| Sixth Semester | | | | | |
|---|---|---|---|---|---|
| **Theory** | | | | | |
| **Sl. No.** | **Category** | **Subject Code** | **Subject Name** | **L-T-P** | **Credit** |
| 1 | BSC | 22CM6BS01T | Optimization Engineering | 4-0-0 | 4 |
| 2 | PCC-9 | 22IT6PC01T | Machine Learning | 3-0-0 | 3 |
| 3 | PCC-10 | 22IT6PC02T | Software Engineering | 3-0-0 | 3 |
| 4 | PEC-3 | **Professional Elective-3:** | | | |
| | | 22IT6PE01T/<br>22IT6PE02T/<br>22IT6PE03T/<br>22IT6PE04T/ | Compiler Design<br>Internet of Things<br>Computer Vision<br>Cyber Security | 3-0-0 | 3 |
| 5 | PEC-4 | **Professional Elective-4:** | | 3-0-0 | 3 |
| | | 22IT6PE05T/<br>22IT6PE06T/<br>22IT6PE07T/<br>22IT6PE08T/<br>22IT6PE09T/ | Natural Language Processing/<br>Computational Intelligence /<br>Pattern Recognition/<br>Wireless Sensor Network<br>Fundamentals of 5G Communications | | |
| 6 | OEC-3 | **Open Elective-3:( For CSE Students)** | | | |
| | | | Courses from other departments | 3-0-0 | 3 |
| | | **Open Elective-3:(For Other Branch Students)** | | | |
| | | 22IT6OE01T | Introduction to Operating System | | |
| **Total Credit (Theory)** | | | | | **19** |
| **Practical** | | | | | |
| 1 | PCC-9 | 22IT6PC01L | Machine learning Laboratory | 0-0-2 | 1 |
| 2 | PCC-10 | 22IT6PC02L | Software Engineering Laboratory | 0-0-2 | 1 |
| 3 | PSI | 22CM6PS01L<br>22CM6PS02L | Technical writing using LATEX<br>Simulation-based Laboratory using NS2/ NS3 | 0-0-3 | 2 |
| 4 | HSMC | 22CM6HS01L | Business Communication and Interview Skills | 0-0-3 | 2 |
| **Total Semester Credit** | | | | | **25** |

| 19CM6BS01 T | Optimization Engineering (3-1-0) | 4 Credits |
|---|---|---|

**Course objectives:**

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
2. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.
3. To apply the mathematical results and numerical of optimization theory to different Engineering problems.

**Module-1:** **[8 Hrs]**

Idea of Engineering optimization, Classification of optimization Problems, Optimization Problem and Model Formulation. **Linear programming:** Formulation of LPP, Simplex method, Big-M method, Two-phase Method, Dual Simplex method, Sensitivity analysis in linear programming.

**Module-2:** **[8 Hrs]**

**Transportation problems:** Finding an initial basic feasible solution by Northwest Corner rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Least common cell method.
**Assignment problems:** Hungarian method for solution of Assignment Problems
**Integer Programming:** Integer Programming, Mixed Integer programming, Branch and Bound method

**Module-3:** **[10 Hrs]**

**Non-linear programming:** Introduction to non-linear programming. Constrained optimization, Multivariable optimization: Method of Lagrange Multipliers, Kuhn-Tucker conditions.
**Unconstraint optimization**: Powell's Method, Steepest Descent (Cauchy) Method, Conjugate Gradient (Fletcher-Reeves) Method, Newton's method.

**Module-4:** **[8 Hrs]**

**Game Theory**: Concept, Game models, Two persons zero sum games and their solution, Pure & Mixed Strategy, solution of 2Xn and mX2 games by graphical approach.
**Decision Theory:** Concept, Decision under risk (EMV) & uncertainty**.**

**Module-5:** **[8 Hrs]**

**Queuing models:** General characteristics, Markovian queuing model, M/M/1model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

**Course outcomes:**

1. Understand importance of optimization of industrial process management.
2. Apply basic concepts of mathematics to formulate an optimization problem.
3. Analyses and appreciate variety of performance measures for various optimization problems

**TEXT BOOKS:**


1. S. S. Rao, *Engineering Optimization*, New Age International Publications.
2. Ravindran, D. T. Philips, J. Solberg, *Operations Research- Principle and Practice*, Second edition, Wiley India Pvt Ltd.

3. H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, *Operations Research*, Pearson Education, Eighth Edition.

**Reference Books:**

1. S.D.Sharma, *Operations Research*, Kedarnath Publications.
2. F.S.Hiller, G.J.Lieberman, *Operations Research*, Tata McGraw Hill.
3. P.C.Biswal,*Optimization Engineering*, Scitech Publications
4. Prem Kumar Gupta, D.S.Hira, *Operations Research*, S.Chand Publications.

