Rajiv Gandhi ProudyogikiVishwavidyalaya Bhopal

M.Tech (Artificial Intelligence & Machine Learning)

Second Semester Syllabus

MTAL 201 – Software Project Management

COURSE OUTCOMES:

After completing the course student should be able to:

1. Demonstrate basic concepts and issues of software project management.
2. Effectively perform Planning, Execution and Evaluation of software projects through managing people, communications and change.
3. Apply mechanisms for monitoring, tracking and risk management of software projects.
4. Design activities necessary to perform quality management and successful completion of Software Projects.

COURSE CONTENTS:

THEORY:

UNIT 1 Project Evaluation and Project Planning: Importance of Software Project Management, Activities Methodologies, Categorization of Software Projects, Setting Objectives, Management Principles, Management Control, Project portfolio Management, Cost, Benefit Evaluation Technology, Risk Evaluation, Strategic Program Management, Stepwise Project Planning.

UNIT 2 Project Life Cycle and Effort Estimation: Software Process and Process Models, Choice of Process Models, Agile Methods: Importance, Extreme Programming, SCRUM; Managing Interactive Processes, Basics of Software Estimation: Effort and Cost Estimation Techniques.

UNIT 3 Activity Planning and Risk Management: Objectives of Activity Planning, Project Schedules, Activities, Sequencing and Scheduling, Network Planning Models, Forward Pass and Backward Pass Techniques, Risk Identification, Assessment, Monitoring, Resource Allocation, Creation of Critical Patterns, Cost Schedules.

UNIT 4 Project Management, Control and Staffing: Framework for Management and Control, Visualizing Progress, Cost Monitoring, Earned Value Analysis, Project Tracking, Change Control, Software Configuration Management, Contract Management, Managing People, Motivation, Decision Making, Team Structures, Communication Genres and Plans, Project Closure: Analysis, Report Generation.

UNIT 5 Quality Management: Introduction, Product versus Process Quality Management, Quality Management Systems and Planning, Process Capability Models, Techniques to Help Enhance Software Quality, Testing and Defect Prevention Planning; Case Studies on Project Management.

TEXT BOOKS RECOMMENDED:

1. Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management", 5th Edition, Tata McGraw Hill, New Delhi, 2012.
2. Pankaj Jalote, "Software Project Management in Practice", Pearson Publication, 2014.

REFERENCE BOOKS:

1. S. A. Kelkar, "Software Project Management: A Concise Study", 3rd Edition, PHI Publication, 2013.
2. Robert K. Wysocki, "Effective Software Project Management", Wiley Publication, 2011.
3. Walker Royce, "Software Project Management", Addison Wesley, 1998.
4. Gopalaswamy Ramesh, "Managing Global Software Projects", McGraw Hill Education (India), 14th Reprint, 2013.

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Second Semester Syllabus

MTAL 202 – Computational Intelligence

Pre-Requisite: Computer Programming
Course Outcomes:
After completing the course student should be able to:

1. Describe in-depth about theories, methods, and algorithms in computation Intelligence.
2. Compare and contrast traditional algorithms with nature inspired algorithms.
3. Examine the nature of a problem at hand and determine whether a computation intelligent technique/algorithm can solve it efficiently enough.
4. Design and implement Computation Intelligence algorithms and approaches for solving real-life problems.

Course Contents:

UNIT 1. Introduction to Computational Intelligence (CI): Basics of CI, History of CI, Adaptation, Learning, Self Organization and Evolution, CI and Soft Computing, CI Techniques; Applications of CI; Decision Trees: Introduction, Training Decision Trees, Evaluation, Splitting Criteria, Decision Tree Induction Algorithms.

UNIT 2. Evolutionary Computation: Genetic Algorithms: Basic Genetics, Concepts, Working Principle, Creation of Offsprings, Encoding, Fitness Function, Selection Functions, Genetic Operators-Reproduction, Crossover, Mutation; Genetic Modeling, Benefits; Problem Solving; Introduction to Genetic Programming, Evolutionary Programming, and Evolutionary Strategies.

UNIT 3. Fuzzy System:Fuzzy Sets: Formal Definitions, Membership Functions, Fuzzy Operators, Fuzzy Set Characteristics, Fuzzy Relations and Composition, Fuzziness and Probability; Fuzzy Logic and Reasoning: Fuzzy Logic, Fuzzy Rules and Inferencing; Fuzzy Controllers: Components of Fuzzy Controllers, Types, Defuzzification.

