ID3 algorithm with real life examples, overfitting, handling continuous attributes and missing attributes [4L]

Bayesian Learning: Bayesian decision theory, Bayesian classification, losses, risks, discriminant functions [2L]

Linear regression and logistic regression – regression vs. classification, hypothesis representation, cost function, logistic function, Derivation of gradient descent algorithm, Learning multiple classes [4L]

Support Vector Machines- Linear Support Vector Machine and brief introduction to Kernel Machines. Multi-class SVM: One vs. all strategy. [4L]

Instance based learning: K-nearest classifier, Curse of dimensionality, When to use KNN? [2L]

Performance measures for Machine learning algorithms- Confusion matrix, Evaluation Measures - Accuracy, Error rate, precision, recall, F-measure etc. Bootstrapping & Cross Validation, ROC curve [2L]

Model selection procedures: overfitting, regularization, model complexity, bias/variance dilemma [2L]

Artificial neural networks: Intro to Artificial neural networks, Backpropagation algorithm, introduction to deep neural networks with real life examples [6L]

Unsupervised learning: Clustering --- Distance based and probabilistic models [5L]

Ensemble learning: boosting , bagging and random forest [2L]

Introduction to modern machine learning tools and packages such as WEKA under Java platform and/or Scikit-learn under python platform and/or machine learning under R platform. [2L]

Books:

1. 1. T. M. Mitchell, Machine Learning, McGraw-Hill, 1997.
2. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.
3. Peter Flach, Machine Learning, Cambridge University Press, 2012
4. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT press
5. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
6. R. O. Duda, P. E. Hart, and D.G. Stork, Pattern Classification, John Wiley and Sons, 2001.
7. Vladimir N. Vapnik, Statistical Learning Theory, John Wiley and Sons, 1998.
8. Shawe-Taylor J. and Cristianini N., Cambridge, Introduction to Support Vector , Machines, University Press, 2000.

Course outcomes:
The students will be able to:

CO1: Have a good understanding of the fundamental issues and challenges of machine learning and understanding differences among various types of machine learning: supervised, un-supervised learning, reinforcement learning etc.
CO2: Learn basic theory of machine learning including concepts of hypothesis space, PAC learning and VC dimension
CO3: Learn various supervised machine learning algorithms-Decision tree, Bayesian, Logistic Regression, SVM with Kernel and instance based learning, and have an understanding of the strengths and weaknesses of the algorithms
CO4: Learn various performance measures of evaluating the Machine Learning algorithms and model selection procedures for choosing the appropriate model
CO5: Learn artificial neural networks with backpropagation algorithm and basics of deep learning, and have understanding of the strengths and weakness of deep learning.
CO6: Learn unsupervised learning methods and Ensemble methods, and implement machine learning systems for real-world applications using modern machine learning tools.

Course code	CSE/PE/B/T/413A
Category	PE
Course title	Pattern Recognition
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

Basic concepts of Pattern Recognition, Pattern Preprocessing and Feature Selection	[5L]
Decision Functions	[2L]
Bayesian decision theory	[2L]
Parametric Estimation: Maximum likelihood estimation and Bayesian estimation	[5L]
Non- parametric Estimation: Parzen windows, Nearest Neighbor estimation	[4L]
Linear classifier: Perceptron, Support Vector Machines (SVM)	[3L]
Non-linear classifiers: MLP, Non-linear SVM	[5L]
Unsupervised learning and Clustering: Partitioning methods, Density-based methods, MST- based methods; Soft Computing based methods, Hierarchical Clustering, Cluster Validity	[10L]
Syntactic Pattern Recognition: (Basic concepts)	[2L]
Some real-life applications	[2L]

Suggested Readings:

1. Pattern Recognition Principles, Tou and Gonzalez, Addison-Wesley

2. Pattern Classification, Duda, Hart and Stork, Second Edition, Wiley
3. Pattern Recognition and Machine Learning, Christopher Bishop, Springer
4. Introduction to Statistical Pattern Recognition, Fukunaga, Second Edition, Academic Press

Course Outcomes (COs):

The students will be able to:

CO1: Understand the basic approach for the development of a typical pattern recognition system and the concept of decision function.
CO2: Analyse the various methods of pattern pre-processing and feature selection.
CO3: Comprehend the concept and the analytical expressions of Bayes decision theory and the various techniques of parametric and non-parametric estimation.
CO4: Apply various supervised, unsupervised and syntactic pattern recognition methods to study and characterize patterns in real-life data.

Course code	CSE/PE/B/T/413B
Category	PE
Course title	Soft Computing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction to Soft Computing, Components of Soft Computing and its Applications. [2L]
2. Fuzzy Set Theory -Definition, Fuzzy set theoretic operations, Properties of membership function, fuzzification and defuzzification, Development of fuzzy set membership functions, Fuzzy rules and fuzzy reasoning, Fuzzy inference systems. [10L]
3. Rough set theory-Definition, Object reduction in Rough set Theory, Recommendation method, Rough-Set-Based Interrelationship Mining for Incomplete Decision Tables [4L]
4. Probabilistic Reasoning: Basic probability, Bayes rule and its application, knowledge representation in uncertain domain, Bayesian Networks [4L]
5. Genetic Algorithms, Simulated Annealing, Use of GAs for single objective and multi objective problem solving. [6L]
6. Neural Networks-Artificial neural networks models, Supervised Learning, Unsupervised Learning, Applications. [10L]
7. Hybrid Systems and its applications: [6L]

Suggested Readings:

1. Soft Computing and Intelligent system design: Karry and Silva, Pearson
2. Fuzzy Logic with Engineering application: Timothy J. Ross, Willey

3. Topics in Rough Set Theory: Current Applications to Granular Computing, Akama, Kudo andMurai, Springer
4. Neuro Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence -Jang, Sun and Mizutani, Printice Hall.
5. Soft Computing: Integrating Evolutionary, Neural, and Fuzzy Systems, by Tettamanzi, Andrea, Tomassini, and Marco. (2001),Springer.

Course Outcomes:

After Completion of the course the student able to

CO 1: Understand the basic concepts of soft computing techniques like artificial neural networks, fuzzy logic, rough set, probabilistic reasoning and genetic algorithms etc.
CO 2: Develop fuzzy logic based system from the imprecise data
CO 3: Design a system effectively using soft computing approaches such as GA, Neural network to solve real life problems
CO 4: Analyze, evaluate and compare solutions by various soft computing approaches such as Fuzzy set, rough set, probability theory etc.
CO 5: Develop and promote research interest in Soft computing in the problems of Engineering and Technology

Course code	CSE/PE/B/T/413C
Category	PE
Course title	Deep Learning
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Machine learning basics-types of machine learning, hypothesis function, target function, feature representation, training data and test data representation [4L]
2. Neural networks basics- logistic regression, gradient descent search, model evaluation, Multilayer Perceptron, Backpropagation algorithm, momentum, effect of learning rate and feature scaling, Network design Examples. [6L]
3. Shallow Vs. Deep learning, Why deep learning? Intuition about deep representation, Training deep neural networks, Forward propagation and Backward propagation in Deep Neural Networks. Local minima problem, Gradient vanishing and explosion problem, pre-training, Auto-encoders. Activation functions-Sigmoid, ReLu, Tanh, Softplus, Approximated Sigmoid, etc. and their comparisons.
   Overfitting –What is overfitting? What causes overfitting? Dealing with overfitting- Early Stopping, Regularization, Drop-out.
   Optimization algorithms- Mini-batch gradient descent, RMSProp and Adam optimization algorithms.

Concepts of hyper parameters. Accelerating the training of Deep Neural Networks with Batch Normalization, a brief introduction to Deep learning tools under python platform.

(3L+ 2L + 2L + 3L + 3L) = [14L]

4. *Automatic feature learning*- Comparisons of handcrafted features and automatically learned features, Importance of automatic feature learning, examples with computer vision problems- Vertical and horizontal edge detection, learning to detect edges, What is convolution? Why convolution? padding, Strided convolutions, convolutions on RGB images, multiple filters, Basic Convolutional Neural Network architecture, Types of layers in CNN (convolution, pooling, fully connected) and their purposes. A simple application of CNN to a real life computer vision problem and its implementation under python platform. [8L]

5. Brief introduction to some classical CNN models -LeNet, AlexNet,VGG-16, ResNet [2L]
6. Sequence learning using recurrent neural networks (RNN), Feed forward ANN vs. RNN, Sequence learning examples, Backpropagation-in-time(BIT) algorithm for training RNN, GRU (Gated Recurrent Unit) and Long Short Term Memory (LSTM) neural networks with real life examples. [6L]

Suggested Books:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville , MIT press
2. Neural Networks and Deep Learning, Michael Nielsen, Determination Press, 2015
3. Deep Learning: A Practitioners Approach, Josh Patterson, Adam Gibson, O'Reilly Media, Inc, August 2017
4. Neural Networks and Learning Machines by Simon Haykin, Publisher-PHI Learning, 2010

Course outcomes:

The students will be able to:

CO1: Learn basic concepts of machine learning and model evaluation techniques

CO2: Learn logistic regression, artificial neural networks and the mathematical derivation of the training algorithms for the basic models.

