Sixth Semester

Theory

Sl. No.	Category	Subject Code	Subject Name	L-T-P	Credit
1	BSC	19CM6BS01T	Optimization Engineering	3-1-0	4
2	PCC	19IT6PC01T	**PCC-9:** Operating System	3-0-0	3
3	PCC	19IT6PC02T	**PCC-10:** Software Engineering	3-0-0	3
4	PEC	19IT6PE01T/ 19IT6PE02T/ 19IT6PE03T/ 19IT6PE04T	**Prof Elective-3:** Compiler Design/ Internet of Things/ Computer Vision/ Cyber Security	3-0-0	3
5	PEC	19IT6PE05T/ 19IT6PE06T/ 19IT6PE07T/ 19IT6PE08T	**Prof Elective-4:** Natural Language Processing / Computational Intelligence/ Pattern Recognition/ Wireless Sensor Network	3-0-0	3
6	OEC	19IT6OE01T	**Open Elective-3 (For other branch students)** Introduction to Operating System	3-0-0	3
6	OEC	19EC6OE01T/ 19EC6OE02T/ 19EE6OE02T	**Open Elective-3: (For IT students)** Fundamentals of Satellite Communication Image Processing Technique Introduction to Robotics and Autonomous Vehicles	3-0-0	3
Total Credit (Theory)					**19**
Practical					
1	PCC	19IT6PC01L	**PCC Lab-9:** Operating System Lab	0-0-2	1
2	PCC	19IT6PC02L	**PCC Lab-10:** Software Engineering Lab	0-0-2	1
3	PSI	19CM6PS01L	Minor Project	0-0-3	2
4	HSMC	19CM6HS01L	Future-ready Contributor Program	0-0-3	2
Total Credit (Practical)					**6**
Total Semester Credit					**25**

19CM6BS01T	Optimization Engineering (4-0-0)	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, Branch and Bound method.

Module-3: **[8 Hrs]**

Non-linear programming: Introduction to non-linear programming. Constrained optimization, Multivariable optimization: Method of Lagrange Multipliers, Kuhn-Tucker conditions Quadratic programming: Wolf's method.

Unconstraint optimization: Unimodal function, Fibonacci Search method and Golden section Search

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. Ravindran, D. T. Philips, J. Solberg, *Operations Research- Principle and Practice*, Second edition, Wiley India Pvt Ltd.
2. H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, *Operations Research*, PearsonEducation, Eighth Edition.
3. S.D.Sharma, *Operations Research*, Kedarnath Publications.
4. F.S.Hiller, G.J.Lieberman, *Operations Research*, Tata McGraw Hill.
5. P.C.Biswal,*Optimization Engineering*, Scitech Publications
6. 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

19IT6PC01T	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-1: **[12 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.

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

Module-2: **[12 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-3: **[14 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-4: **[6 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, John Wiley & Sons

REFERENCE BOOKS:

1.William Stallings, "Operating Systems – Internals and Design Principles", 5/e, Pearson. 2.Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Co., 1998 edition.

3.Andrew S.Tanenbaum, "Modern Operating Systems", 2nd edition, 1995, PHI.

Digital Learning Resources

Course Name	Operating System Fundamentals
Course Link	https://nptel.ac.in/courses/106/105/106105214/
Course Instructor	Prof. Santanu Chattopadhyay IIT Kharagpur

19IT6PC02T	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-1: 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-2: 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.

Module3: 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-4: 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-5: 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

19IT6PE01T	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. Santanu Chattopadhyay, IIT Kharagpur

19IT6PE02T	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, Arshdeep Bahga," 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. Arshdeep Bahga, 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

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

19IT6PE03T	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. Jayanta Mukhopadhyay, IIT Kharagpur

19IT6PE04T	Cyber Security (3-0-0)	3 Credits

Course Objectives:

The course is designed in a way that a candidate can identify, analyze and remediate computer security breaches by learning and implementing the real-world scenarios in Cyber Investigations Laboratory, Network Security Laboratory and in Security and Penetration Testing Laboratory.

1. Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization.
2. Practice with an expertise in academics to design and implement security solutions.
3. Understand key terms and concepts in Cryptography, Governance and Compliance.
4. Develop cyber security strategies and policies
5. Understand principles of web security and to guarantee a secure network by monitoring and analyzing thenature of attacks through cyber/computer forensics software/tools.