Digital Learning Resources

| | |
|---|---|
| Course Name | Optimization from fundamentals |
| Course Link | https://nptel.ac.in/courses/105/103/105103210/ |
| Course Instructor | Prof. Ankur A. Kulkarni IIT Bombay |

| | |
|---|---|
| Course Name | Introduction to Operating Systems |
| Course Link | https://nptel.ac.in/courses/106/106/106106144/ |
| Course Instructor | Prof. Chester Rebeiro IIT Madras |

| 22IT6PC02T | Software Engineering(3-0-0) | 3 Credits |
|---|---|---|

**Course Objectives:**

1. To understand the phases in a software project
2. To understand fundamental concepts of requirements engineering and Analysis Modeling.
3. To understand the various software design methodologies
4. To learn various testing and maintenance measures

**Module-I: SOFTWARE PROCESS AND AGILE DEVELOPMENT [8 Hrs]**

Introduction to Software Engineering, Overview of software development activities, Software Process, Perspective and Specialized Process Models –Introduction to Agility-Agile process- Extreme programming-XP Process.

**Module-II: SOFTWARE REQUIREMENTS ENGINEERING [8 hrs]**

Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document – Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management. Classical analysis: Structured system Analysis, Data Dictionary.

**Module-III: SOFTWARE ANALYSIS & DESIGN [8 hr]**

Overview of design process: High-level and detailed design, Cohesion and coupling, Modularity and layering, Design process – Design Concepts-Design Model– Design Heuristic – Architectural Design. Basic concepts of Object Oriented Analysis & Design. Structured Analysis using DFD - Structured Design using Structure Chart, User interface design, Command language, menu and iconic interfaces.

**Module- IV: TESTING AND MAINTENANCE [8hr]**

Software testing fundamentals-Internal and external views of Testing-white box testing – basis path testing-control structure testing-black box testing- Regression Testing – Unit Testing – Integration Testing – Validation Testing – System Testing And Debugging –Software

**Module- V: IMPLEMENTATION TECHNIQUES [10 hr]**

Implementation Techniques: Coding practices-Refactoring-Maintenance and Reengineering-BPR model-Reengineering process model-Reverse and Forward Engineering.
**Software Project Management:** Introduction to software Estimation techniques, COCOMO I & II Model – Project Scheduling – Earned Value Analysis Planning – Project Plan, Planning Process

**Course Outcome:**

1. To apply the software engineering lifecycle by demonstrating competence in communication, planning, analysis, design, construction, and deployment
2. An ability to work in one or more significant application domains
3. Work as an individual and as part of a multidisciplinary team to develop and deliver quality software
4. Demonstrate an understanding of and apply current theories, models, and techniques that provide a basis for the software lifecycle
5. Demonstrate an ability to use the techniques and tools necessary for engineering practice

**Text Book:**

**1.** Rajib Mall, Fundamentals of Software Engineering, Fifth Edition, PHI, 2018

**Reference Books:**


1. Software Engineering, A Practitioner's Approach, Roger S. Pressman, TMG Hill.
2. Fundamentals of Software Engineering, Rajib Mall, PHI, 2014.
3. Software Engineering, I. Sommerville, 9th Ed., Pearson Education.


## Digital Learning Resources

| | |
|---|---|
| Course Name | Software Engineering |
| Course Link | NPTEL :: Computer Science and Engineering - NOC:Software Engineering |
| Course Instructor | Prof. Rajib Mall, IIT Kharagpur |

| 22IT6PE01T | Compiler Design (3-0-0) | 3 Credits |
|---|---|---|

**Course Objective:**

1. To learn the process of translating a modern high-level language to executable code
2. To provide a student with an understanding of the fundamental principles in compiler design and to provide the skills needed for building compilers for various situations that one may encounter in a career in Computer Science.
3. To develop an awareness of the function and complexity of modern compilers.
4. To apply the code generation algorithms to get the machine code for the optimized code.
5. To apply the optimization techniques to have a better code for code generation

**Module-1:** **[07 Hrs]**

Introduction: Language Processors, Overview and Phases of compilation, Programming language basics.
Lexical Analysis: Non-Deterministic and Deterministic Finite Automata (NFA & DFA), Regular grammar, Regular expressions and Regular languages, Design of a Lexical Analyzer as a NFA & DFA, Lexical Analyzer generator using LEX.

**Module-2:** **[13 Hrs]**

Syntax Analysis: Role of a Parser, Context free grammars and Context free languages, Parse trees and derivations, Ambiguous grammar.
Top Down Parsing: Recursive descent parsing, LL (1) grammars, Non-recursive Predictive Parsing, Error reporting and Recovery.
Bottom Up Parsing: Handle pruning and shift reduces Parsing, SLR parsers and construction or SLR parsing tables, LR(1) parsers and construction of LR(1) parsing tables, LALR parsers and construction of efficient LALR parsing tables, Parsing using Ambiguous grammars, Operator Precedence Parsing, Error reporting and Recovery, Parser generator using YACC.

**Module-3:** **[07 Hrs]**

Syntax directed definitions: inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions, Construction of Syntax Tree.
Type checking: type system, type expressions, structural and name equivalence of types, type conversion.