CO3: Design deep neural network architectures and learn training algorithms with necessary mathematical analysis

CO4: Learn state-of-the-art approaches to deep learning including CNN and LSTM

CO5: Apply deep learning models using modern deep learning tools to real life problems including computer vision and natural language processing

Course code	CSE/PE/B/T/414A
Category	PE
Course title	Multimedia Technology
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction
   Multimedia and its Application, Different Media, Hypertext and Hypermedia, Issues in Multimedia System, Component of a Multimedia System [2L]
2. Overview of Text and Graphics:
   Types of Text Data (Plain/Formatted/Hypertext), Unicode Scheme, Concept of Font, File Formats (txt, doc, rtf, ps, pdf etc.), Vector and Raster Graphics [2L]
3. Image:
   Image Digitization, Digital Image, Binary/GrayScale/ Colour Image, Colour Models, File Formats, Overview of Contrast Intensification, noise removal, edge detection and segmentation [5L]
   Image Descriptors (Shape, Texture and Colour Features) [3L]
   Loss-less and Lossy Image Compression including JPEG [3L]
   An overview of Content Based Image Retrieval System [3L]
4. Audio:
   Audio Digitization (Sampling and Quantization, Representation based on PCM/DPCM/DM/ADM), File Formats [2L]
   Time Domain Descriptors (ZCR, STE etc.), Frequency Domain Descriptors (Spectral Centroid, Spectral Flux, Spectral Roll Off etc.), and Perception based Descriptors (Mel Scale, MFCC) [3L]
   Psycho Acoustics and Audio Compression [2L]
   An Overview of Audio Classification/Retrieval System [2L]
5. Video:
   Structure of Video Data, File Formats [1L]
   Video Compression [2L]
   Motion Estimation [1L]
   Structural Segmentation of Video Data [3L]
   Overview of Video Summarization, Browsing and Retrieval System [2L]
6. Animation:
   Keyframes & tweening, cel & path animation, principles and techniques of animation, Web animation, 3D animation principles, camera, special effects, transformations andediting, rendering algorithms, features of animation software, file formats. [4L]
   Unsupervised learning and Clustering: Partitioning method, Density-based method, MST based method, Self organizing map, Hierarchical Clustering, Cluster validity [10L]
   Syntactic Pattern Recognition (Basic concepts) [2L]
   Some real-life applications [2L]

Books:

1. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods
2. Digital Image Processing and Analysis by B. Chanda and D. Dutta Majumder
3. Principles of Multimedia by Ranjan Parekh
4. Multimedia –A Practical Approach by Sanhker, Jaico.
5. Multimedia Systems by Buford J. K., Pearson Education.
6. Multimedia and Imaging Databases by S. Khoshafian, A. Brad Baker, Morgan Kaufmann.
7. Multimedia Systems Design, Prabhat k. Andleigh & KiranThakkar, Prentice Hall PTR.
8. Digital Multimedia by Nigel Chapman & Jenny Chapman, John-Wiley.
9. Fundamentals of Computer Graphics and Multimedia by D.P. Mukherjee,

Course Outcomes (COs):

After successfully completed the course, students will be able to:

CO1: Understand the essential features of multimedia and applying those in emerging problems in this area.
CO2: Comprehend and analyze the capturing and representation of various multimedia signals, including animations.
CO3: Analyse and evaluate Multimedia Compression Algorithms
CO4: Design algorithms for processing and extraction of information from multimedia signals
CO5: Understand and Design procedures for multimedia applications, including animation.

Course code	CSE/PE/B/T/414B
Category	PE
Course title	Bioinformatics
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction to Bioinformatics, Central dogma of Molecular Biology [2L]
2. Biological Databases- Concepts and Understanding [4L]
3. Sequence alignment: Global and local alignment, scoring, dynamic programming, tree alignment, Hidden Markov Models [6L]
4. Gene finding algorithms [3L]
5. Protein Sequences and Substitution matrices: Suffix tree construction and applications [2L]

6. Introduction to Gene Expression: Microarrays, their uses, idea about normalization [2L]
7. Single Nucleotide Polymorphisms (SNPs): The Haplotype problem [1L]
8. Phylogenetic Tree and Analysis [2L]
9. Introduction to Gene Regulation: Gene regulation, binding sites, transcriptional networks, gene's circuitry [6L]
10. Network of Interactions: Regulatory networks [2L]
11. Signals in Sequences: Weight matrices, higher order MC dependencies, transcription
12. factor binding sites [2L]
13. Introduction to Proteomics: Protein structure, interactions [2L]
14. Protein Structure Prediction: Attempts to predict secondary and tertiary structure of amino acid sequences [4L]
15. Drug docking [2L]

Books:

1. Dan Gusfield. Algorithms on Strings, Trees, and Sequences, Cambridge University Press, 1997
2. Richard Durbin, Sean R Eddy, Anders Krogh, Graeme Mitchison. Biological Sequence Analysis, Cambridge, 1998
3. Roderic D M Page, Edward C Holmes. Molecular Evolution: A phylogenetic Approach, Blackwell Sciences Inc 1999
4. David W Mount. Bioinformatics: Sequence and Genome Analysis, CBS Publishers and Distributors (Pvt.) Ltd., 2005
5. Pierre Baldi, Soren Brunak. Bioinformatics: The Machine Learning Approach, MIT Press, 2001

Course Outcomes (COs):

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

CO1: Understand the Central dogma of Molecular Biology, Biological Databases and Sequence Alignment.
CO2: Understand Substitution matrices, Gene Expression and Phylogenetic tree analysis.
CO3: Understand the concept of Gene Regulation and Regulatory Networks.
CO4: Understand the concept of Proteomics, Protein Structure prediction and Drug Docking.

Course code	CSE/PE/B/T/414C
Category	PE
Course title	Natural Language Processing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

Regular Expressions and Automata: [**2L**]
Introduction to NLP, Regular Expression, Finite State Automata

Tokenization: [**6L**]
Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Expressions, Minimum Edit Distance, Spell Checking

Morphology **:** [**4L**]
Morphology – Inflectional and Derivational Morphology, Finite State Morphological Parsing, Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer

*Language Modeling***:** [**4L**]
Introduction to N-grams, Chain Rule, Smoothing – Interpolation, Backoff, Web-Scale LMs, Add-One Smoothing, Good-Turing Smoothing, Kneser-Ney Smoothing, Evaluation and Perplexity.

Hidden Markov Models and POS Tagging **:** [**4L**]
Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging

Text Classification: [**4L]**
Text Classification, Naïve Bayes' Text Classification, Sentiment Analysis - Opinion Mining and Emotion Analysis, Resources and Techniques, Evaluation

Context Free Grammar **:** **[4L**]
Context Free Grammar and Constituency, Some common CFG phenomena for English, Top-Down and Bottom-up parsing, Probabilistic Context Free Grammar, Dependency Parsing

*Computational Lexical Semantics***:** [**4L**]
Introduction to Lexical Semantics, Thesaurus and WordNet, Word Sense Disambiguation, Word Similarity – Path based, Information Content based, Resnik Similarity, Lin Similarity, Distributional Similarity, Point-wise Mutual Information, Word Sense Induction

Information Retrieval **:** [**4L**]
Boolean Retrieval, Term-document incidence matrix, Inverted Index, Query processing with inverted index, Phrase Queries, Positional Index, Ranked Retrieval – Term Frequency, Inverse Document Frequency, tf-idf weighting, Vector Space Model, Evaluation

Question Answering and Text Summarization: **[2L]**

*Machine Translation***:** [**4L**]
Introduction, Different paradigms –Rule based, Example based, Statistical, Noisy channel model, EM algorithm, Decoding, Evaluation

Suggested Readings:
1. Speech and Language Processing, Jurafsky and Martin, Pearson Education
2. Foundation of Statistical Natural Language Processing, Manning and Schutze, MIT Press

Course Outcomes (COs):
At the end of this course, each student should be able to:

CO1: Develop the mathematical and statistical abilities and understand the models, methods, and algorithms of Natural Language Processing (NLP) for common NLP tasks.
CO2: Apply core computer science concepts and algorithms.

CO3: Gain understanding of linguistic phenomena and explore linguistic features relevant for different NLP tasks.
CO4: Apply the methods to new NLP problems, as well as to problems outside NLP.

Course code	CSE/PE/B/T/414D
Category	PE
Course title	Image Processing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction:
   - Overview of Image Processing System [1L]
   - Image Digitization (Sampling and Quantization), Digital Image [2L]
   - Fundamentals of Colour image and Colour Models, Image File Format [3L]
2. Mathematical Transformation:
   - Fourier Transform (1-D and 2-D), Discrete Cosine Transform [2L]
3. Image Enhancement:
   - Contrast Intensification (linear and non-linear stretching) [2L]
   - Histogram Equalization [1L]
   - Spatial Domain Smoothing Filters [3L]
   - Web Design: [3L]
   - Designing navigation
   - Advanced UI's: [6L]
   - Groupware, 3D UIs, Image Sharpening [1L]
   - Frequency Domain Lowpass and Highpass filters [2L]
   - Colour Image Smoothing and Sharpening [3L]
4. Image Segmentation:
   - Point Detection, Line Detection [1L]
   - Edge Detection (Robert, Prewitt, Sobel and Canny Edge Detector) [2L]
   - Edge Linking and Edge Following by Local Processing, Hough Transform [2L]
   - Region Extraction by Pixel based Approach (Thresholding, Choice of Feature, Optimum Threshold etc.) [3L]
   - Region Extraction by Region based Approach (Intoduction to Region Growing, Splitting, Merging, Split and Merge) [1L]
5. Description and Representation:
   - Boundary Representation by Chain Codes, Polygonal Approximation, Skeletons [2L]
   - Component Labelling and Counting [1L]
   - Geometrical Attributes (Perimeter, Area, Diameter of Enclosing Circle), Geometric Moments [1L]
   - Texture Descriptor (Graylevel Co-Occurrence Matrix etc.), Colour Descriptors [1L]
6. Image Compression:
   - Loss-less Compression by Run Length Coding, Huffman Coding, Predictive Coding [2L]

Lossy Compression by Block Truncation Coding, Vector Quantization [2L]
JPEG Compression [2L]

Books:
1. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods
2. Digital Image Processing and Analysis by B. Chanda and D. Dutta Majumder
3. Fundamentals of Digital Image Processing by Anil K. Jain

Course Outcomes (COs):

After successfully completed the course, students will be able to:

CO1: Understand the basic concepts of Image Processing and applying those in emerging problems in this area.
CO2: Apply various mathematical tools and transformations on images
CO3: Comprehend and designing techniques for image enhancement, segmentation, and representation.
CO4: Analyse and evaluate Image Compression and restoration Algorithms
CO5: Design and implement image processing techniques to solve problems related to current societal needs