UNIT 4. Rough Set Theory: Introduction, Fundamental Concepts, Knowledge Representation, Set Approximations and Accuracy, Vagueness and Uncertainty in Rough Sets, Rough Membership Function, Attributes Dependency and Reduction, Application Domain, Hidden Markov Model (HMM),Graphical Models, Variable Elimination, Belief Propagation,Markov Decision Processes.

UNIT 5. Swarm Intelligence: Introduction to Swarm Intelligence, Swarm Intelligence Techniques: Ant Colony Optimization(ACO): Overview, ACO Algorithm;Particle Swarm Optimization(PSO): Basics, Social Network Structures, PSO Parameters and Algorithm;Application Domain of ACO and PSO; Bee Colony Optimization etc.; Hybrid CI Techniques and applications; CI Tools.

Recommended Books:

1. Russell C. Eberhart and Yuhui Shi, Computational Intelligence: Concepts to Implementations, Morgan Kaufmann Publishers, 2007.
2. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Wiley Publishing, 2007.
3. David E. Goldberg, Genetic Algorithm in Search Optimization and Machine Learning, Pearson Education, 2009.
4. Jagdish Chand Bansal, Pramod Kumar Singh, Nikhil R. Pal, Evolutionary and Swarm Intelligence Algorithms, Springer Publishing, 2019.
5. S. Rajeskaran, G.A. VijaylakshmiPai, "Neural Networks, Fuzzy Logic, GeneticAlgorithms Synthesis and Applications", PHI, 2003.

Research Journals:

1. IEEE Transactions on Evolutionary Computation
2. IEEE Transactions on Systems, Man and Cybernetics
3. IEEE Transaction on Neural Networks and Learning Systems
4. IEEE Transaction on Fuzzy Systems
5. IEEE Transactions on Pattern Analysis and Machine Intelligence
6. ACM Transactions on Intelligent Systems and Technology
7. ACM Genetic and Evolutionary Computation Conference (GECCO)
8. ACM Journal of Machine Learning Research

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M.Tech (Artificial Intelligence & Machine Learning)

Second Semester Syllabus

MTAL 203 – Big Data

COURSE OUTCOMES:

After completing the course student should be able to:

1. Understand the concept and challenges of Bigdata and Demonstrate knowledge of big dataanalytics.
2. Explain Hadoop EcoSystem and develop Big Data Solutions using Hadoop EcoSystem.
3. Practice and gain hands on experience on large-scale analyticstools.
4. Understand social networks mining and analyse the social networkgraphs.

COURSE CONTENTS:

THEORY:

UNIT 1 Introduction to Big data, Big data characteristics, Types of big data, Traditional versus Big data, Evolution of Big data, challenges with Big Data, Technologies available for Big Data, Infrastructure for Big data, Use of Data Analytics, Desired properties of Big Data system.

UNIT 2 Introduction to Hadoop, Core Hadoop components, Hadoop Eco system, Hive Physical Architecture, Hadoop limitations, RDBMS Versus Hadoop, Hadoop Distributed File system, Processing Data with Hadoop, Mapreduce Programming, Managing Resources and Application with Hadoop YARN, Apache Spark.

UNIT 3 Introduction to Hive Hive Architecture, Hive Data types, Hive Hive Query Language, Introduction to Pig, Anatomy of Pig, Pig on Hadoop, Use Case for Pig, ETL Processing, Data types in Pig running Pig, Execution model of Pig, Operators, Evalfunction,Data types of Pig.

UNIT 4 Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data architectural patterns, Variations of NOSQL architectural patterns using NoSQL to Manage Big Data.

UNIT 5 Mining social Network Graphs: Introduction Applications of social Network mining, Social Networks as a Graph, Types of social Networks, Clustering of social Graphs Direct Discovery of communities in a social graph.

