SEMESTER – III

21NN71 PROJECT WORK – I
vide Automotive Engineering 21AE71

SEMESTER – IV

21NN81 PROJECT WORK – II
Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21NN21 AGENT BASED INTELLIGENT SYSTEMS

3 0 0 3

INTRODUCTION: Agents and Objects, Evaluation of Agents, Agent Design Philosophies, Multi-Agent System, Mobile Agents, Agent Communication, Knowledge Query and Manipulation Language, Intelligent Agents, Agents and Environments, Structure of Agents. (10)

PROBLEM SOLVING AGENTS: Searching for solutions: Uninformed search strategies – Informed search strategies, Hill Climbing Search, Online search agents, Constraint satisfaction problems, Adversarial Search. (11)

KNOWLEDGE BASED AND PLANNING AGENTS: Knowledge representation, Logic, Proposition, Inference, First order logic, Inference in FOL, Algorithms, Knowledge representation issues, Semantic Net, Frames, Planning Problem, Partial Order Planning, Conditional Planning, Multi agent planning. (12)

PROBABILISTIC AGENTS: Uncertainty and probabilistic reasoning, Communicative Agents, Probabilistic Agent, NLP, NLP for communication, Perception, Robotics. (12)

Total L: 45

REFERENCES:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Pearson Education, New Delhi, 2017.
2. Kevin Knight, Elaine Rich and Nair, “Artificial Intelligence”, Tata McGraw Hill, New Delhi, 2017.
3. Dan W Patterson, “Introduction to Artificial Intelligence and Expert Systems”, PHI Learning Pvt. Ltd., New Delhi, 2010.
4. Mishra R B, “Artificial Intelligence”, PHI Learning Pvt. Ltd., New Delhi, 2011.

21NN22 BIO-INSPIRED COMPUTATION TECHNIQUES

3 0 0 3

INTRODUCTION: Optimization: Mathematical formulation, Gradient-based algorithms, Gradient-free algorithms, Search problems, NP problems, Principles of evolutionary process, Basic data structures and operators: Encoding schemes, Evaluation function, Search operators, Selection schemes. (11)

NATURE-INSPIRED ALGORITHMS: Genetic algorithms, Differential evolution, Particle swarm optimization, Firefly algorithm, Cuckoo search, Bat algorithm, Flower pollination algorithm. (12)

MULTIOBJECTIVE OPTIMIZATION: Principles of multi objective optimization, Dominance and Pareto Optimality, Methods: Non- Elitist multi objective Algorithms, Elitist multi objective algorithms, Hybrid algorithms. (12)

APPLICATIONS: Travelling salesman problem, Scheduling, Feature selection and classification, Time series prediction, Swarm robotics. (10)

Total L: 45

REFERENCES:

1. Xin-She Yang, “Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications”, Elsevier Science, United Kingdom, 2020.
2. Eiben A.E and Smith J.E., “Introduction to Evolutionary Computing”, Springer, New York, 2015.
3. Aboul Ella Hassanien and EidEmary, “Swarm Intelligence: Principles, Advances, and Applications”, CRC Press, New York, 2016.
4. Kalyanmoy Deb, “Multi-objective optimization using evolutionary algorithms”, John Wiley & Sons, USA, 2011.
5. Neumann, Frank and Carsten Witt, "Bio-inspired Computation in Combinatorial Optimization: Algorithms and their Computational Complexity", ACM, New York, 2013.

21NN23 NEURAL NETWORKS AND DEEP LEARNING

3 0 0 3

INTRODUCTION: Artificial neural networks Vs Biological neural networks, ANN architecture, Basic building block of an artificial neuron, Activation functions, Introduction to Early ANN architectures -McCulloch & Pitts model, Perceptron. (10)

FEEDFORWARD NETWORKS: Multilayer Perceptron, Gradient Descent, Back propagation, Empirical Risk Minimization, regularization, optimization methods, Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Self-Organizing Computational Maps: Kohonen Network. (12)

DEEP NEURAL NETWORKS: Difficulty of training deep neural networks, Recurrent Neural Networks: Backpropagation through time, Long Short Term Memory, Convolutional Neural Networks: LeNet, AlexNet, Applications - Sentiment Analysis, Computer Vision. (12)

DEEP UNSUPERVISED LEARNING: Boltzman machine, Auto encoders - standard, denoising, contractive ,Variational Auto encoders, Generative Adversarial Networks,Applications: Image Compression, Cartoon character generation. (11)

Total L: 45

REFERENCES:

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press, USA, 2016.
2. Adam Gibson and Josh Patterson, "Deep Learning A practitioner's approach", O'Reilly, USA, 2016.
3. Yusuke Sugomori, " Deep Learning: Practical Neural Networks with Java", Packet Publishing, New York, 2016.
4. Lovelyn Rose, L Ashok Kumar, D KarthikaRenuka, “Deep Learning Using Python”, Wiley India Pvt. Ltd, 2019.
5. N D Lewis, "Deep Learning made easy with R: A Gentle Introduction for Data Science", Create space dependent Publishing Platform, New Delhi 2016.