**Module-4:** **[06 Hrs]**

Intermediate code generation: intermediate representations, three address codes - Quadruples and Triples, DAG for expressions, translation of declarations, assignments, control flow, Boolean expressions, Back Patching and procedure calls.
Symbol Table: Structure and features of symbol tables, symbol attributes and scopes.
Run Time Environment: Storage Organizations, Static and Dynamic Storage Allocations, STACK Allocation, Handlings of activation records for calling sequences.

**Module-5:** **[07 Hrs]**

Code Generation: Factors involved, Registers allocation, Basic blocks and flow graphs, Simple code generation using flow graphs.
Code Optimization: Objective, Peephole Optimization, Concepts of Elimination of local common sub-expressions, Redundant and un-reachable codes, Basics of flow of control optimization.

**Course Outcome:**

1. To realize basics of compiler design and apply for real time applications.
1. To introduce different translation languages
2. To understand the importance of code optimization
3. To know about compiler generation tools and techniques
4. To learn working of compiler and non compiler applications
5. Design a compiler for a simple programming language

**Text Books:**


1. Compilers: Principles, Techniques and Tools By Aho, Lam, Sethi, and Ullman, Second Edition, Pearson, 2014
2. Principles Of Compiler Design, CENGAGE, 3rd Edition, Prasad K.S. Nandin
3. Compiler Design, O. G. Kakde, University Science Press.
4. K. C. Louden, Compiler Construction Principles and Practice, Thomson Learning Inc
5. K Cooper, L Torczon, Engineering a Compiler, 2nd Ed., Morgan Kaufmann, 2011
6. NPTEL Course, Prof Y. N. Srikant, IISc, Bangalore (https://nptel.ac.in/courses/106108


## Digital Learning Resources

| Course Name | **Compiler Design** |
|---|---|
| Course Link | NPTEL :: Computer Science and Engineering - NOC:Compiler Design |
| Course Instructor | Prof. SantanuChattopadhyay, IIT Kharagpur |

| 22IT6PE02T | Internet of Things (3-0-0) | 3 Credits |
|---|---|---|

**Course Objective**

1. To learn the basic issues, policy and challenges in the Internet.
2. To get an idea of the application areas where Internet of Things can be applied.
3. To understand the cloud and internet environment and various modes of communications with Internet.
4. To understand the various modes of communications with Internet.

**Module-1**: **[10 Hrs]**

**Introduction & Concepts:** Introduction to Internet of Things, Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels. Domain Specific IOTs: Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style, Challenges and Issues.

**Module-2:** **[10 Hrs]**

**M2M & System Management with NETCONF-YANG:** M2M, Difference between IOT and M2M, SDN and NFV for IOT, Software defined Networking, Network Function Virtualization, Need for IOT Systems Management, Simple Network Management Protocol, Limitations of SNMP, Network Operator Requirements, NETCONF, YANG, IOT Systems management with NETCONF-YANG

**Module-3:** **[10 Hrs]**

**IoT Protocols:** Protocol Standardization for IoT and WSN Protocols-SCADA and RFID Protocols-Issues with IoT Standardization Protocols IEEE802.15.4-BACNet Protocol- , Architecture - Network layer – APS Layer – Security.

**Module-4:** **[10 Hrs]**

**Case Study and IoT Application Development:** IoT applications in home- infrastructuressecurity- Industries- IoT electronic equipments. Use of Big Data and Visualization in IoT Industry 4.0 concepts - Sensors and sensor Node –Interfacing using Raspberry Pi/Arduino- Web Enabled Constrained Devices.

**Course Outcome:**

1. Able to understand the application areas of IOT
2. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
3. Able to understand building blocks of Internet of Things and characteristics.

**Text Book:**


1. VijayMadisetti, ArshdeepBahga," Internet of ThingsA Hands-On- Approach",2014, ISBN:978 0996025515
2. Honbo Zhou, "The Internet of Things in the Cloud:A Middleware Perspective" –– CRCPress- 2012.
3. ArshdeepBahga, Vijay Madisetti, "Internet of Things (A Hands-On-Approach)", VPT, 2014.
4. Luigi Atzor et.al, "The Internet of Things: A survey, ", Journal on Networks, Elsevier Publications, October 2010.

5. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key applications and Protocols”, Wiley, 2012..
6. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013.

**Digital Learning Resources**

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|---|---|
| Course Name | Introduction to internet of things |
| Course Link | NPTEL :: Computer Science and Engineering - NOC:Introduction to internet ofthings |
| Course Instructor | Prof. SudipMisra, IIT Kharagpur |

| 22IT6PE03T | Computer Vision (3-0-0) | 3 Credits |
|---|---|---|

**Course Objective:**

1. To Gain an understanding of the fundamental of extracting information from digital imagery.
2. To learn different task and algorithms related to computer vision
3. To learn to build to integrated computer vision model for solving real world problem

**Module-1:** **[8 Hrs]**

**Introduction to computer vision,** Machine vision systems, optics and lenses, image sensors, human vision and Neurovisual model; Marr's paradigm; Imaging geometry— world co-ordinate system and camera coordinate system, co-ordinate transformations, projection geometry, camera calibration, radiometry,Image brightness and radiometry, image formation and surface reflectance under different conditions, reflectance map and bidirectional reflectance distribution function, photometric stereo recovering albedo and surface orientation, shape from shading.