Module-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.

Module-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.

Module-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.

Module-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.

Module-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 to reduce 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

19IT6PE05T	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-1: **[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-2: **[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-3: **[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-4: **[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 Hinrich Schuetze. *Foundations of Statistical Natural Language Processing*, MIT Press.
4. Ian Goodfellow, Yoshua Bengio, 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

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

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

19IT6PE06T	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-1: **[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-2: **[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-3: **[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-4: **[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. Vijayalakshmi Pai, 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/

19IT6PE07T	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-1: **[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-2: **[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-3: **[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-4: **[8 Hrs]**

Dimensionality reduction, curse of dimensionality, feature selection, feature selection criterion, class separability measures- divergence, Chernoff bound, Bhattacharyya distance, scatter matrices,

Module-5: **[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

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

19IT6PE08T	Wireless Sensor Network (3-0-0)	3 Credits

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-1: **[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-2: **[8 Hrs]**

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

Module-3: **[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-4: **[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-5: **[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 : Bhaskar Krismachari, Cambridge University Press
2. Fundamentals of Wireless Sensor Networks: Theory and Practice- by Waltenegus Dargie, 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 : Kazem Sohraby, Daniel Minoli, Taieb Znati , 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, Taieb Znati , Springer.

Digital Learning Resources

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

19IT6OE01T	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-1: **[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-2:

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

Module-3: **[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-4: **[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-5: **[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

19EC6OE01T	Fundamental of Satellite Communication (3-0-0)	3 Credits

COURSE OBJECTIVE:

The purpose of this course is to introduce students to

1. Make the students understand the basic concept in the field of Satellite Communication.
2. Understand the design of satellite links
3. Gain knowledge about the Satellite Access schemes.
4. Comprehend the details of earth stations designand various useful satellite applications

SYLLABUS

Module-1 **[10 Hrs]**

Introduction to satellite communication: Overview of satellite communications, General structure of satellite communication, Satellite frequency allocation and band spectrum, Satellite orbits – Performance characteristics of different altitude satellites (GEO, MEO and LEO satellite systems)

Orbital mechanics: Introduction, Kepler's laws of planetary motion, Orbital parameters, look angle determination, Launches and Lunch vehicle, Orbital effects in communication system performance.

Satellite subsystem: Attitude and Orbit Control System(AOCS), Telemetry, Tracking and Command System(TT&C), Power System, Satellite antennas, Communications subsystem, Transponders

Module-2 **[8 Hrs]**

Satellite Link Design: Basics of transmission theory, system noise temperature and G/T ratio, Uplink and Downlink design, design of satellite links for specified (C/N) performance.

Module-3 **[8 Hrs]**

Multiple Accesses: Multiplexing techniques for satellite links, Comprehensive study on FDMA, TDMA and CDMA; Spread Spectrum Transmission and Reception.

Propagation on satellite: Earth paths and influence on link design; Quantifying attenuation and depolarization, hydrometric & non hydrometric effects, ionosphere effects, rain and ice effects.

Module-4 **[6 Hrs]**

Satellite Antennas: Types of antenna and relationships; Basic Antennas Theory – linear, rectangular & circular aperture; Gain, pointing loss.

Earth station Technology: Earth station design; Design of large antennas – Cassegrain antennas

Module-5 **[6 Hrs]**

Application of Satellite communication: Overview of VSAT systems, Network architectures, direct broad casting TV.

Other Satellite services: Fundamentals of mobile communication satellite.

COURSE OUTCOME:

After completion of the course, the student will be able to

1. Explain the basic concepts of orbit mechanics and satellite Launching.
2. Analyze the design of satellite links for specified C/N with system design examples.
3. Understand the various multiple access schemes for satellite communication systems, as well as the satellite link propagation impairments.
4. Explain the fundamentals of earth station technology and the role of satellites in various applications.