21NN24 PROBABILISTIC NETWORKS AND EXPERT SYSTEMS

3 0 0 3

INTRODUCTION: Logic, Uncertainty, and Probability, building and using probabilistic networks: Graphical modelling, specification to inference engine, inference process, Bayesian networks in expert systems. Graph Theory: Chordal and decomposable graph, Junction trees, chain graph to junction tree, Markov Properties on Graphs: Conditional independence, Markov fields over undirected graphs, Markov equivalence. (11)

DISCRETE NETWORKS: Basic operations, Local computation on junction tree, generalized marginalization operations, dealing with large cliques. Gaussian and Mixed Discrete-Gaussian Networks: Conditional Gaussian distributions, marked graphs and their junction trees, operating in junction tree, WASTE – Gaussian example, Numerical instability problems. (11)

DISCRETE MULTISTAGE DECISION NETWORKS: Multistage decision problems, solving decision problems, decision potentials, network specification and solution, OIL WILDCATTER and DEC-ASIA example, triangulation issues, asymmetric problems, Applications of Decision Networks. (11)

PROBABILISTIC GRAPHICAL MODELS AND STRUCTURED LEARNING: Statistical modelling and parameter learning, parameterizing directed Markov model, Causal and Bayesian Networks, Belief Updating in Bayesian Networks, Bayesian Networks as Classifiers, Hyper Markov laws for undirected models. Structural Learning: modelling process, Inference about models, Criteria for comparing models, Graphical models and conditional independence, Handling multiple models, Application and case studies. (12)

Total L: 45

REFERENCES:

1. Robert G. Cowell et al, “Probabilistic Networks and Expert Systems: Exact Computational Methods for Bayesian Networks”, Springer, 2007.
2. Thomas D. Nielsen, Finn V. Jensen, “Bayesian Networks and Decision Graphs”, Springer, New York, 2013.
3. Kjaerulff, Uffe B., Madsen, Anders L. “Bayesian Networks and Influence Diagrams: A Guide to Construction and Analysis”, Springer, New York, 2014.
4. Daphne Koller and Nir Friedman, “Probabilistic Graphical Models: Principles and Techniques”, The MIT Press, Massachusetts, 2009.

21NN25 MULTICORE ARCHITECTURE

3 0 0 3

INTRODUCTION TO PARALLEL COMPUTERS: Overview of parallelism - Instruction Level Parallelism (ILP) vs Thread Level Parallelism (TLP) - Architecture: Multicore, GPU, Vector Machines - Performance issues - Brief introduction to cache hierarchy and communication latency. (10)

MULTI THREADED ARCHITECTURE: Architecture and the problem of cache coherence; synchronization primitives: atomic

primitives; locks: TTS, tickets, array; barriers: central and tree; Memory Consistency - Interconnection Networks – shared memory programming - Performance implications in shared memory programs -Chip multiprocessor: CMP; shared L2 Vs. tiled CMP; core complexity; power/performance; Snoopy coherence: invalidate vs. update, MSI, MESI, MOESI, MOSI. (12)

COMPILER OPTIMIZATION: Code Optimization Copy Propagation, Dead code elimination ,Loop Optimizations - Loop Unrolling, Induction variable Simplification, Loop Jamming, Loop Unswitching, Scalar Processors, Special locality, Temporal locality, Vector machine, Strip mining, Shared memory model, SIMD architecture, Do par loop, Do single loop. (12)

PARALLEL PROGRAMMING: Introduction to MPI: Functional Parallelism – Collectives – Data types – Communicators – Process Management – One sided communication – OpenMP, Loop parallelism – Controlling thread data – Reductions - Synchronization - Affinity. (11)

Total L: 45

REFERENCES:

1. Shameem Akhter and Jason Roberts, “Multi-core Programming- Increasing Performance through Software Multi-Threading”, Intel Press,USA,2013.
2. Michael J Quinn, “Parallel programming in C with MPI and OpenMP”, McGraw Hill, New York,2012.
3. J.L.Hennessy and D.A.Patterson.“Computer Architecture:A Quantitative Approach”, Morgan Kaufmann publishers,NewYork, 2011.
4. Victor Eijkhout, “Parallel Programming in MPI and OpenMP”, Lulu, USA, 2017.
5. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques, & Tools with Gradiance”, Pearson, UK, 2007

21NN26 NATURAL LANGUAGE PROCESSING

3 0 0 3

INTRODUCTION: Introduction to NLP, Text Processing, NLP Applications, Information Retrieval, Grammar-based Language Models, Statistical Language Models. (11)

NLP PARTS OF SPEECH TAGGING: Morphology and Finite State Transducers, Part of speech Tagging, Rule-Based Part of Speech Tagging, Markov Models: Hidden Markov Models, Build Parts of speech using Hidden Markov Models. (12)