**Module-2:** **[12 Hrs]**

**Feature detection,** interest point and corner, harris corner detection, shift, surf, ransac and transformation , Local image features, level curve curvature, histogram of oriented gradients, blob detection, difference of gaussian, difference of Laplacian, Gestalt law, saliency detection. Texture- gray level co-ocurrence feature, Local binary pattern. Shape from Texture for Planes, Shape from Texture for Curved Surfaces. Segmentation-Clustering and Segmentation with Mean Shift, Graph cut segmentation.

**Module-3:** **[12 Hrs]**

**Binocular technique—** stereo pair, epipolar line and plane, Stereo matching, photogrammetry, monocular technique— texture processing and shape from texture, depth from focusing and symmetry, different range finder (active) -laser range finder, light-stripe method. Understanding line drawings, gradient and dual space, generalized cylinder, volumetric representation, edge and junction labelling; Labelling and recognition of scene objects; Construction of model-base and visual learning, model based recognition system— Acronym, model based recognition from sparse range data, 3D model based vision system, scene understanding, virtual reality.

**Module-4:** **[10 Hrs]**

**Motion field, optical flow—** smoothness, boundary conditions, discontinuities of optical flow, block based method, pre-recursive method, Bayesian method, motion segmentation method, motion from points and lines, token tracking, stereo and motion tracking, use of Kalman filter, focus of expansion, structure from motion, motion compensated filtering and restoration, video compression, active and passive surveillance

**Course Outcome:**

1. Identify and define basic concepts in computer vision, including camera parameters, camera calibration, edge detection, line detection, stereo algorithms, motion detection, structure from motion, image mosaic, face detection, and object recognition
2. Evaluate the correctness and generality of a computer vision method

3. Build integrated model computer vision model for solving real life problem.

**Text Books:**


1. Forsyth, David A., and Jean Ponce. *Computer vision: a modern approach*. Prentice Hall Professional Technical Reference, 2002.
2. Hartley, R., &Zisserman, A. (2003). *Multiple view geometry in computer vision*. Cambridge university press..
3. Szeliski, Richard. *Computer vision: algorithms and applications*. Springer Science & Business Media, 2010.


## Digital Learning Resources

| | |
|---|---|
| Course Name | Computer Vision and Image Processing - Fundamentals and Applications |
| Course Link | NPTEL :: Electrical Engineering - NOC:Computer Vision and Image Processing - Fundamentals and Applications |
| Course Instructor | Prof. M. K. Bhuyan, IIT Guwahati |

| | |
|---|---|
| Course Name | Computer Vision |
| Course Link | NPTEL :: Computer Science and Engineering - NOC:Computer Vision |
| Course Instructor | Prof. JayantaMukhopadhyay, IIT Kharagpur |

| 22IT6PE04T | Cyber Security (3-0-0) | 3 Credits |
|---|---|---|

**Course Objectives:**

The course is designed in a way that a candidatecan identify, analyze and remediate computer security breachesby learning and implementing the real-world scenarios in Cyber Investigations Laboratory, NetworkSecurity Laboratory and in Security and Penetration Testing Laboratory.

- Exhibit knowledge to securecorrupted systems, protect personal data, and secure computer networksin an Organization.
- Practice with an expertise in academics to design and implement security solutions.
- Understand key terms and concepts in Cryptography, Governance and Compliance.
- Develop cyber security strategies and policies
- Understand principles of web security and to guarantee a secure network by monitoring and analyzing the nature of attacks through cyber/computer forensics software/tools.

**Unit 1: Introduction to Cyber Security**

Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats:- Cyber Warfare-Cyber Crime-Cyber terrorism-Cyber Espionage, Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, Need for an International convention on Cyberspace.

**Unit 2: Cyber Security Vulnerabilities and Cyber Security Safeguards**

Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.

**Unit 3: Securing Web Application, Services and Servers**

Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

**Unit 4: Intrusion Detection and Prevention**

Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.

**Unit 5: Cryptography and Network Security**

Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of

Firewalls, User Management, VPN Security Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPSec.

**Course Outcomes:**

Upon successful completion of the programme, candidates will be familiar with cyber security landscapes and able to

a) Analyze and evaluate the cyber security needs of an organization.
b) Determine and analyze software vulnerabilities and security solutions toreduce the risk of exploitation.
c) Measure the performance and troubleshoot cyber security systems.
d) Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.
e) Comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators
f) Design and develop a security architecture for an organization.
g) Design operational and strategic cyber security strategies and policies

| 22IT6PE05T | Natural Language Processing (3-0-0) | 3 Credits |
|---|---|---|

**Course Objectives**

1. Developing ability to syntactically, semantically and pragmatically understand Natural Language data for rule based processing.
2. Learn how Natural Language can also be analyzed statistically.
3. And to learn nuances of Natural Language based machine learning.

**Module-I: [10 Hrs]**

Introduction, Regular Expression, Text Normalization, Edit Distance, N-gram Language Model, Data Generalization and Smoothing, Kneser-Ney Smoothing.