Course code	CSE/PE/B/T/414E
Category	PE
Course title	Digital Signal Processing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction: Purpose of digital signal processing (DSP), theories and concepts, role of DSP in computer science and engineering. [2L]
2. Discrete time signals and systems: Discrete time signals and systems, convolution and analysis of Linear Time-Invariant (LTI) systems, Difference equations, Correlation of discrete time signals. [5L]
3. Frequency analysis of signals and systems: Analysis of continuous-time and discrete-time signals, Frequency domain characteristics of LTI systems. [4L]
4. Z-Transform and its application to the analysis of LTI systems. [4L]
5. Discrete Fourier Transform (DFT): Its properties, computation and applications. Fast Fourier Transform (FFT) and its computational complexity. [4L]
6. Sampling of signals in the time and frequency domains: Time domain sampling of continuous-time signals, Frequency domain sampling of Discrete-time signals. [4L]
7. Design of special filters: Null Filters, Comb Filters, Digital Oscillators, All-Pass Filters etc. [4L]
8. Design of digital filters: Finite Impulse Response (FIR) filters, Infinite Impulse Response (IIR) filters. [5L]

9. Applications in communication systems: Pulse Code Modulation (PCM), Differential PCM (DPCM), Delta Modulation (DM), Applications in system simulation. [4L]
10. Applications in Audio and Speech processing [2L]
11. Digital Signal processors [2L]

Books:

1. Digital Signal Processing by J. G. Proakis, D. G. Manolakis, PHI.
2. Digital Signal Processing using MATLAB by V. K. Ingle, J. G. Proakis, Vikas Publishing House.
3. Digital Signal Processing by A. V. Oppenheim, R. W. Shafer, Pearson.
4. Digital Signal Processing – A Computer Based Approach by S. K. Mitra, TMH.
5. Theory and Applications of Digital Signal Processing by L. R. Rabiner , B. Gold, Pearson.
6. Digital Signal Processing – Fundamentals and Applications by Li Tan and Jean Jiang, Academic Press (Elsevier).

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the purpose of digital signal processing (DSP), theories and concepts, role of DSP in communication systems and system simulation.
CO2: Apply different mathematical transforms on discrete time signals.
CO3: Illustrate Time domain sampling of continuous-time signals, Frequency domain sampling of Discrete-time signals.
CO4: Analyze continuous time and discrete time signals both in time domain and frequency domain.
CO5: Design an appropriate filter depending upon the application domain.

Course code	CSE/PE/H/T/415A
Category	PE
Course title	Data Mining
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

Introduction to Data Mining: Process of Knowledge Discovery; Database to Data Warehouses; Data Mining Functionalities [2L]

Data Preprocessing: Data Summarization; Data Cleaning; Data Integration; Data Transformation; Data Reduction; Data Discretization & Concept Hierarchy Generation [6L]

Data Warehousing Techniques: OLAP vs. OLTP; Data cubes; Multidimensional Data Models and Schemas with their definitions; OLAP operations; Data Warehouse Architectures and Design Strategies [4L]

Frequent Pattern Mining, Association Rule Generation, Correlation Analysis: Concepts; Frequent Itemset Mining Algorithms - Apriori, FP-Tree Growth; Association Rules & their types; Association to Correlation [6L]

Data visualization [2L]

Classification Algorithms: Eager Learning Techniques – Decision trees, Naïve Bayesian Methods, Lazy Learning Techniques - K Nearest Neighbours, Case Based Reasoning. [8L]

Cluster Analysis- Various Data types involved and Data Structures; Categories of Clustering Methods: Partitioning, Hierarchical, Density-based, Model-based; Industry Standard Techniques [5L]

*Mining Specific Data***:** Stream, Time-Series and Sequence Data Mining; Graph Mining; Text Mining; Web Data Mining [5L]

Applications and Trends in Data Mining: Outlier Analysis and Fraud Detection; Social Impacts of Data Mining [2L]

Suggested Readings:

1. J. Han , M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, 3rd Ed. ELSEVIER

2. Margaret H. Dunham & S. Sridhar: Data Mining Introductory and Advanced Topics, Pearson Education

3. P-N Tan, M. Steinbach, V. Kumar: Introduction To Data Mining, Pearson Education

4. A. Berson, S. J. Smith: Data Warehousing, Data Mining, & OLAP, Tata McGraw-Hill Edition

Course Outcomes:

At the end of this course, each student should be able to:

CO1: Understand the necessity for knowledge Discovery within data and be able to pre-process data using available and novel techniques.
CO2: Analyze and design huge amount of heterogeneous, multidimensional data models for efficient Data Warehouse architectures.
CO3: Mine Frequent Patterns effectively and derive Association Rules and Correlation Measures from the same.
CO4: Generate various types of Classifier models to predict class values for test data after proper training.
CO5: Develop different clustering techniques to segregate data accurately.
CO6: Handle all categories of data including unstructured text, graphics, images, videos, sequences, series and web data, and apply Data Mining techniques on them for the benefit of the society.

Course code	CSE/PE/H/T/415B
Category	PE
Course title	Big Data Analytics
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. What is Big data – Properties of Big Data – Volume, Velocity, Variety and Veracity. [1 L]

2. Data Mining and Analytics – Types of Analytics, Statistical, Machine learning and Computational Models [2 L]

3. Distributed File Systems – Hadoop and other variants – Data Ingestion and Munging [3 L]

4. Map-Reduce mechanism – Its architecture and algorithmic issues [6 L]

5. Similarity Search in very large data sets [3 L]

6. Frequent Item-set Mining in very large data sets [3 L]

7. Clustering very large high dimensional data sets [3 L]

8. Outlier Detection in very large data sets [2 L]

9. Data Stream Analytics [3 L]

10. Applications: Advertisement on the Web [2 L]

    Recommendation Systems for Online Stores [3 L]

    Mining very large graphs (social graphs) [3 L]

11. Infrastructural Issues:

    Hardware and Software Architectures [3 L]

    Reliability and Availability Issues [3 L]

Reference Books:

1. Understanding Big data by Zikopou Los, Eaton, deRoos, Deutsch & Lapis, McGrawHill, 2012
2. Mining of Massive Data Sets by Rajaraman, Leskovec, Ullman, Stanford University, 2013
3. Data Streams: Models and Algorithms ed. by C. C. Aggarwal, Kluwer Academic Publishers, 2013.
4. Outlier Analysis by C. C. Aggarwal, Springer, 2013.

Course Outcomes:

The students of this course should be able to

CO1. Understand the concept and challenge of big data and why traditional technology is inadequate to analyze big data

CO2. Collect, manage, store, query, and analyze various forms of big data

CO3. Gain experience on analytics methods and tools to solve big data problems

CO4. Translate data into clear, actionable insights

Course code	CSE/PE/H/T/415C
Category	PE
Course title	Information Storage and Retrieval
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction [2L]
   Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses, Information Retrieval System Capabilities.
2. Information storage [4L]
   Storage of structured, semi-structured and unstructured data, introduction to VLDB (Very large databases), Resource Description Framework (RDF) for Storing semi-structured data.
3. Natural Language Interface to Databases: [2L]
   Natural language query processing, intermediate representation, SQL command generation.
4. Cataloging and Indexing: [7L]
   Indexing Processes, Information Extraction.
   Data Structures: Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure Automatic Indexing: Classes of automatic indexing, Statistical indexing, Concept indexing
5. Information retrieval models [5L]
   Boolean model, Vector Space Model, Probabilistic information retrieval models,
6. User Search Techniques, [4L]
   Similarity measures and ranking, Query expansion, Relevance feedback, Pseudo relevance feedback.
7. Text Search Algorithms [6L]
   Pattern matching Algorithms: Rabin-Karp, Knuth-Morris-Pratt, Boyer-Moore. Searching the web: PageRank algorithm, HITS algorithm
8. Introduction to Multimedia Information Retrieval [5L]
   Attribute-based image retrieval, Text-based image retrieval, Query by Image Content (Using content descriptors; color and texture, Identifying shapes - image objects) Streamed Image Retrieval - basic concepts, Improving Result Quality
9. Information retrieval from Digital Libraries: [3L]
   Digital Libraries: history, definition, characteristics, architectures, collection management, Metadata. Representation of different media, Interoperability between different information resources, collections, and systems
10. Evaluation of information retrieval systems [2L]
    Measures used in system evaluation, Measurement example – TREC results.

Books:

1. Information Storage and Retrieval Systems: Theory and Implementation By Kowalski, Gerald, Mark T Maybury, Kluwer Academic Press, 2000
2. Modern Information Retrival by Ricardo Baeza-Yates, Pearson Education, 2007
3. Information Retrieval: Algorithms and Heuristics By David A Grossman and OphirFrieder, 2nd Edition, Springer International Edition, 2004
4. Information Retrieval Data Structures and Algorithms By William B Frakes, Ricardo Baeza-Yates, Pearson Education, 1992
5. Information Storage & Retieval by Robert Korfhage – John Wiley & Sons
6. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press, 2008

Course Outcomes (COs):

The students of this course should be able to

CO1: Understand various strategies for storing semi-structured and unstructured data and how this kind of database differs from the traditional database of structured data and its relation to VLDB
CO2: Learn how to develop system capable of returning structured output in response to unstructured natural language query.
CO3: Learn various Cataloging and Indexing techniques along with the necessary data structures and the well known text document retrieval models
CO4: be familiar with the efficient text search algorithms
CO5:be familiar with the basic multimedia information retrieval models and evaluation of retrieval systems
CO6: Understand basic architecture of digital library and application of retrieval models to digital library development

Course code	CSE/PE/H/T/415D
Category	PE
Course title	Programming Environment and User Interface Design
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Introduction : [3L]
Importance of User Interfaces (UI) in Computer Applications.UI Design as an Engineering problem.Ergonomic aspects of UI, Cognitive and Cultural aspects of UI, Principles of UID Ease of Learning.Ease of Use – Consistency - Terseness.