SYNTAX PARSING AND SEMANTIC ANALYSIS: Syntax Parsing, Grammar formalisms and tree banks, Parsing with Context Free Grammars, Features and Unification, Statistical parsing and probabilistic CFGs (PCFGs) - Lexicalized PCFGs, Semantic Analysis, Lexical semantics, Word-sense disambiguation, Supervised and Unsupervised Approaches, Compositional semantics Semantic Role Labelling and Semantic Parsing, Discourse Analysis. (12)

APPLICATIONS: Named entity recognition and relation extraction, IE using sequence labeling, Machine Translation (MT), Basic issues in MT, Statistical translation, Word alignment , phrase-based translation , Question Answering. (10)

Total L: 45

REFERENCES:

1. Daniel Jurafsky and James H Martin, “Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, Prentice Hall, USA, 2014.
2. Ela Kumar, “Natural language processing”, IK International Pvt Ltd,New Delhi, 2011.
3. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, UK, 2008.
4. Bates M, Weischedel RM, “Challenges in natural language processing”, Cambridge University Press, UK, 2006.
5. James Allen, “Natural Language Understanding”, Benjamin /Cummings publishing company, Netherlands, 2003.

21NN27 NETWORK ALGORITHMS

3 0 0 3

INTRODUCTION: Network Flow Problems, Applications, Paths, Trees, And Cycles: Notation and Definitions, Network Representations, Network Transformations, Algorithm Design And Analysis: Complexity Analysis, Developing Polynomial-Time Algorithms, Search Algorithms, Flow Decomposition Algorithms. (12)

SHORTEST PATHS LABEL-SETTING ALGORITHMS: Applications, Tree of Shortest Paths, Shortest Path Problems in Acyclic Networks, Dijkstra's Algorithm, Dial's Implementation, Heap Implementations, Radix Heap Implementation. (10)

SHORTEST PATHS LABEL-CORRECTING ALGORITHMS: Optimality Conditions, Generic Label-Correcting Algorithms, Special Implementations of the Modified Label-Correcting Algorithm, Detecting Negative Cycles, All-Pairs Shortest Path Problem, Minimum Cost-to-Time Ratio Cycle Problem. (10)

MINIMUM SPANNING TREES: Applications, Optimality Conditions, Kruskal's Algorithm, S Prim's Algorithm, Sollin's Algorithm, Minimum Spanning Trees and Matroids, Minimum Spanning Trees and Linear Programming, Computational Testing of Algorithms. (13)

Total L: 45

REFERENCES:

1. Ravindra K. Ahuja, Thomas L. Magnanti and James B. Orlin "Network Flows: Theory, Algorithms, and Applications", Prentice Hall, New Jersey, 2002.
2. Jungnickel and Dieter, "Graphs, Networks and Algorithms", Springer, 2013
3. Robert Endre Tarjan, "Data Structure and Network Algorithms", Murray Hill, New Jersey, 1983.
4. Alan Dolan and Joan Aldous, "Networks and Algorithms: An Introductory Approach", Wiley-Blackwell, USA, 1993.

21NN28 SERVICE ORIENTED ARCHITECTURE

3 0 0 3

INTRODUCTION: Common Characteristics and principles of SOA, Governance, Comparison of SOA with client server and Distributed architectures, Technical and business benefits of SOA, Web services protocol stack and Microservices, Applications using SOA. (11)

SOAP AND RESTFUL WEB SERVICES: XMLandXML Schema, Web services components: SOAP, UDDI and WSDL, Message processing, MIME attachments, ,REST Architectural principles, SOAP Vs REST, writing RESTful APIs with JSON, XML Vs JSON, SOAP implementation : JAX-WS, REST implementation : JAX-RS. (12)

MICRO SERVICES AND SOA EXTENDED PLATFORMS: Benefits of Micro services, Micro service system design model, Adopting microservices in practice, Microservices, REST and Web service API Integration, Message passing. Business Process Languages: WS-BPEL, WS-CDL, SOA support in J2EE, SOA support in .NET, WS interoperability Technologies, WS Enhancements. (11)

WEB SERVICES SECURITY: WS overarching concern, Core concepts, Challenges, Threats and remedies, Securing the communication layer, Message level security, WS security framework, WS security policy, WS trust, WS secure conversation, Data level security, XML encryption, XML signature. Current trends. (11)

Total L: 45

REFERENCES:

1. Eric Newcomer, "Understanding Web Services: XML, WSDL, SOAP and UDDI", Addison Wesley, USA, 2017.
2. Irakli Nadareishvili, Ronnie Mitr and Matt McLart,"Microservice Architecture: Aligning Principles, Practices, and Culture", O'ReilyMedia, USA, 2016
3. Sanjay Patni, "Pro RESTful APIs: Design, Build and Integrate with REST, JSON, XML and JAX-RS", Springer, USA, 2017.
4. Bill Burke, "RESTful Java with JAX-RS 2.0", O'Reilly, USA, 2014.
5. Greg Lomow and Eric Newcomer, "Understanding SOA with Web Services", Pearson Education, New Delhi, 2013.