TEXT BOOKS:

1. T. Pratt, C. Bostian, *Satellite Communication,* 2nd Edition John Wiley Co.,2003,India
2. R.N.Mutagi, *Satellite Communication: Principles & Applications*, 1st Edition, Oxford University Press, 2016,India

REFERENCE BOOKS:

1. Dennis Roddy, *Satellite Communications*, 2nd Edition, McGraw Hill, 1996,India
2. M. Richcharia, *Satellite Communications: Design Principles*, 2nd Edition, BSP, 2003,India
3. Tri T. Ha, *Digital Satellite Communication*, Special Indian Edition, Tata McGraw- Hill, 2009, India

DIGITAL LEARNING RESOURCES:

Course Name	Satellite Communication Systems
Course Link	https://nptel.ac.in/courses/117/105/117105131/
Course Instructor	**Prof. Kalyankumar Bandyopadhyay**

19EC6OE02T	Image Processing Techniques(3-0-0)	3 Credits

COURSE OBJECTIVE:

The program is expected to enable the students to

1. Gain an insight into the various analytical methods used in image processing.
2. Familiarize with image enhancement and restoration techniques.
3. Mathematical modeling of different image compression techniques and their applications.
4. Understand the Concept of color image processing and morphological operations on gray image.

SYLLABUS

Module- 01 **[8 Hrs]**

Introduction: Background of image processing, Fundamental steps in image processing, Elements of digital image processing systems. Digital image representation, Sampling and quantization, Relationship between pixels: Neighbours, adjacency, connectivity, regions, boundaries and distance measure, Image geometry: translation, rotation, perspective transformation.

Module-02 **[8 Hrs]**

Image Enhancement: Enhancement in spatial domain: Point Processing: Log, Power law, Image Negatives, Piecewise linear transformation, Spatial correlation and convolution Histogram processing. Smoothing and Sharpening of Spatial Filters.

Enhancement in frequency domain: Introduction to filtering in frequency domain, Smoothing and Sharpening of frequency domain filters.

Module-03 **[8 Hrs]**

Image Restoration and Reconstruction: Image Restoration: Degradation model, Restoration in presence of noise only – spatial filtering, Linear position invariant degradations, Estimating degradation functions, Inverse filtering, Wiener filtering.

Color Image Processing: Color fundamentals, Conversion of color image to gray scale image, Color model (RGB, HSI, HSV, HLS, CMK, CMYK).

Module-04 **[6 Hrs]**

Image compression: Introduction and motivation, Fundamental concepts: Data redundancy (coding redundancy, inter pixel redundancy and psycho visual redundancy), Fidelity criteria, Image compression models, Image compression standards, Elements of information theory. Image compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-Length Coding, Bit plane coding.

Module-05 **[6 Hrs]**

Morphological Image Processing: Morphological Image Processing: Preliminaries, Erosion, Dilation, Opening and Closing, hit or Miss transformation, Boundary extraction, Hole filling, Extraction of connected components, Thinning, Thickening.

COURSE OUTCOMES:

On Completion of this course, the students should be able to:

1. Understand the need for different types of image transforms and their properties for processing of gray and color image data.
2. Implement the signal processing algorithms and techniques in image enhancement, image restoration, Morphology and Image Compression.
3. Implement basic image processin g algorithms in MATLAB.
4. Understand practical scope of digital image processing for most of the work currently underway in this field.

TEXT BOOKS:

1. R.C. Gonzalez, R.E. Woods, Digital Image Processing, 3rd Edition, Pearson Education, 2007, New Delhi.
2. S. Sridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2016, New Delhi.

REFERENCE BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods Digital Image Processing using MATLAB, Seventh Edition , Pearson Education, Inc, 2004, New Delhi.
2. William K. Pratt, Digital Image Processing, 4th Edition, Wiley, 2002, New York.
3. Anil K. Jain, 'Fundamentals of Digital Image Processing', 1st Edition, Pearson 2019, New Delhi.
4. B. Chanda, Dutta D. Majumder, Digital Image Processing And Analysis, 2ndEdition ,PHI, 2011 , New Delhi.

DIGITAL LEARNING RESOURCES:

Course Name	DIGITAL IMAGE PROCESSING
Course Link	https://nptel.ac.in/courses/117/105/117105135/
Course Instructor	Prof. P.K. Biswas , Department of Electronics & Electrical Communication Engineering, I.I.T, Kharagpur

19EE6OE02T	Introduction to Robotics and Autonomous Vehicles(3-0-0)	3 Credits

Course Objective:

1. Gain basic knowledge on control and design of robotic system and it applications to solve common human society problems.
2. Will able to gain knowledge on sensor technology and computer vision.
3. Knowledge on autonomous vehicle technology.
4. Will generate fundamental knowledge needed for the future technological advances that will able to drive the economic engines of the society.