2. Design of Programming Environment [2L]

3. Human Computer Interaction: [3L]
Hick-Hyman Law

Fitt's Law

4. Formal methods for specification of UIs: [6L]
   Grammar, PetriNets, Menu Trees etc.
5. UI Development Case study [4L]
6. Interaction Elements [1L]
7. Methodology for Design of Command Names [2L]
8. Error Messages and Exception Handling [1L]
9. Direct Manipulation - Graphic Design [3L]
10. Multilingual UI: [4L]
    Internationalization, Handling locale-sensitive UI components like screen, layouts, colors, date, time etc
11. Web Design: [3L]
    Designing navigation, Increasing accessibility- interface for differently-abled users
12. Advanced UIs : [6L]
    Groupware, 3D UIs, Virtual reality, Augmented reality, Multimedia UIs

13. Evaluation of UIs [2L]

Books:

1. D. A Norman, The Design of Everyday Things. New York, NY: Doubleday, 1990.
2. B. Schneiderman, Designing the User Interface, Addison Wesley, fifth edition.
3. Alan Cooper, About Face: (3rd edition) The Essentials of Interaction Design, Wiley.

Course Outcomes:

At the end of this course, each student should be able to:

CO1: Understand the requirement specifications of an application / software
CO2: Comprehend the requirement specifications of an application / software using graphical structures like PetriNet
CO3: Design an interface of application / software.
CO4: Apply various programming paradigms for understanding fundamentals of an interface
CO5: Analyze the concepts of various graph theoretical models of an interface.

Course code	CSE/PE/H/T/415E
Category	PE
Course title	Advanced Numerical Computation
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

1. Linear system of Equations: Solution using Over-relaxation Method, Solution of sparse linear system of equations, Eigenvalue and Eigenvectors, Singular Value Decomposition. **[12L]**
2. Non-linear system of Equations: Newton's Method, Broyden's method. **[2L]**

3. Ordinary Differential Equations:

Initial Value problem: Solution using Runge-Kutta Method, Predictor-Corrector Method. **[6L]**
Boundary Value Problem: Solution using Shooting Method, Finite Difference Method, Finite Element Method. **[8L]**

4. Partial Differential Equations:
   Modeling of practical applications using different types of Partial Differential Equations, Solution using Successive Over-Relaxation Method, Fourier Transform Method, Finite Element Methods. **[12L]**

Books:

Text Books:

1. Numerical Methods for Scientists and Engineers by H.M. Antia, Third Edition, Hindustan Book Agency (India), 2012.
2. An Algorithmic Approach to Nonlinear Analysis and Optimization by Edward J. Beltrani, Academic Press, New York and London, 1970.

Reference Books:

1. Numerical Mathematical Analysis by J. B. Scarborough and H. Milford, Oxford University Press, 1930.
2. Optimization and Non-smooth Analysis by F. H. Clarke, John Wiley and Sons, Inc., New York 1983.

Course Outcomes:

At the end of the course students will be able to:

CO1: Develop methods for solution of linear system of equations including sparse linear system of equations.
CO2: Analyze non-linear system of equations.
CO3: Devise suitable method for solution for both initial-value-problems and boundary-value-problems.
CO4: Determine appropriate methodology for solution of partial differential equation

Course code	CSE/PS/B/S/411
Category	PS
Course title	Project - I
Scheme and Credits	L–T–P: 0-1-4; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

Topics for Project I cover all areas of Computer Science & Engineering and related interdisciplinary applications.

Course Outcomes (COs):

A student shall be able to:

CO1: Understand and identify different application domains of Computer Science & Engineering.

CO2: Identify the application domain suitable for project.

CO3: Conceive the topic and its applicability in the project.

CO4: Analyse the state of the art in the chosen domain.

Course code	CSE/PS/B/S/412
Category	PS
Course title	Seminar - I
Scheme and Credits	L–T–P: 0-1-4; Credits: 3.0; Semester – I
Pre-requisites (if any)	

Syllabus:

Topics for Seminar I cover all areas of Computer Science & Engineering and related interdisciplinary fields.

Course Outcomes (COs):

A student shall be able to:

CO1: Understand state of the art issues in Computer Science & Engineering and allied areas

CO2: Acquire knowledge regarding the issue/s from literature using different media

CO3: Identify an appropriate topic of recent relevance

CO4: Develop understanding of the issue as a whole and with respect to society requirements, and incorporate the acquired knowledge during delivery in seminar presentation

CO5: Present the acquired knowledge through oral communication

Course code	CSE/PC/H/S/413
Category	PC
Course title	Machine Learning Lab
Scheme and Credits	L–T–P: 0-1-2; Credits: 2.0; Semester – I
Pre-requisites (if any)	

General Description:

- The programs can be implemented in either JAVA or Python.
- Programs can be developed without using the built-in classes or APIs of Java/Python.
- Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

Syllabus:

1. Implementation of the decision tree based ID3 algorithm using an appropriate data set and verification of inductive bias of decision tree learning algorithm
2. Implementation of Backpropagation algorithm for training Multilayer Perceptron Neural Networks and testing the same using appropriate data sets. Verification of the performance of the model by varying number of hidden layers and number of hidden nodes per layer as well. Tuning various hyper-parameters such as momentum, learning rate.
3. Implementation of the naïve Bayesian classifier for text classification task using WEKA / Python platform.
4. Implementation of Backpropagation algorithm for deep neural networks. Study of impact on performance when activation functions are changed. Consider three common activations functions.- Sigmoid, Relu, Tanh.
5. Implementation of an EM algorithm for document clustering. Use the same data set for implementing k-Means algorithm and comparing the results of these two algorithms(Java/Python ML library classes/API can be used)
6. Implementation of k-Nearest Neighbour algorithm for text classification task using traditional programming languages (C/C++/JAVA/Python). Study on impact of K on the performance of the classifier. Performance comparison of KNN and Naïve Bayes classifier for text classification task.
7. Implementation of SVM for hand written character recognition using MNIST dataset(Java/Python ML library classes/API can be used)
8. Implementation of a heterogeneous ensemble of classifiers using three base classifiers-Naïve Bayes, ANN and SVM for text classification task and performance comparison of the ensemble model with each base classifier.

Course Outcomes:

CO1: Make use of Data sets in implementing the machine learning algorithms
CO2: Implement the machine learning concepts and algorithms in any suitable language of choice
CO3: Evaluation of machine Learning algorithms
CO4: Comparing the performance of machine learning algorithms

B.C.S.E FOURTH YEAR SECOND SEMESTER

Course code	CSE/PE/H/T/421A
Category	PE
Course title	Optimization Techniques
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

1. Introduction [2L]
   Historical development, Engineering application of optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems.
2. Linear Programming [8L]
   Graphical method, Simplex method, Revised simplex method, Duality in linear programming, Sensitivity analysis, other algorithms for solving LP problems.
3. Application of Linear Programming [6L]
   Transportation Problem, Assignment Problem and other applications, Integer Programming.
4. Non-Linear Programming [15L]
   Unconstrained optimization techniques, Convex/Concave function and Global Optimality, Gradient Descent methods, Constrained optimization, Convex Separable Quadratic Programming, Direct and indirect methods, Optimization with calculus, Lagrangian Multiplier methods and Kharush-Khun-Tucker optimality conditions.
5. Dynamic Programming [3L]
   Introduction, Sequential optimization, computational procedure, curse of dimensionality.
6. Multi Objective optimization [3L]
   Introduction, weighted Sum optimization and efficient points
7. Theory of games [3L]
   Introduction, Maximin-Minimax Principle, Games with or without saddle points.

Suggested Readings:

1. H. A. Taha: Operations research
2. S. Fang et al: Linear optimizations and Extensions
3. G. Hadley: Linear programming, Narosa Publishing House, New Delhi, 1990.
4. K. Deb: Optimization for Engineering Design – Algorithms and Examples.
5. R. Rardin: Optimization in Operation research, Pearson
6. J. K. sharma, Operations Research: Theory and Application 6/e, Laxmi Publications

Course Outcomes:

CO 1: Able to understand the theory of optimization methods and algorithms
CO 2: Able to interpret the various concepts of solving linear and nonlinear optimization problems and its usage
CO 3: Able to understand the concept of convexity and usage of it for solving nonlinear programming

CO 4: Able to understand the usage of dynamic programming, game theory etc. for solving the optimization problem
CO 5: Able to develop and promote research interest in optimization techniques in the problems of Engineering and Technology especially in Machine learning

Course code	CSE/PE/H/T/421B
Category	PE
Course title	Information and Coding Theory
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

Information Theory
Introduction to Information Theory [1L]
Information and Entropy [1L]
Joint Entropy [2L]
Mutual Information [1L]
Extension of a zero Memory Source [1L]
Source Encoding, Kraft's Inequality, Huffman Coding [3L]
Shannon's 1st Fundamental Theorem [1L]
Idea of Markov Source [1L]
BSC, BEC and Channel Capacity [3L]

Coding Theory
Introduction to Coding Theory [1L]

Block Codes:
Introduction [1L]
Parity Check Code, Product code, Repetition Code [2L]
Hamming Code, Minimum Distance of Block Codes [2L]

Review of Linear Algebra and Galois Field
Finite Field, Vector Spaces, Matrices [2L]
Roots of Equation, GF(2p), Primitive Field Element, Irreducible and Primitive Polynomial, Minimal Polynomial [3L]

Linear Codes:
Definition, Systematic Format, Generator and Parity Check Matrices [2L]
Syndrome and Error Detection [2L]
Standard Array and Syndrome Decoding [2L]
Hamming Code [1L]

Cyclic Codes:
Definition, Generator Polynomial and Its Properties,
Parity Check Polynomial [2L]

Encoding and Decoding [2L]
Cyclic Hamming Code [1L]

Introduction to BCH Codes and Advanced topics [3L]

Books:

1. Principles of Digital Communication – Das, Mukherjee, Chatterjee
2. Introduction to Error Control Codes – S. Gravano
3. Error Control Coding: Fundamentals and Applications – Shu Lin, Danilel J. Costello, Jr.
4. The Theory of Error-Correcting Codes, Vol 1 & 2, by F.J. MacWilliams and N.J.A. Sloane
5. Coding and Information Theory by Richard W. Hamming
6. Handbook of Coding Theory, Vol 1 & 2, by V. S. Pless and W. C. Huffman
7. Algebraic Codes for Data Transmission by Richard E. Blahut
8. Introduction to Coding Theory by Jacobus Hendricus van Lint
9. Coding and Information Theory by Steven Roman
10. Error Control Coding by Shu Lin and Daniel J. Costello
11. Error Correction Coding: Mathematical Methods and Algorithms by Todd K. Moon

Course Outcomes:

At the end of the course a student will be able to:
CO1: Understand the fundamental concepts of information theory
CO2: Learn and apply the techniques of Source coding and channel capacity
CO3: Conceptualize the foundations of coding theory and block code
CO4: Understand the concept of linear code and analyze the techniques
CO5: Understand the concept of cyclic code and analyze the techniques

Course code	CSE/PE/H/T/421C
Category	PE
Course title	Cryptography
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

- Introduction to Cryptography [8L]
  Cryptosystem. Encryption and Decryption. Cryptographic Attacks. Notions of Security. Perfect Secrecy. Symmetric and Asymmetric Key Cryptosystems. Block and Stream Ciphers.
- DES and AES [6L]
  Data Encryption Standard. Advanced Encryption Standard. Variants of DES and AES.
- Stream Ciphers [4L]

LFSR based stream ciphers, software stream ciphers

- Cryptanalysis [6L]
  Differential Cryptanalysis. Linear Cryptanalysis. Correlation. Algebraic and other attacks
- Public Key and Related Concepts [8L]
  RSA and other public key systems. Elliptic Curve Cryptosystems. Hash Functions. Identification and Authentication. Digital Signatures.
- Key Management [4L]
  Key Distribution. Key Agreement. Key Exchange protocols. Public key infrastructure.
  Protocols and Techniques [4L]
  Secret Sharing. Multiparty Computation. Zero-knowledge Protocols.