Lexical Semantics, Vector Semantics, Words and Vectors, Similarity Metrics Measures, Term Frequency Inverse Document Frequency, Word Embedding and its Semantic properties, Word2vec Models, Parts-of-Speech, HMM based POS Tagging, Sequence Processing, Context Free Grammar, Treebanks, Lexicalized Grammars.

**Module-II: [10Hrs]**

Parsing: Ambiguity Resolution, Statistical/Probabilistic Parsing, PCFG, Evaluating Parser, Dependency Parsing, Dependency Relations and Formalisms, Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Representation of Meaning, Model-Theoretic Semantics, First-Order Logic, Event and State Representations, Description Logics.

**Module-III: [10 Hrs]**

Information Extraction, Named Entity Recognition, Relation Extraction, Time Extraction, Event Extraction, Template Filling, Semantic Role Labeling, Diathesis Alterations, The Proposition Bank, FramNet, Selection Restrictions, Sentiment Analysis: Defining Emotions, Creating Affect Lexicons, Semi-supervised Induction of Affect Lexcons, Sentiment Recognition, Affect Recognition, Connotation Frames.

**Module-IV [10 Hrs]**

Extraction based Text Summarization, Abstraction based Text Summarization, Coreference Resolution, Discourse Analysis, Machine translation, Information Retrieval based Question Answering, Knowledge based Question Answering, Dialog Systems, Chatbots.

**Course Outcome:**

1. Provides a modern and statistical perspective on natural language processing.
2. Enable the student to: acquire fundamentals of language technology; understand, implement, and apply state-of-the-art techniques to novel problems involving natural language data
3. Able to read and understand current research literature.

**Text Books:**


1. Dan Jurafsky and James H. Martin. *Speech and Language Processing*, Prentice-Hall. (3rd Edition)
2. James Allen. *Natural Language Understanding*, Pearson.
3. Chris Manning and HinrichSchuetze. *Foundations of Statistical Natural Language Processing*, MIT Press.
4. Ian Goodfellow, YoshuaBengio, and Aaron Courville. *Deep Learning*, MIT Press.

**Online Materials**

1. Natural Language Processing, Skills gain - NLP, Tenserflow, Dialog Systems, Deep Learning.
2. Natural Language Processing using Python, Skills gain - NLP, Machine Learning specific NLP models.
3. Advanced NLP using Deep Learning, Skills gain - Deep Learning, Advanced NLP.
4. NLP Notes by Jacob Eisenstein.

## Digital Learning Resources

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|---|---|
| Course Name | **Natural Language Processing** |
| Course Link | NPTEL :: Computer Science and Engineering - NOC:Natural Language Processing |
| Course Instructor | Prof. PawanGoyal, IIT Kharagpur |

| | |
|---|---|
| Course Name | **Natural Language Processing** |
| Course Link | NPTEL :: Computer Science and Engineering - Natural Language Processing |
| Course Instructor | Prof. Pushpak Bhattacharyya, IIT Bombay |

| 22IT6PE06T | Computational Intelligence (3-0-0) | 3 Credits |
|---|---|---|

**Course Objective**:

After completing this course, you will be able to learn:

1. Fuzzy logic and its applications.
2. Artificial neural networks and its applications.
3. Solving single-objective optimization problems using Gas and Neuro-Fuzzy Hybrid Systems.
4. Applications of Soft computing to solve problems in varieties of application domains.

**Module-I:** **[10 Hrs]**

Fuzzy Set Theory Fuzzy sets: Introduction, Basic definition and terminology, Set-Theoratic Operations, Membership Function Formulation and Parameterization, T-norm, T-conorm. Fuzzy Rules and Fuzzy Reasoning: Extension Principle and Fuzzy Relations, Fuzzy if-then rules, Fuzzy reasoning. Fuzzy Inference Systems: Mamdani Fuzzy models, Sugeno Fuzzy models, Tsukamoto Fuzzy models.

**Module-II:** **[10 Hrs]**

Neural Networks: What is Neural Network, Learning rules and various activation functions, Single layer Perceptrons , Back Propagation networks, Architecture of Backpropagation(BP) Networks, Backpropagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.

**Module-III:** **[10 Hrs]**

Nature Inspired Computing Simulated Annealing, Genetic Algorithm, Differential Evolution, Ant & Bee Algorithm, Particle Swarm Optimization, Firefly algorithm, Cuckoo Search, Bat Algorithm, Harmony Search, Flower algorithm.

**Module-IV:** **[10 Hrs]**

Hybrid Systems: Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems, GA and Fuzzy based Backpropagation Networks: GA based Weight Determination, K - factor determination in Columns, LR type Fuzzy numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BP, Application of Fuzzy BP Networks.