21NN29 SOFTWARE DEFINED NETWORKS

3 0 0 3

INTRODUCTION: Packet switching terminology, Modern Data Center, Traditional Switch Architecture, Autonomous and Dynamic Forwarding Tables, SDN: Evolution of Switches and Control Planes-Implications for Research and Innovation-Data Center Innovation and Needs. (11)

CONTROL AND DATA PLANES: Control Plane and Data Plane, Moving Information between Planes, Distributed Control Planes, Centralized Control Planes, Data Center Concepts and Constructs: Multitenant Data Center, SDN Solutions for Data Center Network. (11)

OPEN FLOW: Wire Protocol, Replication, FAWG, Config and Extensibility, Architecture, Hybrid Approaches, SDN Controllers: General Concepts - Mininet, NOX/POX, Trema, Ryu, Layer 3 Centric, OpenDaylight SDN Controller, (11)

NETWORK FUNCTION VIRTUALIZATION: Virtualization and Data Plane I/O, Services Engineered Path, Service Locations and Chaining, NFV at ETSI, NFV Standards (SOL and IFA), Management and Network Orchestration, Non-ETSI NFV work. Network Programmability- Modern Programmatic Interfaces, I2RS, Modern Orchestration, Building SDN Framework. Open Source NFV Orchestrators: Open Network Automation Platform (ONAP), Open MANO Orchestrator and OpenStack Cloud Controller. (12)

Total L: 45

REFERENCES:

1. Jim Doherty, "SDN and NFV Simplified A Visual Guide to understanding SDN and NFV", Pearson Education, Indiana, 2016.
2. Paul Goransson and Chuck Black and Morgan Kaufmann, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann,USA,2014.
3. FeiHu , "Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, USA,2014.

4. Thomas D. Nadeau and Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”,O'ReillyMedia,USA, 2013.
5. Tom Fifield, Diane Fleming and Anne Gentle, “OpenStack Operations Guide: Set Up and Manage Your Openstack”, O'Reilly, USA, 2014

21NN30 AGILE METHODOLOGY

3 0 0 3

INTRODUCTION: Theories for Agile management ,Agile software development ,Traditional model vs agile model, Classification of agile methods , Agile manifesto and principles, Agile culture, Ethics, Agile Project management: Project Selection, Planning approach - velocity, Time, cost and functionality, Estimation Techniques, Retrospectives, Project Charter , Agile team interactions, Agile documentations, Open source Project Management Tools. (12)

AGILE PROCESSES: Lean production – SCRUM Framework: Roles - User stories - Product backlogs - Activities and artifacts - Sprint, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices, Story card Maturity Model(SMM), Agile decision making , Earl's schools of KM, Agile Open source SCRUM tools. (11)

AGILITY AND REQUIREMENT ENGINEERING: Impact of Agile Processes in RE, Current Agile Practices, Managing Unstable Requirements, Requirements Elicitation, Agile Requirements Abstraction Model, Requirements Management in Agile Environment, Agile Requirements Prioritization, Concurrency in Agile Requirements Generation. (11)

AGILE PRODUCT DEVELOPMENT AND TESTING: Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD, Devops, Agile Test Driven Development, Agile Approach to Quality Assurance, Agile Approach in Global Software Development. (11)

Total L: 45

REFERENCES:

1. Mike Cohn, “Agile Estimating and Planning”, Pearson Education Inc, India, 2016.
2. John C. Goodpasture,“ Project Management the Agile Way”, J. Ross Publishing, USA, 2016.
3. Andrew Stellman and Jennifer Greene ,”Learning Agile: Understanding Scrum, XP, Lean, and Kanban”, O'Reilly Media, USA,2017.
4. David J. Anderson and Eli Schragenheim, “Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results”, Prentice Hall, USA, 2018.
5. Charles G. Cobb, “The Project Manager's Guide to Mastering Agile: Principles and Practices for an Adaptive Approach”, Wiley, New Jersery, 2017.

21NN31 GAME PROGRAMMING

3 0 0 3

3D GRAPHICS FOR GAME PROGRAMMING 3D Transformations, Quaternions, 3D Modeling and Rendering, Ray Tracing, Shader Models, Lighting, Color, Texturing, Camera and Projections, Culling and Clipping, Character Animation, Physics-based Simulation, Scene Graphs. (11)

GAME ENGINE DESIGN Game engine architecture, Engine support systems, Resources and File systems, Game loop and real-time simulation, Human Interface devices, Collision and rigid body dynamics, Game profiling**.** (12)

GAMING PLATFORMS AND FRAMEWORKS: 2D And 3D Game Development Using Flash, DirectX, Java, Python, Game Engines – DX Studio, Unity. (11)

GAME DEVELOPMENT: Developing 2D And 3D Interactive Games Using DirectX, Python – Isometric And Tile Based Games, Puzzle Games, Single Player Games, MultiPlayer Games. (11)

Total L: 45

REFERENCES:

1. Mike McShaffrfy and David Graham, “Game Coding Complete”, 4th Edition, Cengage Learning, PTR, New Delhi, 2017
2 Jason Gregory, “Game Engine Architecture”, CRC Press / A K Peters, Boca Raton, 2015.
3. RadhaShankarmani, Saurabh Jain and Gaurang Sinha, “Game Architecture and Programming”, Wiley India Pvt Ltd., New Delhi, 2012.
4. Ernest Adams and Andrew Rollings, “Fundamentals of Game Design”, 2ndEdition Prentice Hall / New Riders, New Delhi, 2009.