Suggested Readings:

1. Fundamentals of Computer Security by Josef Pieprzyk, Thomas Hardjono and Jennifer Seberry (Springer), 2008.
2. Cryptography: Theory and Practice by Douglas Stinson, CRC Press, 2006.
3. Applied Cryptography: Protocols, Algorithms, and Source Code in C, by Bruce Schneier, Wiley, 1996.
4. Handbook of Applied Cryptography by Alfred Menezes, Paul van Oorschot and Scott Vanstone, CRC Press, 1996.

Course Outcomes (COs):

At the end of this course, each student should be able to:
CO1: Comprehend the concept and requirement of cryptosystem.
CO2: Describe and analyse different cryptographic protocols and standards.
CO3: Comprehend cryptanalysis.
CO4: Assess various key management techniques and protocols.

Course code	CSE/PE/H/T/421D
Category	PE
Course title	Information Security
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

- Introduction - What is Information Security and its requirement, CIA triad, Policies, procedures, Authentication, Access Control, People, Process, Technology, Segregation and Separation of Duties & Roles and responsibilities [5L]
- Introduction to cryptography [2L]
- Brief Overview of Standards: Cobit, ISO 27001, OWASP, OSSTMM, etc [2L]
- Vulnerability, Threat and Risk, Risk Assessment and Mitigation [3L]
- Introduction to BCP / DRP / Incident management [2L]
- IT ACT 2000 [2L]
- Types of assessments for Information Security: [6L]

a. VAPT of Networks, b. IT assessments or audits, c. Data Center Assessment, d. Security of Application Software, e. SAP Security, f. Desktop Security, g. RDBMS Security, h. BCP / DRP assessments

- Windows and Linux security, Types of Audits in Windows Environment: Server Security, Active Directory (Group Policy),Anti-Virus, Mails, Malware, End point protection, Shadow Passwords, SUDO users, etc [6L]
- Software Security: Buffer Overflow Attacks, Defense against Buffer Overflows, Handling Program Inputs, Writing Safe Program Codes, Interaction with Operating System and Other Software [4L]

- Current Trends in information Security - Cloud Computing, Big Data: benefits and Issues [4L]

- IT Security Management Issues: IT Security Management, IT Security Standards, Organizational Context and Security Policy, Security Risk Assessment, IT Security Controls, Plans and Procedures, IT Security Audit, Cybercrime and Computer Crime, Intellectual Property, Privacy, Ethical Issues [4L]

Reference Books:

1. Matt Bishop, "Computer Security, Arts and Science", Pearson Education, 2003.

2. Pceprzyk et. al., "Fundamentals of Computer Security", Allied Publishers, 2004.

3. Derek Atkins, "Internet Security", Second Edition, Techmedia, 1997.

Course Outcomes:

At the end of this course, each student should be able to:

CO1: Comprehend the concept of security, related issues and methods of providing security.
CO2: Analyse standards, software and OS security.
CO3: Assess different information security techniques.
CO4: Assess overall security management in IT and current trends.

Course code	CSE/PE/H/T/421E
Category	PE
Course title	Approximation Algorithms
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

Revision of Greedy Algorithms. Dynamic Programming , Graph Algorithms [6 L]

NP Completeness, Common NP complete problems, Proving NP Completeness, [3L]

Combating hardness with approximation, formal definition of approximation algorithm, absolute approximation, relative approximation, Approximation ratio, approximation error**,** relative error bound [3L]

Approximation algorithm design techniques: Greedy approach, dynamic programming, randomization, local search, linear programming and rounding, semi-definite programming and rounding, and metric embedding. [12L]

Approximation Algorithms with Analysis for some selected problems: -

- Covering problems [2L]
- Scheduling Problems [2L]
- Packing problems [2L]
- Clustering: k-center, k-median, k-means, and facility location [2L]
- Tour problems: metric TSP, asymmetric TSP [2L]
- Network design problems [2L]
- Cut problems [2L]
- Routing problems [2L]

Books

1. The Design of Approximation Algorithms by David Williamson and David Shmoys, Cambridge University Press, 2011.
2. Approximation Algorithms by Vijay Vazirani, Springer-Verlag, 2004.
3. Geometric Approximation Algorithms by Sariel Har-Peled, First Edition, 2011.
4. Algorithm Design by Jon Kleinberg and Eva Tardos, Pearson

Course Outcomes:
Students will be able to:

CO1: have familiarity with basics of general algorithm design techniques
CO2: Understand hardness of problems
CO3: Know how to combat hardness of the problems with approximation algorithms and be familiar with various approximation algorithm design techniques
CO4: Be familiar with the basic approximation algorithms for the various approximation problems in various real-world applications such as scheduling, packing, clustering, network design, routing etc.

Course code	CSE/HS/B/T/422
Category	HS
Course title	Industrial Management
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

1. Basic functions of Management – Planning, organizing, staffing, directing and controlling. [2L]
2. Introduction to Industrial Engineering techniques. [2L]

3. Productivity: definition, measurement. Work study and its role in improving productivity of an organization. [5L]
4. Types of production systems. Introduction to production planning and control. [5L]
5. Concepts of Human Resource Management – Selection, Training & Development. [6L]
6. Finance Management – Capital Budgeting Techniques. Pay-back period, ARR, NPV, IRR, PI; Sources of capital; Cost concepts and Break-even analysis. [6L]
7. Project Management – Introduction, Network construction & identification of critical activities in CPM & PERT [6L]
8. Introduction to optimization techniques; Linear programming - formulation and its graphical solution. [8L]

Suggested Readings:

1. Industrial Engineering & Production Management – M. Mahajan, Dhanpat Rai & Co. (P) Ltd., Delhi
2. Finance Sense: Finance for Non-finance Executives - Prasanna Chandra, Mcgraw Hill
3. Industrial Management - M E Thukaram Rao, Himalaya Publishing House.
4. Introduction to Work Study - I.L.O., International Labour Organization
5. A Management Guide to PERT/CPM – J D Wiest and F K Levy, Prentice Hall India.
6. Operations Research - A M Natarajan, P Balasubramani, and A Tamilarasi

Course Outcomes:

The students will be able:

CO1: To understand the concept of management functions and industrial engineering techniques

CO2: To develop understanding of the Productivity and its role in improving performance of the organization

CO3: To understand the concept and application of production planning and control, human resource management, financial management, and project management in any organization

CO4: To acquaint the concept of optimization and linear programming technique for decision making.

Course code	CSE/PE/H/T/423A
Category	PE
Course title	Distributed Computing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

Introduction to distributed environment: Goals, hardware & software concepts, Overview of high performance computing, Parallel computing. Collaborative computing, architecture, middleware, Strengths and weaknesses of distributed computing, Single System Image (SSI), Service oriented design, Service level agreement, Quality of Service. [4L]

Communication: Message-oriented communication, stream oriented communication, MPI, Socket, sockets with non-blocking I/O, secure socket API, Web Socket, Remote procedure call, Remote method Invocation, registry, remote Interface. [4L]

Client Server model: Architecture, multi-tier design, applications (e.g., email, chat, Mobile Agents) [4L]

P2P: Architecture, design, application (e.g., Napster). [2L]

Cluster Computing: Hardware and software, Architecture, middleware, cluster computing environments, cluster resource management, SSI, Level of abstractions, performance metrics, case study (e.g., Condor, LSF) [3L]
Grid Computing: Grid Service Architecture, Infrastructure, middleware, resource management, application, case study (e.g., Globus Toolkit) [3L]

Cloud Computing: Architecture, types of cloud services (IaaS, PaaS, SaaS, XaaS), Parallel processing in the cloud, Distributed storage systems, Virtualization, Pros and cons of Virtualization, Types of Virtualization – System VM, Process VM, Virtual Machine monitor, Virtual machine properties, Interpretation and binary translation, Hypervisors (e.g., Xen, KVM, VMWare, Virtual Box, Hyper-V), state-of-the-art solutions for cloud computing (e.g., GCP, AWS (EC2, S3), Azure, Heroku etc.), Federated Cloud. [8L]

Hadoop: core components of Hadoop, Hadoop master-slave architecture, Hadoop Cluster, Daemon types - Name node, Data node, Secondary Name node, HDFS, Hadoop Ecosystem
HDFS [5L]

Resource Management and Job Scheduling and monitoring [2L]

MapReduce: Overview of MapReduce Framework, MapReduce Architecture, Job tracker and Task tracker, Use cases of MapReduce. [3L]

In memory processing, resilient distributed datasets (RDD) [2L]

Suggested Readings:

1. Distributed Computing: Principles and Applications, M. L. Liu, Pearson/AddisonWesley.
2. Cloud Computing Principles and Paradigms - Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley
3. Hadoop: The Definitive Guide Book by Tom White, O'Reilly
4. Map Reduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop by Donald Miner, O'Reilly

Course Outcomes:
By the end of the course, students should be able to
CO1: Understand the evolution, architecture, principles, middleware and key components of distributed computing environments.
CO2: Understand the techniques of communication in distributed environment.
CO3: Demonstrate knowledge of the core design and architectural aspects of distributed computing environments like Cluster, P2P, Grid and Cloud.
CO4: Understand the design of distributed computing software and framework like Hadoop and MapReduce

Course code	CSE/PE/H/T/423B
Category	PE
Course title	Wireless Sensor Networks
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

- Int*roduction***:** Brief survey of sensor networks, background of sensor technologies, brief review of Ad-Hoc networks, applications (environment monitoring, habitat monitoring, Infrastructure health monitoring, Human health monitoring, Pollution Monitoring, Disaster Management etc.,), sensing node and sensor network architectural elements [4 L**]**
- *Communication:* wireless communication standards IEEE 802.15.4, zigbee, Bluetooth, 6lowpan etc. [4 L]
- *Multi-hop wireless networks:* wireless transmission basics, wireless networking challenges – medium access, routing. [2 L]
- *MAC in sensor networks:* Fundamentals and assumptions of MAC protocols, MAC protocols for WSNs: schedule based, random access based, coordination, contention, schedule, synchronization, adaptive listening, access control and data exchange (some popular MAC protocols: B-MAC, S-MAC, T-MAC, Query-MAC, QoS –MAC, Z-MAC, X-MAC, Box-MAC etc). [10L]

- *Routing in sensor networks:* Routing challenges and design issues in WSN, network scale and time varying characteristics, resource constraints, data models, data dissemination and gathering, routing strategies in WSN (Flooding and its variants, SPIN, LEACH, directed diffusion, collection tree protocol, energy aware routing, geographic routing, attribute based routing etc.,) [12L]
- *Time synchronization and Localization:* Time synchronization for sensor networks, intermittent connectivity, time stamp synchronization, traditional localization approaches (GPS, Active Bats), centralized localization approaches (convex position estimation, multidimensional scaling), distributed localization approaches (ad-hoc positioning system (DV-HOP, DV-Distance), Multilateration (iterative, collaboration), self positioning system). [6L]
- *Security:* Different techniques, Key management, effect on routing protocols [2L]

Reference Books:

1. "Protocols and Architectures for Wireless Sensor Networks", H. Karl and A. Willig, John Wiley & Sons, 2006.
2. “Wireless Sensor Networks: An Information Processing Approach”, F. Zhao and L. Guibas, Morgan Kaufmann, 2004
3. “Wireless Sensor Networks”, edited by C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Kluwer, 2004.
4. “Introduction to Wireless and Mobile Systems”, D. P. Agarwal and Q. Zeng, Thomson, 2006.

Course Outcomes:

On completion of this course, students should be able to:

CO1: Understand the principles, technologies and standards of Wireless Sensor Networks.

CO2: Understand and analyze existing protocols for MAC, routing, synchronization and localization.
CO3: Acquire skills on developing algorithms and protocols for Wireless Sensor Networks.
CO4: Understand the challenges of designing WSN applications.

Course code	CSE/PE/H/T/423C
Category	PE
Course title	High Performance parallel computing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

(a) Parallel Processing Concepts (Quick Overview) [2L]
Levels of parallelism (instruction, task, thread etc.); Models (SIMD, MIMD, SPMD, Dataflow Models etc.); Architectures: Superscalar architectures, Multi-core, Multi-threaded.

(b) Introduction to HPC Systems [8L]
Introduction to basic architecture and OS concepts -- Distributed memory systems, Shared memory systems and cache coherence, Heterogeneous system architecture, Interconnection networks; Multi-core CPUs; GPU systems; High performance clusters.

(c) Parallel Programming Models and Languages [12L]
Shared memory model and Distributed memory model; OpenMP and MPI; Thread Management, Workload manager and Job Schedulers;
Introduction to CUDA programming; MapReduce System Architecture.

(d) Parallel Algorithms [12L]
Decomposition techniques, Characteristics of tasks and interactions, Mapping techniques for load balancing, Parallel algorithm models.

(e) Performance Tuning [6L]
Runtime Systems, Performance Issues, Sources of Overheads, Optimising parallel codes.

Books:

(a) “Computer Architecture -- A Quantitative Approach” - John L. Hennessy and David A. Patterson
(b) “Parallel Computing: Theory and Practice” - Michael J. Quinn
(c) “Parallel Programming in C with MPI and OpenMP” - M J Quinn
(d) CUDA Reference manual
(e) “Introduction to Parallel Computing” - Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta.
(f) Several other study materials as necessary for the course.

Course Outcomes:

Through this course students will

CO1: Learn the details of hardware architecture that contribute to performance enhancements of the codes
CO2: Learn different parallel programming models that exploit the underlying parallel architecture

for performance enhancement

CO3: Learn to design parallel algorithms for various underlying architectures and programming models

CO4: Be familiar with various state-of-the-art parallel programming languages

CO5: Be able to understand performance tuning techniques of parallel codes by applying code optimization techniques

Course code	CSE/PE/H/T/423D
Category	PE
Course title	Internet of Things
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

- *Introduction:* Background of foundation technologies, architectural principles, Things oriented vision. [3 L]
- *Communication Technologies used in IoT:* RFID, UID, NFC, ZigBee, Bluetooth, Challenges and requirements [6 L]
- *IoT Applications:* real-world application scenarios (e.g., smart city related) [2 L]
- *Web of Things:* IoT vs WoT, virtual infrastructures, Web of systems, HTTP in the IoT context [3 L]
- *Making Things Smart:* Arduino, Raspberry Pi [3 L]
- *IoT Stack***:** Raw data - physical device level, data transformation - sensor middleware level, Data aggregation- virtual sensor level, data management and control – Semantic Level, data representation- application level, data visualization- business level. [4 L]
- *IoT communication protocols:* COAP, XMPP, AMQP, MQTT, WebRTC, WebSocket [3 L]
- *Basics of Cloud Infrastructure:* Cloud storage, computational infrastructure, Distributed frameworks and programming paradigms, e.g., Hadoop ecosystem [4 L]
- *Integrating IoT and Cloud***:** Issues related to the integration, what to offload and what not to [4 L]
- *Analyzing IoT data:* Overview of data analytics and visualization for IoT applications [4 L]
- *IoT Case Study* [2 L]
- *Privacy Issues:* Issues regarding data sharing [2 L]

References:

1. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
2. Keysight Technologies, “The Internet of Things: Enabling Technologies and Solutions for Design and Test”, Application Note, 2016.
3. Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.

Course Outcomes:

By the end of the course, students should be able to

CO1: Understand the principles, standards and key components of IoT.

CO2: Understand the protocols and technologies employed at each layer of the stack.

CO3: Acquire skills on developing IoT applications.

CO4: Understand the role of big data, cloud computing and data analytics in a typical IoT system

Course code	CSE/PE/H/T/423E
Category	PE
Course title	Mobile Computing
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

1. Introduction to wireless networking and characteristics of mobile computing [4L]
2. Fundamentals of wireless transmission - Medium Access Control Protocols FDMA, TDMA, CDMA [3L]
3. Overview of Wireless LAN (IEEE 802.11) [3L]
4. Overview of Bluetooth architecture [2L]
5. Introduction to Mobile Adhoc Network and routing protocols- DSDV, WRP, CGSR, FSR, AODV, DSR, ABR, TORA etc. [5L]
6. Mobile Networking protocol (Mobile IP) [3L]
7. Mobile transport layer - Effects of mobility on Reliable Transport Protocols, Mechanisms for improving TCP performances on wireless links [4L]
8. Energy / Power Management [3L]
9. Wireless application Environments Wireless Application Protocol, WML, Push Architecture, Push/Pull Services [8L]
10. Overview of Security in mobile environments [3L]
11. Overview of fault tolerance in mobile computing systems [2L]

Suggested Readings:

3. *Ad Hoc Wireless Networks: Architectures and Protocols*, C. Siva Ram Murthy and B. S. Manoj.
4. Adhoc Networking, Charles Perkins, Pearson Education
5. Wireless Communication, W. Stallings

Course Outcomes (COs):

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

CO1: Understand the basic concepts of Wireless and Mobile Networking.
CO2: Assess Wireless LAN technology and protocols used in different layers
CO3: Analyse routing techniques and Power Management in Adhoc Networks.
CO4: Discuss on Security aspects of Mobile Computing Systems.

Course code	CSE/PE/H/T/424A
Category	PE
Course title	Software Project Management
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

1. Introduction to Project management [3L]
   a. Project Management Basics b. Role of a Project Manager c. Project Resources d. Phases of Software Project
2. Introduction to PERT/CPM [5L]
   a. Work Breakdown Structure b. Network diagramming c. Critical Path d. PERT Probability e. Crashing f. Resource Leveling
3. Software Effort Estimation [4L]
   a. Estimations Basics b. LOC Method c. Function Points d. Activity Based Estimation e. COCOMO f. Uncertainty in estimation
4. Project Planning [5L]
   a. Management b. Risk c. Quality Assurance d. Schedule
5. Configuration Management [4L]
   a. Configuration Management Basics b. Environment for Configuration Control c. Configuration Control vs. Version Control d. Code Management e. Change Management f. Information Management
6. Quality Assurance in Projects [4L]
   a. Quality Basics b. Quality Assurance Activities in Projects c. Quality Control Activities in d. Introduction to ISO 9000, SEI – CMM Maturity Levels, Six Sigma
7. Productivity Aspects [2L]
   a. Productivity Basics b. Productivity Measurement & Metrics
8. Human Factors and Leadership [4L]
   a. Communication b. Leadership c. Team Dynamics
9. Progress Tracking & Control [3L]
   a. Progress Assessment & Reporting b. Scope Management c. Risk Mitigation
10. Project Closeout [3L]
    a. Project post-mortem b. Collection of re-usable Components c. Practices adopted in the project d. Project-End Audit
11. Organizational Support for Effective Project Management [3L]
    a. Recognition as a Specialist Discipline b. Organize Knowledge Repository c. Processes, Standards & Guidelines d. Training

Suggested Readings:

1. Gilb, T., “Principles of Software Engineering Management”, Addison Weskey. Reading. M. A 1988.
2. Putnam. L.H., Myers. W., “Industrial Sire: Software - Effective Management using Measurement”. IEEE C.S. Press. 1997.