Syllabus

Module-01:

Introduction and Overview of Robotic Systems and their Dynamics [12Hours]

Introduction. Construction of manipulators, advantages and disadvantages of various Kinematic structures. Applications, Nonservo robots, motion planning. Feedback systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, jacobian, work envelopes.

Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulate or dynamics and force control. Sensors: Vision, ranging, laser, acoustic, tactile.

Module-02: Evolution of Automotive Electronics [8 Hours]

Basic Control System Theory applied to Automobiles -Overview of the Operation of ECUs - Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems- Autonomous Vehicles

Module-03:Sensor Technology for Autonomous Vehicles [8 Hours]

Basics of Radar Technology and Systems -Ultrasonic Sonar Systems -LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters

Module -04: Computer Vision and Deep Learning for Autonomous Vehicles [7 Hours]

Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing –Tensor Flow -Overview of Deep Neural Networks -Convolutional Neural Networks

Module -05:

Autonomous Vehicle Technology [7 Hours]

Driverless Car Technology-Different Levels of Automation -Localization, Unmanned Aerial Vehicle (UAV) Technology, Navigation, Path Planning, Path Following, Obstacle avoidance technology. Controllers to Actuate a Vehicle: PID Controllers -Model Predictive Controllers.

Course Outcomes:

After completion of this course the students will be able to:

1. Gain the knowledge on robotics and its applications to operate autonomous vehicles
2. Explain the applications of controllers in the field of robotics
3. Gain depth knowledge Sensor Technology and computer vision
4. Gain knowledge in different types of motor drives
5. Explain different applications of Deep Learning for Autonomous Vehicles
6. Describe the Technology of Autonomous Vehicle including the design and path planning

Text Books:

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
2. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.
3. Hong Cheng, "Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation", Springer, 2011.
4. Williams. B. Ribbens: "Understanding Automotive Electronics", 7th Edition, Elsevier Inc, 2012.

Reference Books:

1. Shaoshan Liu, Liyun Li, "Creating Autonomous Vehicle Systems", Morgan and Claypool Publishers, 2017.
2. Marcus Maurer, J.ChristianGerdes, "Autonomous Driving: Technical, Legal and Social Aspects" Springer, 2016.
3. Ronald.K.Jurgen, "Autonomous Vehicles for Safer Driving", SAE International, 2013.
4. James Anderson, KalraNidhi, Karlyn Stanly, "Autonomous Vehicle Technology: A Guide for Policymakers", Rand Co, 2014.
5. Lawrence. D. Burns, ChrostopherShulgan, "Autonomy – The quest to build the driverless car and how it will reshape our world", Harper Collins Publishers, 2018.

Digital Learning Resources

Course Name	Introduction to Robotics
Course Link	https://nptel.ac.in/courses/107/106/107106090/
Course Instructor	Prof. Asokan T, Indian Institute of Technology Madras

19IT6PC01L	Operating System Lab (0-0-1)	1 Credits

Course Objective:

1. To introduce Basic Linux general purpose Commands
2. To learn network Linux commands.
3. To learn shell script.
4. To learn different programming language in Linux editor environment and implement different Operating system algorithm
5. To learn about file management and different types of permission setup.
6. To understand how system processes work and how to manage them

Laboratory Experiments

1. Practice with UNIX commands(File management, Process Management, User Management, String searching and manipulation, Administrative Commands)
2. Basics of Shell Scripting, Conditional Blocks and Loop
3. Array, String, Function in Shell Script
4. Process Creation using Fork and exec
5. Inter-process Communication using Named Pipe
6. Process Synchronization Using Semaphore
7. Simulation of CPU Scheduling Algorithms(FCFS, SJF, RR)
8. Simulation of Deadlock Prevention Algorithms(Banker's Algorithm)
9. Simulation of Page Replacement Algorithms (FIFO, LRU)
10. Simulation of Disk Scheduling Algorithms

Course Outcome:

1. Experiment with Unix commands and shell programming.
2. Able to build shell program for process and file system management with system calls.
3. Able to implement and analyse the performance of different algorithm of Operating Systems like CPU scheduling algorithm, page replacement algorithms, deadlock avoidance, detection algorithm and so on.