21NN32 5G COMMUNICATION NETWORKS

3 0 0 3

INTRODUCTION: Wireless Communication technologies evolution, LTE Advanced pro, 5G Roadmap and Use Cases, Pillars of 5G, Allocation of New Spectrum for 5G, Spectrum Sharing, 5G Infrastructure PPP, 5G Innovation Centre. (8)

5G SYSTEM AND SECURITY: 5G Architecture, Telco Cloud and Network Function Virtualization, 5G Core and RAN virtualization, Internet of Things and Context Awareness, Networking Reconfiguration and Virtualization Support, Mobility, Network Resource Provisioning, Emerging Approach for Resource Over Provisioning, Security for 5G Communications. (12)

5G RADIO AND COOPERATION FOR NEXT GENERATION WIRELESS NETWORKS :5G NR QoS architecture, QoS attribute and QoS flow, Drivers to increase network capacity and coverage, Self Organizing Network(SON),Small Cells, Capacity Limits and Achievable Gains with Densification, Cooperative Diversity and Relaying Strategies, Case Study: NCCARQ. (12)

KEY TECHNOLOGIES FOR 5G WIRELESS NETWORKS: Cognitive Radio Technology in 5G Wireless, Spectrum Optimization using Cognitive Radio, Relevant Spectrum optimization literature in 5G, Cognitive Radio and Carrier Aggregation Energy Efficient Cognitive Radio Technology, Key Requirements and Challenges for 5G Cognitive Terminals, Distributed Massive MIMO, Software Defined Networking(SDN), Network Slicing. (13)

Total L: 45

REFERENCES:

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”,Wiley, USA, 2015.
2. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge UniversityPress, UK, 2016.
3. Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, “5G System Design – Architectural and Functional Considerations and Long Term Research”, Wiley, USA, 2018
4. Wei Xiang, KanZheng and Xuemin Shen, “5G Mobile Communications”, Springer, 2017.

21NN33 PARALLEL AND DISTRIBUTED ALGORITHMS

3 0 0 3

INTRODUCTION: Need for Parallel Processing, Data and Temporal Parallelism ,Models of Computation, RAM and PRAM Model, Shared Memory and Message Passing Models, Processor Organizations, PRAM Algorithm: Parallel Algorithms for Reduction – Prefix Sum – List Ranking – Preorder Tree Traversal –Searching -Sorting – Merging Two Sorted Lists – Matrix Multiplication – Graph Coloring -Graph Searching (12)

PARALLEL ALGORITHMS: SIMD algorithms: 2D Mesh SIMD Model – Parallel Algorithms for Reduction – Prefix Computation – Selection -Odd-Even Merge Sorting – Bitonic Merge Sort – Matrix Multiplication – Minimum Cost Spanning Tree, MIMD algorithms: UMA Multiprocessor Model -Parallel Summing on Multiprocessor- Matrix Multiplication on Multiprocessors and Multicomputer – Parallel Quick Sort – Mapping Data to Processors. (12)

DISTRIBUTED ALGORITHMS: Introduction, Waves: Traversal algorithm, Tree algorithm, Echo algorithm-Termination detection algorithm-Garbage collection- Distributed routing algorithm - Consensus and agreement algorithms- Designing distributed systems: Google case study (10)

DISTRIBUTED TRANSACTIONS ALGORITHMS: Flat and nested distributed transactions, Concurrency control, Actor model, Distributed deadlocks, Replication, Fault tolerance. (11)

Total L: 45

REFERENCES:

1. Michael J. Quinn, “Parallel Computing: Theory & Practice”, Tata McGraw Hill Edition, New York, 2017.
2. Fokkink W, “Distributed algorithms: An intuitive approach”, MIT Press, USA, 2018.
3. Van Steen Maarten and Tanenbaum Andrew S., “Distributed Systems”, Create Space Independent Publishing Platform, USA, 2017.
4. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, “Distributed Systems: Concepts and Design, Pearson Education”, USA, 2017.
5. John L.Hennessy and David A.Patterson, “Computer Architecture: A Quantitative Approach”, ,Morgan kaufmann publishers, USA, 2017.