Course Outcomes (COs):

At the end of this course, each student should be able to:

CO1: Describe the reasons and activities of project management including tracking and closure.

CO2: Illustrate and assess various software project representation and effort estimation techniques.
CO3: Prepare project planning and quality assurance activities and productivity metrics.
CO4: Illustrate organizational support, human involvement and employ configuration management practices

Course code	CSE/PE/H/T/424B
Category	PE
Course title	Advanced topics in Software Engineering
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

1. Introduction and Brief Overview – Basic methods and principles used by engineering, including fundamentals of technical communication, measurement, analysis and design. Some aspects of the engineering profession, including standards, safety and intellectual property are also covered. [4L]
2. Software Model Driven Development Process - Analysis, Design, Testing(traditional practice diagrams such as DFDs and ERDs etc and Object-Oriented Software Engineering – Concept)- Case study with complete examples. [4L]
3. Requirements Engineering – Definition, Analysis, Development, Management; Standards/Guidelines (IEEE-Analysis, Specification, management) and CASE Tools - Case study with complete examples. [3L]
4. Effort and Cost Estimation Techniques - using COCOMO, COCOMO-II (using Lines of code, Object points, Function points) - Case study with complete examples [4L]
5. Software Architecture - Architectural styles, architectural patterns, analysis of architectures, formal descriptions of software architectures, architectural description languages and tools, scalability and interoperability issues, Web Engineering Architectures - case studies with example [3L]
6. Software Quality metrics – Product Revision (Maintainability, Flexibility, Testability); Product Transition(Reusability, Interoperability, Portability); Product Operations(Reliability, Usability, Correctness, Integrity, Efficiency)- Measure Reliability; Availability; Reusability; Measure Software Complexity; - Case study with complete examples [8L]
7. Software Evaluation Metrics (Supervised and Unsupervised techniques) – Methods of evaluating clustering- Assessing Clustering tendency, Determination number of clusters, Measuring Clustering quality; Methods for estimating a classifier's accuracy: Holdout method, Random subsampling, Cross-validation, Bootstrap. Classifier Evaluation Metrics: Accuracy, Error Rate, Sensitivity and Specificity / Precision and Recall, and F-measures - Case study with complete examples. [10L]
8. Software Testing Technique and Strategies – Black Box, White Box, Integrity testing (top down, bottom up, mixed); test case design; System testing (Recovery, Security, Stress, Performance, Regression, Smoke, Verification, Validation, Acceptance etc..)- case study with example [4L]

Suggested Books:

1. Software Engineering – A practitioner approach by M. L. Shooman

2. Data Mining: Concepts and Techniques by Jiawei Han Micheline Kamber Jian Pei

3. Software Engineering – A practitioner approach by Pressman

4. Software Engineering by Rajib Mall

Course Outcomes:

After completion of this course, each student should be able to :

CO1: Understand the concept and the fundamentals of basic methods and principles. Fundamentals of technical communication, measurement, analysis and design.
CO2: Develop model driven process - analysis, design, testing. The requirements definition and analysis phase is critical to keep the development and maintenance costs to a minimum.
CO3: Understand the concept about effort and cost estimation techniques of a software product using tools.
CO4: Explain software architecture. Analysis and formal descriptions of software architectures.
CO5: Understand the concept and able to measure the software quality and evaluation of software product. Performance measure of software product.
CO6: Understand the software testing technique and strategies.

Course code	CSE/PE/H/T/424C
Category	PE
Course title	Computational Geometry
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

Geometric Objects – Points, Lines, Planes, Polygons, 3D Objects – Geometric Algorithms – Degeneracies and Robustness – Application Domains [3L]

Convex Hull in 2D – Incremental Algorithm [2L]

Line Segment Intersection Algorithms – Doubly Connected Edge List – Map Overlays – Boolean operations [4L]

Polygon Triangulation – Partitioning Polygons into Monotone Pieces – Triangulation of Monotone Polygons – Art Gallery Problem [6L]

Half Plane Intersections – Use of Linear Programming Techniques [6L]

Orthogonal Range Searching – Kd Trees – Range Trees – Higher Dimensional Range Trees – Database Searching – Point Location [6L]

Voronoi Diagrams – VD of Line Segments – Farthest Point VDs – Post Office Problem [6L]

Convex Hulls in 3-space [3L]

Robot Motion Planning – Work Space and Configuration Space – Translational Motion Planning [2L]

Kinetic Data Structures [2L]

Suggested Readings:

1. Computational Geometry – Algorithms and Applications by Berg, Cheong, Kreveld and Overmars 3e, Springer
2. Computational Geometry – An Introduction by Preparata and Shamos, Springer
3. Computational Geometry in C – Joseph O'Rourke, 2e, Cambridge Univ Press

Course Outcomes:

CO1: Create knowledge to apply to analyze new problems through an understanding of the mathematical framework that supports engineering, science, and mathematics.
CO2: Organizing and conceptualizing given problems by analyzing arguments, in relation to their premises, assumptions, contexts, and conclusions.
CO3: Understanding the mathematical notation used to express physical problems
CO4: Problem solving is naturalized through critical and analytical thinking.

Course code	CSE/PE/H/T/424D
Category	PE
Course title	VLSI Systems
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

Syllabus:

1. Introduction:
   Categorization of Integrated Circuits; SSI, MSI, LSI, VLSI etc.Technologies for VLSI and their features : TTL, ECL, NMOS, CMOS, Bi-CMOS, GaAs MOSFET. Comparison between different technologies for VLSI implementation. [2L]
2. Fabrication processes:
   Diffusion, doping, oxidation, Epitaxial layer formation, photo, ion-beam and x-ray lithographies. Silicon, Aluminium, Copper and polysilicon etching. Local oxidation and dielectric isolation, ion implantation. Outlines of Bipolar, MOS, CMOS and GaAs VLSI fabrication. [4L]
3. Advanced MOS and CMOS technology :
   Silicon gate technology, SOI technology, supper buffers, pre-charge nMOS and CMOS, Dynamic CMOS, Bi-CMOS. [4L]
4. Design of MOS and CMOS:
   Standard MOS inverters, MOS inverters driven by pass transistors, MOS and CMOS inverter pair delay, Driving large capacitive load by MOS and CMOS inverters, stick and mask diagrams for MOS and CMOS, λ-based design rules, scaling. [8L]
5. Structured design of VLSI:
   ROM, Multiplexer, PLA, PAL, CPLD and FPGA based implementation of VLSI, VHDL Programming [10L]
6. CAD tools for VLSI design:
   Design entry, functional and timing simulation, logic synthesis and optimization, layout synthesis. Different placement and routing algorithm algorithms of standard cells. [7L]

7. Testing and testability:
   Different fault models; stuck-at, short circuit and open circuit faults. Automatic test pattern generator (ATPG), Design for testability; ad-hoc, scan-based and built in self test(BIST) techniques. [5L]

Books:

1. K. Eshraghian. D. A. Pucknell and S. Eshraghian, " Essential of VLSI Circuits and Systems", Prentice Hall of India Pvt. Ltd.
2. D. A. Pucknell and K. Eshraghian, "Basic VLSI Design", Prentice-Hall of India Pvt. Ltd.
3. J. P. Uyemura, "Chip design for Submicron VLSI: CMOS layout and Simulation", Thomson India Edition.
4. W. Wolf, "Modern VLSI design System- On chip Design", Pearson Education.
5. N. Sherwani, "Algorithms for VLSI", Springer
6. Bhaskar, "VHDL Programming", Pearson.

Course Outcomes:

At the end of this course, each student should be able to:

CO1: Categorize different VLSI implementation technologies.
CO2: Illustrate different IC fabrication technologies.
CO3: Develop complex circuits at an abstract level using Hardware Description Language (HDL)
CO4: Apply CAD tools for VLSI design.
CO5: Interpret the importance of testing an IC and various testability measures built into the architecture of an IC.

Course code	CSE/PE/H/T/424E
Category	PE
Course title	Embedded Systems
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I I
Pre-requisites (if any)	

Syllabus:

1. Introduction, Definitions, constituents of embedded systems, application areas, various categories of embedded systems. [2L]
2. Architecture of embedded systems: hardware, software, memory, Communication interfaces. [2L]
3. Overview of 8051 Microcontroller, ARM processor, and Digital Signal Processors. [8L]
4. Overview of embedded/real-time operating systems [4L]
5. Simulation of embedded systems with VHDL / Verilog. [4L]
6. Implementation of embedded systems with FPGA. [4L]
7. Partitioning of hardware-software and hardware-software co-design. [6L]
8. Functional Partitioning and Optimization. [4L]
9. Low power embedded system design. [2L]
10. Overview of Arduino hardware-software development platform. [2L]
11. Design Case Studies: Data Compressor, Elevator Controller, Digital Camera etc. using UML as design tool. [2L]

Books:

1. Embedded System Design by S. Chattopadhyay, PHI
2. Embedded System Design - A unified Hardware/ Software Introduction by F. Vahid, T. Givargis, Willey India Edition
3. Embedded System Design with Platform FPGAs – Principles and Practices by R. Sass, A. G. Schmidt, Morgan Kaufmann Publisher
4. Computers as Components: Principles of Embedded Computing Design by Wolf. W., Morgan Kaufmann Publisher.
5. An Embedded Software Primer by David E. Simon, Pearson.
6. Embedded/Real-time Systems: Concepts Design and Programming by Dr. K.V.K.K. Prasad, Dreamtech Press.
7. Programming for Embedded Systems, Dreamtech Software team, Wiley-Dreamtech India Pvt.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand various components of an embedded system and its architecture.