TEXT BOOKS RECOMMENDED:

1. RadhaShankarmani, M. Vijaylakshmi, " Big Data Analytics", Wiley, Secondedition
2. Seema Acharya, SubhashiniChellappan, " Big Data and Analytics", Wiley, Firstedition

REFERENCE BOOKS:

1. KaiHwang,Geoffrey C., Fox. Jack, J. Dongarra, “Distributed and Cloud Computing”, Elsevier, Firstedition
2. Michael Minelli, Michele Chambers, AmbigaDhiraj, “Big Data Big Analytics”,Wiley

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M.Tech (Artificial Intelligence & Machine Learning)

Second Semester Syllabus

MTAL 204 – Deep Learning

Pre-Requisite: *Machine Learning and ML tools*

Course Outcomes:
After completing the course student should be able to:

1. Describe in-depth about theories, fundamentals, and techniques in Deep learning.
2. Understanding of the on-going research in computer vision and multimedia field.
3. Design and Implement, train, and validate their own deep neural network.
4. Solve and implement the real world problems using deep learning.

Course Contents:

Unit-1 History of Deep Learning, Deep Learning Success Stories, review of Neuron model, activation functions, Perceptron Learning, Multilayer Perceptrons (MLPs), Feedforward Neural Networks,Backpropagation, weight initialization methods,Batch Normalization, Representation Learning,GPU implementation, Decomposition – PCA and SVD.

Unit-2 Deep Feedforward Neural Networks, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad,Adam,RMSProp,Auto-encoder, Regularization in auto-encoders, Denoising auto-encoders, Sparse auto-encoders, Contractive auto-encoders,Variational auto-encoder, Auto-encoders relationship with PCA, Dataset augmentation.

Unit-3 Introduction to Convolutional neural Networks (CNN) and its architectures, CCN terminologies: ReLu activation function, Stride, padding, pooling, convolutions operations, Convolutional kernels, types of layers:Convolutional,pooling,fully connected,Visualizing CNN, CNN examples: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, RCNNetc.Deep Dream, Deep Art. Regularization:Dropout, drop Connect, unit pruning, stochastic pooling, artificial data,injectingnoise in input,early stopping,Limit Number of parameters, Weight decay etc.

Unit-4 Introduction to Deep Recurrent Neural Networks and its architectures, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM), Solving the vanishing gradient problem with LSTMs, Encoding and decoding in RNN network, Attention Mechanism, Attention over images, Hierarchical Attention, Directed Graphical Models.

Unit-5 Introduction to Deep Generative Models,Restricted Boltzmann Machines (RBMs), Gibbs Sampling for training RBMs, Deep belief networks, Markov Networks, Markov Chains,Autoregressive Models: NADE, MADE, PixelRNN, Generative Adversarial Networks (GANs), Applications of Deep Learning inObject detection, speech/ image recognition, video analysis, NLP, medical science etc.

Recommended Books:

1. IanGoodfellow, YoshuaBengio and Aaron Courville; Deep Learning, MIT Press, 2017.
2. Chris Bishop; Pattern Recognition and Machine Learning,Springer publication, 2006
3. Aurelien Geon, “Hands-On Machine Learning with Scikit-Learn and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems”, First Edition, O'Reilly publication, 2017.
4. Francois Chollet, "Deep Learning with Python", First Edition, Manning Publications, 2018.
5. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", First edition,O'Reilly Edition, 2016.

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Second Semester Syllabus

MTAL 205 *(A)* Reinforcement Learning

Pre-Requisite: *Machine Learning and ML Tools*

Course Outcomes:
After completing the course student should be able to:

1. Define the key features of reinforcement learning that distinguishes it from others machine learning techniques.
2. Describe multiple criteria for analyzing RL algorithms and evaluate algorithms on RL performance metrics.
3. Design and Implement, train, and validate their own RL models.
4. Solve and implement the real world problems using reinforcement learning.

Course Contents:

UNIT 1 Introduction to Reinforcement Learning (RL), Elements of RL, RL framework and applications, Introduction to immediate RL, RL tabular solution methods: Bandit Algorithms, Bandit optimalities, Contextual bandits, Value function based methods,Gradient Bandit algorithms, UCB, UCB Theorem, Concentration bounds, Median elimination, Thompson sampling.

UNIT 2 Policies planning, policy evaluation, Policy search, Policy iteration, value iteration,Policy Gradient Methods,Markov Decision Process (MDP), MDP Formulation, MDP modelling, Bellman Equations & Optimality Proofs, Bellman optimality equation, Cauchy sequence & Green's equation, Banach fixed point theorem, Convergence proof, Dynamic Programming, LPI convergence.