21NN34 ADVANCED DATABASES

3 0 0 3

INTRODUCTION: Database System Architectures: Parallel Systems- Distributed Systems, Storage: Data Partitioning - Parallel Indexing - Distributed File Systems - Parallel key value stores, Query Processing: Parallel Evaluation of Query Plans - Distributed Query Processing, Transaction Processing: Distributed Transactions - Commit Protocols - Concurrency Control in Distributed Databases (12)

OBJECT BASED AND XML DATABASES: Object Relational Database: Overview of Object Database Concepts - Object Database Extensions to SQL - Object Definition Language (ODL) - Object Database Conceptual Design - Object Query Language (OQL), XML Database: Hierarchical Data Model - XML Documents - DTD - Schema - Extracting XML Documents from Relational Databases - SQL Functions for XML (11)

BLOCKCHAIN DATABASES: Introduction, Blockchain Properties, Cryptographic Hash Functions, Blockchain Transactions, Consensus, Data Management in a Blockchain, Smart Contracts, Performance Enhancement: Sharding - Off-chain transaction processing - Database - style blockchain data structures, Emerging Applications: Trade finance - Accounting and audit (12)

NON RELATIONAL DATABASES: Need for NoSQL databases, Types, ACID and BASE, Key - Value database: Architecture – Implementation – Design, Document database: Basic operations – Types of partitions – Data modeling and query processing – Design, Column based data store: Architecture – Process and protocols – Design, Graph Database: Graphs and network modeling – Operations on graph – Types – Design. (10)

Total L: 45

REFERENCES:

1. Abraham Silberschatz, Henry F Korth and Sudarshan S, “Database System Concepts”, Tata McGraw Hill, New Delhi,2019.
2. Ramez Elmasri and Shamkant B Navathe, “Fundamentals of Database Systems”, Pearson Education, New Delhi, 2019.
3. Dan Sullivan, “NoSQL for Mere Mortals”, Pearson Education, New Delhi, 2015.
4. KristinaChodorow and Michael Dirolf, “MONGODB: The Definitive Guide”, Shroff Publishers,Mumbai, 2018.

21NN35 ATTACKS AND DEFENSE

3 0 0 3

INTRODUCTION: Exploiting vulnerability, Phishing, Zero-day, steps to compromise a system, Mobile phone (iOS / Android attacks), Strategies for compromising a user's identity, DDoS Attacks, DDoS Attack Cases, Mirai Source Code Analysis. (11)

DEFENSE SYSTEMS AND TECHNIQUES: DDoS Defense Challenges and the Approaches, Major DDoS Defense Techniques, Intrusion Response and Intrusion Tolerance, Autonomous Anti-DDoS Network, A2D2 Design and Implementation, A2D2 DDoS Defense Experiments, AnIoTDDoS Botnet Analysis. (11)

CYBER ATTACK AND RECONNAISSANCE: Cyber Attacks, cyber-physical-cyber and physical-cyber-physical attacks, cyber security threats and challenges. Understanding Cyber security Kill Chain, Threat Life Cycle Management, Tools used in the Cyber Kill Chain Phases. External and internal reconnaissance, Web Browser Enumeration Tools**.** (11)

CYBER DEFENSE MECHANISMS AND CHALLENGES: The defense in depth approach, Defense Mechanism to Self-Adaptive Cyber-Physical Security Systems. Defense against Survivability to Network Strategies, Challenges to Data-Intensive Techniques, Dynamic Modeling on Malware and its defense in Wireless Computer Network**.** (12)

Total L: 45

REFERENCES:

1. George Loukas, “Cyber-Physical Attacks: A Growing Invisible Threat”, Elsevier Science, 2015.
2. Gautam Kumar, Dinesh Kumar Saini, Nguyen Ha HuyCuong, “Cyber Defense Mechanisms: Security, Privacy, and Challenges”, Taylor & Francis Group, 2020.
3. Edward Amoroso, “Cyber Attacks: Protecting National Infrastructure” Elsevier Science, 2012.
4. Martin Gitlin, Margaret J. Goldstein, “Cyber Attack”, Twenty-First Century Books, 2015.

21NN36 DIGITAL IMAGE AND VIDEO PROCESSING

3 0 0 3

INTRODUCTION AND IMAGE ENHANCEMENT: Components of Image Processing System - Image Sampling and Quantization - Basic relationship between pixels. Fourier Transform - Intensity Transformations and Spatial Filtering: Basics - Histogram processing - Smoothing spatial filters - Sharpening spatial filters. Basics of filtering in frequency domain - Image smoothing - Image sharpening - Selective filtering. (11)

IMAGE COMPRESSION AND IMAGE SEGMENTATION: Image compression: Coding Redundancy - Spatial and Temporal redundancy - Compression models Huffman coding - Bit plane coding – Block Transform coding - Predictive coding - Wavelet coding – Image Segmentation: Point, Line and Edge Detection - Thresholding - Region based segmentation, Case study: Character Recognition, paper currency recognition. (11)

VIDEO PROCESSING: Introduction - Sampling - Nyquist Sampling Rule - Digital Filtering – Median Filtering - FIR Filter - Video Scaling – Video Deinterlacing - Entropy, Predictive Coding and Quantization. (11)