**Course Outcome:**

1. course outcome-1
2. course outcome-2
3. course outcome-3

**Suggested Books:**


1. A. P. Engelbrecht, Computational Intelligence: An Introduction, John Wiley & Sons, 2007.
2. F. O. Karry and C. de Silva, "Soft Computing and Intelligent Systems Design – Theory, Tools and Applications". Pearson Education. (Printed in India)
3. S. Rajasekaran and G. A. VijayalakshmiPai, Neural Network, fuzzy Logic and Genetic Algorithms: Synthesis and Applications
4. S. N. Sivanandam and S. Sumathi, Principles of Soft Computing, John Wiley & Sons
5. **Online/MOOC courses:** https://nptel.ac.in/courses/106105173/

| 22IT6PE07T | Pattern Recognition(3-0-0) | 3 Credits |
|---|---|---|

**Course Objective:**

1. To introduce the fundamental principles of pattern recognition
2. To learn the algorithms involved in design and construction of various pattern recognition system component.
3. To analyse different components of pattern recognition system and learn to integrate them to form a unified system.

**Module-I:** **[8 Hrs]**

Metric, positive definite matrix, Eigen values and eigen vectors, SVD, statistical measures- mean, median, mode, correlation, dispersion matrix, binomial distribution, normal distribution, multi- variate normal distribution, basic concepts in probability theory-Bayes' theorem, Chebyshev's inequality, Laws of large numbers, central limit theorem. Unbiased estimation, maximum- likelihood, linear discriminant function, Introduction to pattern, recognition and its application, feature, and its characteristics, supervised and unsupervised approach to pattern recognition, pattern recognition system

**Module-II:** **[8 Hrs]**

**Classification systems and its characteristics**- overfitting, underfitting, training and test sets, standardization, normalization, distance function- Euclidean, Mahalanobis, Bayes decision classifier, error in bayes decision classifier, minimum distance classifier, Naive-Bayes rule, perceptron, K-NN classifier, SVM classifier, Multi-layer perceptron, decision tree, ensemble method of classifiers- bagging, boosting, random forest, cross-validation, Selection criteria of classification model- No Free Lunch Theorem, Bias-Variance problem, assessment of classification system- confusion matrix, precision, recall, F-score, sensitivity, specificity, ROC analysis AUC analysis. Class imbalance problem.

**Module-III:** **[8 Hrs]**

Clustering, clustering criterion, similarity measures, types of clustering, partition-based K-means, K- medoid, PAM, affinity based, Fuzzy C-means. Hierarchical clustering- agglomerative, divisive, Density based clustering-DBSCAN, probability based- mean-shift clustering, mixture model, spectral clustering, ensemble of clustering, subspace clustering for high dimensional data, cluster validation- external and internal criteria.

**Module-IV:** **[8 Hrs]**

Dimensionality reduction, curse of dimensionality, feature selection, feature selection criterion, class separability measures- divergence, Chernoff bound, Bhattacharyya distance, scatter matrices, **Module-V: [8 Hrs]**

Filters- mutual information, the pointwise mutual information, Pearson product-moment correlation coefficient, Relief-based algorithms, branch and bound, wrappers, feature reduction- Karhunen-loeve transform, independent component analysis, principle component analysis, linear discriminant analysis, Kernel PCA. Application of Pattern recognition for image analysis.

**Course Outcome:**

1. Equip students with knowledge of different algorithms for classification, clustering and dimensionality reduction.
2. Ability to analyse and validate different algorithms used for pattern recognition.

3. Ability to integrate algorithm to build a unified pattern recognition model for solving real world problem.

**Text Books:**


1. Duda, R.O., Hart, P.E., and Stork, D.G. *PatternClassification*. Wiley-Interscience. 2nd Edition. 2001
2. Theodoridis, S. and Koutroumbas, K. *Pattern Recognition*. Edition 4. Academic Press, 2008.
3. Hastie, T., Tibshirani, R. and Friedman, J. *The Elements of Statistical Learning*. Springer. 2001.
4. Bishop, C. M. *Pattern Recognition and Machine Learning*. Springer. 2007


## Digital Learning Resources

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|---|---|
| Course Name | **Pattern Recognition** |
| Course Link | NPTEL :: Computer Science and Engineering - Pattern Recognition |
| Course Instructor | Prof. Sukhendu Das, Prof. C.A. Murthy |

| 22IT6PE08T | Wireless Sensor Network (3-0-0) | 3 Credits |
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**Course Objective**

1. Able to classify and explain different WSN applications and challenges and solve the tracking issues in WSN
2. Able to identify the wireless characteristics and different MAC protocols for WSN and also to interpret different routing protocols for WSN
3. Understand the security challenges in WSN

**Module-I:** **[8 Hrs]**

Motivation for a Network of Wireless Sensor Nodes: Definition and Background, Challenges and constraints, Advantages of WSNs.
Applications: Structural Health monitoring, Traffic Control, Health Care, Pipeline Monitoring, Precision Agriculture, Active Volcano, Underground Mining.

Node Architecture: The Sensing Subsystem, The Processor Subsystem, Communication Interfaces, Prototypes, WSN protocol stack.

**Module-II:** **[8 Hrs]**

Network Deployment : Structured versus Randomized Deployment.
WSN Physical Layer: Basic Components, Source Encoding, Channel Encoding, Modulation, signal Propagation.