UNIT 3 Monte Carlo(MC) methods, Control in MC, Off Policy MC, MC tree search, Temporal Difference Learning, , Q-learning, Eligibility traces, Backward view of eligibility traces, Eligibility trace control, n-step bootstrapping,

UNIT 4 Function approximation, Linear parameterization, State aggregation methods, Function approximation, Afterstatevalue functions, Batch RL: LSTD & LSTDQ, LSPI & Fitted Q, DQN, Fitted Q & Policy Gradient Approaches, DQN & Fitted Q-iteration, Actor critic &reinforce, Policy gradient with function approximation

UNIT 5 Hierarchical reinforcement learning, Types of optimality, Semi-Markov decision processes, Options, Learning with options, Hierarchical abstract machines, MAXQ,

MAXQ value function decomposition, Option discovery, POMDP introduction, Solving POMDP, applications of RL.

Recommended Books:

1. "Reinforcement Learning: An Introduction" by Andrew Barto and Richard S. Sutton, Second Edition, MIT Press, 2018
2. "Deep Reinforcement Learning Hands-On: Apply Modern RL Methods, with Deep Q-networks, Value Iteration, Policy Gradients, TRPO, AlphaGo Zero and More" by Maxim Lapan, Third Edition, Packt Publishing, 2020
3. Marco Wiering and Martijn van Otterlo, “Reinforcement Learning: State-of-the-Art (Adaptation, Learning, and Optimization)” Springer publication, 2012

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Second Semester Syllabus

MTAL 204 *(B)* Modern Computer Networks

COURSE OUTCOMES:

After completing the course student should be able to:

1. Visualize a network issues inside out and able to debug the networking errors.
2. Apply various protocols and algorithms to design and implement a computer netwrok
3. Estimate the performance of various networking devices and can argue on efficiency relatd issues.
4. Identify various challenges of the implemented network and can present optimized solutions for those challenges.

COURSE CONTENTS:

THEORY:

UNIT 1 Introduction to computer networks & their uses, Different topologies. ISO-OSI model: Layered Architecture, Peer-to-Peer processes and encapsulation, Function and Services of OSI layers; The Physical layer: Digital Signals, Transmission Impairments and Maximum data rate of a channel, Shennons theorem, Nyquist theorem. Circuit, Packet and Message switching, virtual Circuit. The data link layer: Design issues & function, Error detection & correction, Hamming code & CRC codes, Framing: Fixed size and Variable size Frame, Bit stuffing and Byte stuffing. Data link layer protocols: Simplest, Stop and Wait, Sliding window protocols, The medium access sublayer: Static and Dynamic Channel Allocation, Protocols: ALOHA Protocol, CSMA (CSMA/CD, CSMA/CA).

UNIT 2 IEEE 802.3, LAN Devices: HUB, Switches- Learning, Cut-Through and store and forward switches, Internetworking Devices: Routers & gateways. The network layer: Design issues and functions,. TCP/IP Protocol Architecture: ARP/RARP, IP addressing, IP Datagram format and its Delivery, Routing table format.

UNIT 3 IPv4 fragmentation, Subnet, Supernet, CIDR. Different ICMP messages. Routing algorithms: Shortest path routing, Flooding, LSR, Distance Vector Routing, Hierarchical Routing. Routing Protocols: BGP- Concept of hidden network and autonomous system, An Exterior gateway protocol, Different messages of BGP. Interior Gateway protocol: RIP, OSPF.

UNIT 4 Transport layer: Multiplexing and ports, TCP: Segment format, Sockets, Synchronization, Three Way Hand Shaking, Variable window size and Flow control, Timeout and Retransmission algorithms, Connection Control, Silly window Syndrome, UDP: Message

Encapsulation, Format and Pseudo header. Wireless LAN: Transmission Medium For WLANs, MAC problems, Hidden and Exposed terminals, Near and Far terminals, Infrastructure and Ad hoc Networks, IEEE 802.11- System arch, Protocol arch, Physical layer, Concept of spread spectrum, MAC and its management, Power management.

UNIT 5 Mobile IP: unsuitability of Traditional IP; Goals, Terminology, Agent advertisement and discovery, Registration, Tunneling techniques. Ad hoc network routing: Ad hoc Network routing v/s Traditional IP routing, types of routing protocols, Examples: OADV, DSDV, DSR, ZRP. Mobile Transport Layer: unsuitability of Traditional TCP; I-TCP, S-TCP, MTCP.