VIDEO COMPRESSION: Video Compression Fundamentals - Compressing I-frames, P -frames and B-frames - Video compression encoder and decoder - Video Noise and Compression Artifacts - Salt-and-pepper Noise - Mosquito Noise - Block Artifacts - Motion Segmentation - Motion Estimation, Case study: Face Recognition from Video. (12)

Total L: 45

REFERENCES:

1. Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, Pearson Education, New Delhi, 2014.
2. Anil K Jain, “Fundamentals of Digital Image Processing”, PHI Learning, New Delhi, 2014.
3. Cornelius T. Leondes, "Image Processing and Pattern Recognition", Elsevier Science, UK, 1998.
4. Suhel Dhanani and Michael Parker, "Digital Video Processing for Engineers", ScienceDirect, 2012.
5. Oge Marques, "Practical Image and Video Processing Using MATLAB", Wiley, USA, 2011.
6. A Murat Tekalp, “Digital Video Processing”, Person Education, New Delhi, 2015

21NN37 QUANTUM COMPUTING

3 0 0 3

INTRODUCTION: Fundamentals of Linear algebra, Inner Products and Hilbert Spaces, Hermitian and Unitary Matrices, Tensor Products of Vector Spaces. (9)

QUANTUM MECHANICS: Deterministic Systems, Probabilistic Descriptions and Quantum Systems, Basics of Quantum Theory - Wave Nature of Particles - State Vector - Operators, Postulates of Quantum Mechanics, Dirac Formalism, Stern-Gerlach Experiment, Electron Spin, Superposition of States, Entanglement, Quantum Computation – Bits and Qubits, Classical Gates vs. Quantum Gates, Probabilistic and Quantum Computations. (13)

QUANTUM ALGORITHMS: Deutsch’s Algorithm, Deutsch Jozsa Algorithm, Simon’s Periodicity Algorithm, Grover’s Search Algorithm, Shor’s Factoring Algorithm. (13)

QUANTUM CRYPTOGRAPHY: Quantum Cryptography and Quantum Information Theory, Quantum Key Distribution, BB84 Protocol, Teleportation vs. Superdense Coding, Quantum Programming - IBM Quantum Experience, Quantum Simulators – Qiskit, Microsoft Quantum Katas, Google Cirq, Applications - Quantum Tic-Tac-Toe, Quantum Chess. (10)

Total L: 45

REFERENCES:

1. Michael A. Nielsen and Isaac L. Chuang, “Quantum Computation and Quantum Information”, Cambridge University Press, New Delhi, 2014.
2. David McMahon, “Quantum Computing Explained”, Wiley India Pvt Ltd, New Delhi, 2017.
3. Dan C. Marinescu and Gabriela M. Marinescu, “Approaching Quantum Computing”, Pearson Education, New Delhi, 2009.
4. David J. Griffiths, “Introduction to Quantum Mechanics”, 2nd Edition, Cambridge University Press, New Delhi, 2016.

21NN38 / 21NB21 INFORMATION SYSTEM SECURITY MANAGEMENT

3 0 0 3

INTRODUCTION: Information Security Overview, Threat and Attack Vectors, Types of Attacks, Common Vulnerabilities and Exposure (CVE), Security Attacks, Fundamentals of Information Security, Computer Security Concerns, Information Security Measures, NOS 9001. (11)

FUNDAMENTALS AND DATA LEAKAGE: Key Elements of Networks, Logical Elements of Networks, Critical Information Characteristics, Information States, Work Effectively with Colleagues (NOS 9002), Data Leakage and Statistics, Data Leakage Threats, Reducing the Risk of Data Loss, Key Performance Indicators (KPI), Database Security. (11)

POLICIES, PROCEDURES AND AUDITS: Information Security Policies – Necessity, Key Elements and Characteristics, Security Policy Implementation, Configuration, Security Standards - Guidelines and Frameworks, Case Study: Cyber Security Audit. (11)

ROLES AND RESPONSIBILITIES: Security Roles and Responsibilities, Accountability, Roles and Responsibilities of Information Security Management, Team Responding to Emergency Situation- Risk Analysis Process, Case Study: Popular Standard- ISO/IEC 27001 Information Security Management. (12)

Total L: 45

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21NN39 MIXED REALITY

3 0 0 3

OVERVIEW MIXED REALITY: History of AR - VR– Reality-Virtuality Continuum - AR & VR & MR- Examples of AR/VR/MR - Mixed Reality Steps - MR software ,Toolkits and application programming Interfaces. (9)

HARDWARE DISPLAYS: Head Mount Displays - Handheld Displays - Ambient Projectors - Handheld Projectors - User Case of HOLOLENS -1 & 2- Microsoft Azure and Hololens (12)

MARKERS: Visual Registrations - Global Positioning System - Visual Markers - Markerless Tracking - Acoustical Tracking System - Magnetic and Inertial Sensors - Hybrid system- Examples of setting Markers in MR (12)

USE CASE & MR DEVELOPMENTS: MR use in Engineering Design Module - Training and Employee Education- MR in Sales - Education & Entertainment - MR in unity - MR Azure services : Language translation - Computer vision - Custom Vision - Natural Language understanding - Face recognition - Storage Functions (12)