Text Books:

1. Jain S,Pillai V, Kratika, Rai A, Basics of OS, UNIX and SHELL Programming, BPB Publication,2017
2. Abraham Silberschatz, Peter Baer Galvin & Greg Gagne "Operating System Concepts", 8th edition, John Wiley & Sons

19IT6PC02L	Software Engineering Lab (0-0-1)	1 Credits

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 ofthe 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 Designing - Develop DFD, use case diagrams and activity diagrams, class diagrams, sequence diagram, interaction diagram. **[8hr 30 min]**
Software Testing – Manual Testing process with real time example / sample experiments. **[2hr]**

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.

19CM6HS01L	Future Ready Contributor Program (0-0-2)	2 Credits

Outcomes: The Future-ready Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them recognize how they as technical professionals, can participate and make a positive contribution to their communities and to their state.

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Odisha.

The Contributor Program syllabus has been evolved and fine-tuned over severalyears, to –

a) address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire;
b) working extensively with universities and students and an appreciation of their challenges and concerns;
c) guided by the higher ideas and principles of practical Vedanta in work.

Sr. No.		Content	Total Hrs
1	Part 1 : Developing self-efficacy and basic inner strength	**Who is a Future-ready Contributor?** *In this topic, students understand the new work environment, expectations from future workforce, and importance of being a future-ready contributor. This enables students to transform their expectation of themselves in work*	3 hrs lab sessions (discovery-based facilitator led)
2		**Self-esteem & Growth Identity** *In this topic, students learn how to develop a deeper and more resilient self esteem and how to adopt a growth identity/ mindset, that is more appropriate to the demands of the future workplace.*	Same as above
3		**Become a Creator of one's destiny** *In a "victim stance", we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator of destiny stance" to challenges and situations. This stance helps them take ownership & responsibility to shape destiny, build a new future & find answers to challenges; and stop being complainers.*	Same as above
4	Part 2 : Building ability to make more effective career choices	**Achieving Sustainable Success** *In this topic, students discover how to achieve sustainable or lasting success, by making themselves success-worthy. Where their focus shifts to building one's "engine of success" rather than being on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. This helps them make better choices in life, that leads to steady success & long-term career fulfillment in an uncertain world.*	Same as above
5		**Career Development Pathways for a changing world**	Same as above

		In this topic, students explore a range of diverse "career development models" and the possibilities for contribution each opens up to them. This helps them open up hidden opportunities that such an environment offers. And free themselves from a herd mentality when making career choices.	
6		**Make an impact in every part of one's life** *In this topic, students learn how to expand the contribution possible in any role they have. This helps them take charge of own career growth & discover their power to contribute in any role or job.*	Same as above
7		**Think Solutions** *The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of "finding solutions" rather than "seeing problems or roadblocks". Students learn how to build this way of thinking, in this topic.*	Same as above
8	**Part 3 : Building ability to become solution and value creating individuals in the world**	**Value Thinking** *Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.*	Same as above
9		**Engaging Deeply** *The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student's ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is*	Same as above

		important. In this topic, students learn how to engage deeply. Learning how to dive deep, to quickly understand what is going on, get involved in any area, and rapidly learn.	
10	**Part 4 : Building ability to work collaboratively and as good citizens of organizations and the country**	**Enlightened self-interest & collaboration at work** *The changing nature of work in organizations and in the global environment, is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved, is "thinking in enlightened self-interest". In this topic, students learn how to widen their thinking from "narrow self-interest" to "enlightened self-interest" to work more effectively in teams & collaboratives.*	Same as above
11		**Human-centered thinking & Empathy** *In this topic, students learn to recognize & respond to human needs and challenges – the way of thinking at the heart of user-centric designs & customer-centricity.*	Same as above
12		**Trust Conduct** *The biggest currency in a sustainable career is "trust" i.e. being trusted by team members, bosses, customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make mistakes, and work seamlessly with each other without always having to "prove ourselves". In this topic, students learn how to build trust with people they engage with.*	Same as above
Contribution Project Lab Sessions		*3 Contribution projects that help them apply contributor thinking. After students complete their project work (beyond the classroom), each project ends with this 3 hr lab session where they build their project output and present.*	9 hrs (3 hr lab sessions for each of 3 projects)
Project work		*The above Contribution Projects require research, and may need field work beyond the classroom that students are expected to do.*	Beyond classroom