TEXT BOOKS RECOMMENDED:

1. Tanenbaum A. S., "Computer Networks", Pearson Education, 5th edition, 2011.
2. Comer, "Internetworking with TCP/ IP Vol-1", Pearson education, 6 th Edition, 2015.
3. Jochen Schiller "Mobile communication", 2nd edition, Pearson education, 2008

REFERENCE BOOKS:

1. W. Richard Stevens, "TCP/IP Illustrated Vol-1 ", 2nd Edition, Addison-Wesley, 2011.

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Second Semester Syllabus

MTAL 204 *(C)* Expert System

Course Objectives:

After completing the course, student should be able to:

- Understand the basics of Expert Systems and its terminology.
- Learn about programming languages and tools for expert systems
- Apply the different knowledge representation techniques as per requirements.
- Design and implement real world problems using expert system.

UNIT I : Basics of Expert Systems : Introduction to expert system, need and history of expert systems, components of expert system, application of expert systems, types of expert system, advantages and limitation of an expert system, Organization, Characteristics, Prospector and Features of an expert system,.

UNIT II: Expert System Tools: Knowledge Representation and reasoning in expert systems, Expert systems tools, Programming languages for expert systems, Expert system shells, System building aids, Support facilities, Stages in development of expert system tools, knowledge engineering languages and tools.

UNIT III: Building of an Expert Systems: Tasks in building expert systems, general stages in the development of an expert system, types of errors in the development stages, Choosing a tool for building expert systems, Acquiring the knowledge from the experts, Expert system development life cycle, Handling of uncertainties. Truth Maintenance Systems

UNIT IV : Difficulties in Development of Expert Systems: Difficulties such as lack of resources, inherent limitations of expert systems, Common pitfalls in planning of expert systems, Pitfalls in choosing the domain of expert systems

UNIT V: Expert Systems in Market Place: Where is expert systems work being done, High performance expert systems used in research, business, XCON, case studies.

Reference Books:

1. Stuart Russel and Peter Norvig, ‘Artificial Intelligence A Modern Approach’, Second Edition, Pearson Education, 2003 / PHI.

2. Donald A.Waterman, ‘A Guide to Expert Systems’, Pearson Education.

3. Foundation Artificial Intelligence & Expert Systems by VS Janakiraman K, Sarukesi P Gopalakrishnan Macmillan series in computer science

4. . Janakiraman, K.Sarukesi, ‘Foundations of Artificial Intelligence and Expert Systems’, Macmillan Series in Computer Science.

5. W. Patterson, ‘Introduction to Artificial Intelligence and Expert Systems’, Prentice Hall of India, 2003.

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Second Semester Syllabus

MTAL 204 *(D)* Bioinformatics Computing

Pre-Requisite: Basics of statistic & probability

Course Outcomes:

After completing the course student should be able to:

1. Describe the fundamental principles and theories of bioinformatics computing.
2. Compare and analyze the different bioinformatics methodology.
3. Solve problem in biology and medicine.
4. Solve the real world problems using bioinformatics.

Course Contents:

UNIT 1. Introduction to bioinformatics, Proteomics, Strategies for Protein Separation, Secondary structure and Tertiary structure, Strategies for Protein Identification, Quantitation, Structural Proteomics, Protein Chips, Methods of Protein Engineering.

UNIT 2. Introduction to Molecular biology, Molecular Dynamics, Monte Carlo and Molecular Dynamics in Various Ensembles. System biology, biological sequences, patterns in biological sequences, genetic, genetic alterations and genomics, Engineering of Macromolecules.

UNIT 3. DNA, RNA, Application of Recombinant DNA Technology.DNA re-association kinetics, repetitive and unique sequences, kinetics and sequence complexities, DNA polymorphism, nucleotides, DNA sequences, DNA engineering.

UNIT 4. Biological database, DNA and protein database, DNA Data Bank of Japan (DDBJ), DHCP database,

UNIT 5. Applications of Bioinformatics in molecular medicine, personalized medicine, preventative medicine, gene therapy, agriculture, animal, waste cleanup etc. case studies.

Recommended Books:

1. Bryan Bergeron M.D., Bioinformatics Computing, Pearson publication, 2002.
2. Hancock J M, Bioinformatics and Computational Biology, Second Edition, Wiley publication,2014.
3. David Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition,2004
4. Vince Buffalo, Bioinformatics Data Skills, O'Reilly publication,2015.