Total L: 45

References:

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21NN40 DATA MINING AND APPLICATIONS

3 0 0 3

INTRODUCTION: Data Mining Functionalities, Confluence of Data Mining: Machine Learning - Deep Learning, Data Preprocessing: Data Summarization - Data Cleaning - Data Transformation - Data Reduction: Dimensionality Reduction Techniques. (10)

ASSOCIATION MINING AND CLASSIFICATION: Frequent Item Set Mining Methods: Apriori Algorithm - Pattern Growth Approach - Pattern Evaluation Methods, Mining Multilevel and Multidimensional Association, Association and sequence rules, Sequential Pattern analysis. CLASSIFICATION: Decision Tree Induction, Bayes Classification, Rule Based Classification, Classification by Back Propagation, Support Vector Machines, Lazy Learners, Classifier Evaluation. (13)

CLUSTER ANALYSIS: Partitioning Methods: K- Means Method, K- Medoid Method, Hierarchical Methods: Agglomerative Methods, Divisive Methods, BIRCH, Chameleon, Density Based Methods, Evaluation of Clustering. Outlier detection: Outlier Analysis, Detection Methods, Statistical and Proximity based approaches. (11)

APPLICATIONS: Mining complex types: Time-Series, Spatial, Graphs and Networks, Statistical Data Mining, Visual and Audio Mining, Analysis of text patterns, Web mining: Crawlers, Web search, Web usage mining, Web personalization and recommender systems, Privacy, Security and Social impacts of Data Mining. (11)

Total L: 45

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21NN41 DATA ANALYSIS FOR IMAGE AND VIDEO PROCESSING

3 0 0 3

IMAGE REPRESENTATION AND PROPERTIES: Image Representation - Image Digitization - Digital Image Properties - Discrete Fourier Transform - Image Pre-Processing in Spatial and Frequency Domain - Edge Detectors - Corner Detectors - Convolution - Image Restoration - Feature Extraction Filters - Image Recognition Applications - Character Recognition. (11)

IMAGE SEGMENTATION AND SYNTHESIS: Thresholding - K-Means Clustering - Histogram-Based Image Segmentation - Semantic Segmentation Vs. Instance Segmentation - Semantic Segmentation with Convolution Neural Networks, SegNet - Object Segmentation from Images and Videos - Generative Adversarial Networks — Generation of Arbitrary Realistic Images.

(11)

OBJECT DETECTION: Deep Learning for Vision Tasks - Object Detection and Identification of Objects - Convolutional Architectures for Image Categorization, Fine-Grained Recognition, Content-Based Retrieval – YOLO, Mask R-CNN - Face Detection Model using a Deep Convolutional Neural Network. (11)

OBJECT TRACKING AND ACTION RECOGNITION: Challenges of Object Tracking, -Offline and Online Object Tracking - Object Tracking Algorithms: Simple Online and Real-Time Tracking (SORT), Generic Object Tracking using Regression Network (GOTURN), Multi-Domain Network (MDNet), Action Recognition Algorithms: LSTM, 3D ConvNet - Amazon GO, Emotion Recognition. (12)

Total L: 45

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OPEN ELECTIVES THEORY COURSE

21NN91 / 21NB91 COMPUTATIONAL FINANCE

3 0 0 3

RETURNS AND PORTFOLIO OPTIMIZATION: Compute Risk and Returns – How to measure drawdown in stock returns? – How to measure deviations from normality? – Estimating Value at Risk – How to construct Efficient Frontier using Quadprog – Fund Separation Theorem and Capital Market Line – How to construct Max Sharpe Ratio Portfolio- The limits of Portfolio diversification (11)

PORTFOLIO INSURANCE STRATEGIES AND DYNAMIC ALLOCATION: Constant proportion portfolio insurance (CPPI) – Designing and Calibrating CPPI strategies – Liability Driven Investing (LDI) – Performance-Seeking Portfolio and Liability-Hedging Portfolio (PSP/LHP) – Naïve Risk and Dynamic Risk Budgeting (11)

FACTOR INVESTING MODELS: CAPM and Introduction to factor models – Fama-French Models – Factor benchmarks and Style analysis – Difference in cap-weighted benchmarks and smart-weighted benchmarks – How to estimate the covariance matrix ?– How to use factor models to calculate expected returns? – Univariate time series Models (Autoregressive and Moving Average Models) – ARIMA – Forecasting Macro fundamentals – Volatility Models – ARCH & GARCH – Black-Litterman and Risk Parity Portfolios (11)

MACHINE LEARNING ALGORITHMS AND APPLICATIONS IN FINANCE: Supervised and Unsupervised Learning methods– Penalized Regression Techniques: Lasso, Ridge, and Elastic Net – Estimation of factor models with machine learning techniques – Graphical network analysis – Credit risk modelling using logistic/beta regression – Regime Switching Models – Forecasting investment models and Prediction of crash regime (12)

Total L: 45

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