CO2: Experiment with 8051 Microcontroller, ARM processor, different Digital Signal Processors and different real-time operating systems

CO3: Simulate an embedded system with VHDL / Verilog for optimizing hardware, software and power requirements.

CO4: Implement embedded systems with FPGA

CO5: Design some embedded system applications using any standard hardware-software development platform.

Course code	CSE/PE/H/T/424F
Category	PE
Course title	Biometric Systems
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – I I
Pre-requisites (if any)	

Syllabus:

1. Introduction to Biometric Systems: History, Definition, Characteristics, Systems model, Identification, Verification/Authentication, Applications [2L]
2. Image processing and Pattern recognition Fundamentals: Introduction tobiometric samples, Representation, Biometrics as pattern recognition systems,Preprocessing, Segmentation, Noise removal techniques, etc. [4L]
3. Biometric Traits: Fundamentals of acquisition sensors and techniques,Characteristics of Biometric traits- Face, Gait, Iris, Fingerprint, Signature, etc. [2L]
4. Biometric Systems Performance Terminology: Performance assessmentterminology – Estimation of errors, FAR, FRR, ROC, Ranking; Testing methods usedin biometrics, Graphical analysis of system performance. [2L]

5. Biometric Feature Extraction: Subspace-based approaches: Principal Component Analysis (PCA), Fisher's Linear Discriminant Analysis (FLDA), 2DPCA, 2DFLDA,Generalized 2DPCA, Generalized 2DFLDA, Kernel version of subspace-based approaches; Geometric-feature-based approaches; Hybrid approaches. Invariant features, etc. [10L]
6. Biometric Classification & Recognition: Design of classifiers: Neural networks based classifiers, Probabilistic classifiers, Neuro-Fuzzy classifiers; Template matching, etc. [5L]
7. Multi-biometric Systems: Introduction to multi-biometric systems, Types of multi-biometric systems, levels of fusion in multi-biometric systems: Image fusion, Feature level fusion, Dimension reduction, Decision level fusion, Dempster Shafer (DS) Theory, Multi-level fusion. [5L]
8. Video-based Person Identification: Acquisition, Generic systems model, Facedetection and recognition from video, Tracking. [4L]
9. 3D face recognition systems: 3D face model – Reconstruction, feature extraction and recognition; Expression and Action recognition; Multi-view 3D reconstruction. [4L]
10. Biometric Standards & Privacy: Introduction to biometric standards, importance ofbiometric standards, privacy, Biometric attacks, interoperability of data, systems and applications. [2L]

Books:

1. Biometrics: Theory, Methods & Applications, N. V. Boulgouris, K. N. Plataniotis, E. Micheli-Tzanakou, IEEE Press, 2009.

2. A. Ross, K. Nandakumar and A. K. Jain, "Handbook of Multibiometrics", Springer Publishers.

3. Guide to Biometrics, Ruud Bolle, J. Connell, S Pankanti, N Ratha, A Senior, Springer.

4. Biometric Technologies and Verification Systems, J R Vacca, Elsevier.

5. Biometric Systems: Technology, Design & Performance Evaluation, J. Wayman, A. K. Jain, D. Maltoni, D. Maio, Springer Verlag, 2004.

6. Handbook of Biometrics, Springer Verlag, 2008, A. K. Jain, P. Flynn and A. A. Ross.

7. Introduction to Biometrics by Anil K. Jain, Arun A. Ross and Karthik Nandakumar, Springer publisher

Course Outcomes (COs):

The student will be able to:

CO1: Understand the different phases and basic principles of designing secured biometric systems.

CO2: Understand the different methods for feature extraction and also write codes for the same.

CO3: Know the different terminologies for performance analysis.

CO4: Understand and design classifiers for biometric systems.

CO5: Understand the fusion techniques for multi-biometric systems.

CO6: Understand the steps and modules for video-based person identification systems.

Course code	-------
Category	OE
Course title	Open Elective
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – II
Pre-requisites (if any)	

This Open Elective subject will be chosen by BCSE students from the list of open elective courses offered by other departments and its syllabus will be provided by respective departments.

Course code	CSE/PS/B/S/421
Category	PS
Course title	Project - II
Scheme and Credits	L–T–P: 0-1-4; Credits: 3.0; Semester – I I
Pre-requisites (if any)	

Syllabus:
Topics for Project II cover all areas of Computer Science & Engineering and related interdisciplinary fields.

Course Outcomes (COs)
CO1: Design solution to the chosen problem
CO2: Develop feasible and appropriate method/s / methodologies / tools / software using appropriate Technology
CO3: Implement the methods using appropriate technology and in the specified application field/area
CO4: Analyse and Compare results obtained with existing similar methods, as applicable
CO5: Develop Technical Report and demonstrate the approach used, as applicable.

Course code	CSE/PS/B/S/422
Category	PS
Course title	Seminar - II
Scheme and Credits	L–T–P: 0-3-0; Credits: 3.0; Semester – I I
Pre-requisites (if any)	

Syllabus:

Topics for Seminar II cover all areas of Computer Science & Engineering and related interdisciplinary fields.

Course Outcomes (COs):

A student shall be able to:

CO1: Explore recent research trends in Computer Science & Engineering and allied areas

CO2: Understand the progress in the trend and / or Identify the challenges and issue/s

CO3: Develop understanding on a topic and / or apply in a chosen domain

CO4: Present the acquired knowledge through oral communication

CO5: Develop a Report on the chosen topic

Two open electives which will be offered by CSE Department for non-CSE students are as follows:

Odd Semester – Introduction to Machine Learning (Max intake: 60)

Even Semester – Artificial Intelligence (Max intake: 60)

Syllabi of Open Electives Offered by the Department of Computer science and Engineering for *non-CSE students*

Course code	---
Category	OE
Course title	Open Elective
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – Odd
Pre-requisites (if any)	

Introduction to Machine Learning

(Open elective for non-CSE students)

Syllabus:

Basic definitions, applications of machine Learning, types of machine learning--supervised, unsupervised, semi-supervised, reinforcement learning, hypothesis space, learning as search, inductive bias-restriction bias and preference bias, evaluation [4L]

Data representation-training and test data design, output vector representation [1L]

Decision tree learning with real life examples, noise and overfitting. [4L]

Instance based learning, Curse of dimensionality [2L]

Probabilistic learning model and Bayesian learning [4L]

Linear regression, Logistic Regression, Support Vector Machine (SVM), Learning multiple classes [6L]

Performance measures for Machine learning algorithms: Bootstrapping & Cross Validation, Class Evaluation Measures [2L]

Artificial Neural networks: Perceptron, multilayer neural networks, backpropagation algorithm, Introduction to deep learning [7L]

Clustering: Partitional, hierarchical clustering, Gaussian mixture model. [5L]

Introduction to modern machine learning tools and packages such as WEKA under Java platform and/or Scikit-learn under python platform and/or machine learning under R platform. [5L]

Course Outcomes:

The students will be able to:
CO1: Have a good understanding of the fundamental issues and challenges of machine learning and understanding differences among various types of machine learning: supervised, un-supervised learning, reinforcement learning etc.
CO2: Learn fundamental supervised machine learning Algorithms- decision tree learning, Bayesian learning, Instance based learning, Logistic regression, Support vector machines
CO3: Learn artificial neural networks with backpropagation algorithm and basics of deep learning, and evaluate performance of the Machine Learning algorithms
CO4: Learn unsupervised learning methods and its applications to real word problems
CO5: Learn to implement machine learning systems using modern machine learning tools and packages

Course code	
Category	OE
Course title	Open Elective
Scheme and Credits	L–T–P: 3-0-0; Credits: 3.0; Semester – Even
Pre-requisites (if any)	

Artificial Intelligence

(An Open Elective for non CSE Students)

Syllabus:

1. Introduction **[**2 L]

Definition & Scope, A Brief History, Subfields

2. **State Space Search** **[**9 L]

Definition of State Space & illustration of search on it
Blind Search: Breadth First & Depth First (only illustration)
Heuristic Search: Hill Climbing, Best First, Evaluation Function, Algorithm A^*, Admissibility of A^* (only definition), Informedness of A^*& its advantage
Randomized Search: Genetic Algorithm (GA)

3. Knowledge Representation and Inference **[**9 L]

Introduction to First Order Predicate Calculus
Elements of Predicate Calculus: Syntax, Alphabet, Predicate Symbols, Terms (Constants, variables, Functions), Atomic Formulas, Well Formed Formulas (WFFs), Interpretation of WFFs, Connectives (And, Or, Not), Implication, Literals, Propositional Calculus, Quantifiers (Universal & Existential), Properties of WFFs, Predicate Calculus Representation of various English sentences
Rules of Inference, Theorems & Proofs: Modus Ponens & Universal Specialization, Unification, Validity & Satisfiability
Resolution: Clauses, Resolution for Ground Clauses, General Resolution, Resolution Refutation, Horn Clauses & PROLOG (A cursory discussion)

4. Uncertainty Management **[**8 L]

Probability & Bayes theorem, Certainty Factors & Rule Based Systems, Dempster-Shafer Theory

5. Machine Learning **[**12 L]

Learning Problems, Learning Heuristic Functions, Neural Networks

Suggested Readings:

1. N. J. Nilsson, *Principles of Artificial Intelligence*, Narosa Publishing House, 2002

2. N. J. Nilsson, *Artificial Intelligence*: *A New Synthesis*, Elsevier India, 2010

3. D. W. Patterson, *Introduction to Artificial Intelligence & Expert Systems*,Pearson,2015.

4. S. Russel, P. Norvig, *Artificial Intelligence and Modern Approach*, 3rd Edition, Pearson Education, 2015
5. E. Rich, K. Knight, *Artificial Intelligence*, 2nd Edition, Tata McGraw Hill.

Course Outcomes:
After studying the course, the students are expected to do the following:

CO1: To analyze intelligent problems in terms of *State Space Search* and apply heuristics for a short-cut solution
CO2: To analyze experts' knowledge for formal representation and apply inference rules of *Predicate Calculus* for generating expert decisions.
CO3: To analyze real world problems amid uncertain data and imprecise knowledge
CO4: To apply machine learning paradigms to generate effective knowledge essential for developing solution to complex real world problems