**Module-III:** **[8 Hrs]**

Medium Access Control: Overview, Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, and Hybrid MAC Protocols.

**Module-IV:** **[8 Hrs]**

Network Layer: Overview, Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols.
Power Management: Local Power Management Aspects, Dynamic Power Management. Conceptual Architecture.

**Module-V:** **[8 Hrs]**

Time Synchronization: Clocks and the Synchronization Problem, time Synchronization in WSNs, Basics of Time Synchronization, Time Synchronization Protocols.
Localization: Ranging Techniques, Range-Based Localization, Range-Free Localization, Event-Driven Localization.
WSNs Security: Fundamentals of Network Security, Challenges of Security, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security.

**Course Outcomes:**

**Text Book:**

1. Networking Wireless Sensors : BhaskarKrismachari, Cambridge University Press
2. Fundamentals of Wireless Sensor Networks: Theory and Practice- by WaltenegusDargie, Christian Poellabauer in John Wiley and Sons, Ltd., Publication, 2010.

**Suggested Book:**

1. Wireless Sensor Networks : An Information Processing Approach- by Feng Zhao, Leonidas Guibas , Morgan Kaufmann Series in Networking 2004.
2. Wireless Sensor Networks : Technology, Protocols, and Applications : KazemSohraby, Daniel Minoli, TaiebZnati , Wiley Inter Science.
3. Guide to Wireless Sensor Networks, Springer, SudipMisra• Isaac Woungang•Subhas Chandra Misra.
4. Wireless Sensor Networks : Edited by C.S Raghavendra, Krishna M, Sivalingam, TaiebZnati , Springer.

## Digital Learning Resources

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|---|---|
| Course Name | Wireless Ad Hoc and Sensor Networks |
| Course Link | NPTEL :: Computer Science and Engineering - NOC:Wireless Ad Hoc and SensorNetworks |
| Course Instructor | Prof. SudipMisra, IIT Kharagpur |

| 22IT6OE01T | Introduction to Operating System (3-0-0) | 3 Credits |
|---|---|---|

**COURSE OBJECTIVES:**

1. Recognize the concepts and principles of operating systems.
2. Provide comprehensive introduction to understand the underlying principles, techniques and approaches which constitute a coherent body of knowledge in operating systems.
3. To teach understanding how the various elements that underlie operating system interact and provides services for execution of application software.

**Module-I:** **[8 Hrs]**

**Overview of operating systems**: computer system organization, computer system architecture, operating system operations, Need of Process/Memory/Storage Management, Protection and security, Distributed systems, Real-Time Embedded Systems. Operating systems services, User- Operating System Interface, Systems calls and its types, operating system structure.

**Module-II:**

**Process Concept**; Process Scheduling; Operations on Processes; Interprocess Communication; Thread; Multithreading models;

**Module-III:** **[8 Hrs]**

**Scheduling Criteria**, Algorithms (FCFS, SJF, SRTF, Round Robin, Priority, Multi-level Queue and Feedback Queue), Thread scheduling.

The Critical- section problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical problems of synchronization, monitors

**Module-IV:** **[8 Hrs]**

System model; Deadlock Characterization; Methods for Handling Deadlock (Deadlock prevention, detection and Avoidance, recovery);

Swapping; Contiguous memory allocation; Paging; Structure of the page table; Segmentation; Virtual memory, demand paging, Copy on write, page-Replacement algorithms (FIFO, LRU, LFU, Optimal Page Replacement)

**Module-V:** **[8 Hrs]**

File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing and Protection, File system structure, File System Implementation, Directory Implementation, Allocation Methods. Overview of Mass-storage structure, disk structure, disk attachment, disk scheduling, swap-space management

**Course Outcome:**

1. Identify basic components of operating system.
2. Conceptualize synchronization amongst various components of a typical operating system.
3. Understand and simulate activities of various operating system components.
4. Correlate basic concepts of operating system with an existing operating system.

**TEXT BOOK:**


1. Abraham Silberschatz, Peter Baer Galvin & Greg Gagne "Operating System Concepts", 8th edition,
2. John Wiley &SonsWilliam Stallings, "Operating Systems – Internals and Design Principles", 5/e, Pearson.

3. Charles Crowley, “Operating Systems: A Design-Oriented Approach”, Tata McGraw Hill Co., 1998 edition.
4. Andrew S.Tanenbaum, “Modern Operating Systems”, 2nd edition, 1995, PHI.

## Digital Learning Resources

| | |
|---|---|
| Course Name | Foundation Engineering |
| Course Link | https://nptel.ac.in/courses/105/105/105105176/ |
| Course Instructor | Prof. Koushik Deb, Department of Civil Engineering, IIT Kharagpur |

| 22IT6PC01L | Machine Learning Laboratory (0-0-2) | 1 Credits |
|---|---|---|

1. Make use of Data sets in implementing the machine learning algorithms
2. Implement the machine learning concepts and algorithms in any suitable language of choice.

**Laboratory Experiments**

**1.** Build a multivariate logistic regression model to classify glass type of glass given different glass mixture features using the Glass Identification Dataset from UCI Machine Learning Repository.

**2.** Implement supervised machine learning algorithm (Classification – K Nearest Neighbourhood) in python to classify breast tumour data into malignant breast tumour or benign breast tumour (use breast tumour dataset) and obtain its accuracy level.

**3.** Implement supervised machine learning algorithm (Classification – K Nearest Neighbourhood) in python to classify iris data into setosa, virginica, versicolor using iris dataset and obtain its accuracy level.

**4.** Implement supervised machine learning algorithm (Classification – Support Vector Machine) in python to classify breast tumour data into malignant breast tumour or benign breast tumour (use breast tumour dataset) and obtain its accuracy level.

**5.** Write a python program to build an email spam classifier using support vector machines for the Spam base dataset from UCI machine learning repository.

**6.** Implement unsupervised machine learning algorithm (Clustering – K Means) in python on Titanic dataset to cluster data (use Titanic dataset) by removing the class label.

**7.** Implement unsupervised machine learning algorithm (Clustering – K Means) in python on Breast Tumour dataset to cluster data (use Breast Tumour dataset) by removing the class label.

**8.** Implement unsupervised machine learning algorithm (Clustering – Hierarchical) in python on Titanic dataset to cluster data (use Titanic dataset).

**9.** Implement Apriori algorithm in python to find rules which explain association between different products for given transactions at a retail store. (The data is available at https://drive.google.com/file/d/1NUXoptUlHY8z4KcFKpFA6sQN5KnWzk3p/view?usp=sharing)

**10.** Implement text classification using neural network in python/R on Twenty Newsgroupdataset from UCI machine learning repository.

**11.** Implement supervised machine learning algorithm (Classification - Naïve Bayes algorithm) in python/R on Pima Indians Diabetes dataset and obtain its accuracy level.

**12.** classification and prediction algorithms on UCI dataset using Python's

scikit-learnlibrary

## References:


**1)** Peter Harrington, “Machine Learning in Action”, DreamTech

**2)** Michael Bowles, “Machine Learning in Python”, Wiley

**3)** Gavin Hackeling, Mastering Machine Learning with scikit-learn, Packt

**4)** Giuseppe Bonaccorso, Machine Learning Algorithms - Second Edition, Packt


**Course Outcome:**

1. Understand the implementation procedures for the machine learning algorithms
2. Design Java/Python programs for various Learning algorithms.
3. Apply appropriate data sets to the Machine Learning algorithms
4. Identify and apply Machine Learning algorithms to solve real world problems

| 22IT6PC02L | Software Engineering Lab (0-0-2) | 1 Credits |
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**Course Objectives:**

1. To understand the software engineering methodologies involved in the phases for project development.
2. To gain knowledge about open source tools used for implementing software engineering methods.
3. To exercise developing product-startups implementing software engineering methods.
4. Open source Tools: StarUML / UMLGraph / Topcased

**Laboratory Experiments**

Prepare the following documents and develop the software project startup, prototype model, using software engineering methodology for at least two real time scenarios.

**Problem Analysis and Project Planning & Software Requirement Analysis**-Thorough study of the problem – Identify Project scope, Objectives, Describe the individual Phases/modules of the project and Identify deliverables. Identify functional and non-functional requirements. **[3hr]**

**Data Modeling** – Use work products – data dictionary. **[1hr 30 min] Software D**
**[2h**
**r]**

**Sample problem statement for Experiments:**

**Title: Library Information System:**

- The library has 10,000 books each book is assigned a unique identification number. The library clerk should be able to enter the details of the books into the library information system (LIS) through suitable interface.
- There are four categories of members i.e., undergraduate students, postgraduate student, research scholar and faculty members.
- Each library member is assigned a unique library member code.
- Each undergraduate student can issue up to two books for one month duration.
- Each postgraduate student can issue up to four books for one month duration.
- Each research scholar student can issue up to six books for three months duration.
- Each faculty member can issue up to ten books for six months duration.
- The LIS should answer query regarding the availability of the book. If available, it also shows the rack number and number of copies available.
- LIS issue book to each register member. When the member returns the book, update the member's account and makes books available for future use.
- Member can reserve books, which have been issued. When the book is returned, the LIS must issue the book to the member who has reserve the book.
- When the member return the book, LIS checks for the issue date and return date, if it is greater than the authorized days than issue a fine to them.
- LIS issues reminder to the members who issue the book and it is overdue.
- *LIS should allow the librarian to create and delete member records.*

**Course Outcome:**

1. Build a fully functional, interactive, layered, distributed, database-backed software system from the ground-up as part of a small, agile, development team in a laboratory setting

2. Become acquainted with historical and modern software methodologies
3. Understand the phases of software projects and practice the activities of each phase
4. Practice clean coding
5. Take part in project management
6. Become adept at such skills as distributed version control, unit testing, integration testing, build management, and deployment

**Text Books:**

1. Robert C. Martin, Clean Code: A Handbook of Agile Software Craftsmanship, Prentice Hall, 2008.