Syllabus for M. Tech. in Computer Science and Engineering in Artificial Intelligence

M. Tech. in Computer Science and Engineering in Artificial Intelligence					
Semester - I					
Code	**Course Title**	**Hours per week**			**Credits**
		L	**T**	**P**	
PGCSE(AI)101	**Program Core I -** Artificial Intelligence	4	0	0	4
PGCSE(AI)102	**Program Core II-** Machine Learning	4	0	0	4
PGCSE(AI)103	**Program Core III-** Expert System	4	0	0	4
PGCSE(AI)104	**Program Core IV-** Mathematics for Computer Science	4	0	0	4
PGCSE(AI)105	**Program Elective I –** [A] Data Preparation and Analysis [B] Data Visualization [C] Soft Computing	4	0	0	4
PGCSE(AI)191	**Laboratory I –** Python and Artificial Intelligence Lab	0	0	4	2
PGCSE(AI)192	**Laboratory II –** Machine Learning Lab	0	0	4	2
PGCSE(AI)193	Seminar based on Literature Survey	0	2	0	1
Total		20	2	8	25
Semester - II					
Code	**Course Title**	**Hours per week**			**Credits**
		L	**T**	**P**	
PGCSE(AI)201	**Program Core V –** Knowledge Representation and Reasoning	4	0	0	4
PGCSE(AI)202	**Program Core VI –** Deep Learning	4	0	0	4
PGCSE(AI)203	**Program Core VII –** Advanced Algorithms	4	0	0	4
PGCSE(AI)204	**Program Core VIII –** Research Methodology and IPR	4	0	0	4
PGCSE(AI)205	**Program Elective II –** [A] Cloud and Edge Computing [B] Mobile Computing	4	0	0	4

	[C] Advanced Data Mining [D] Geographical Information System [E] Cyber Law and Security Policies				
PGCSE(AI)291	**Laboratory I –** Knowledge Representation and Reasoning Lab	0	0	4	2
PGCSE(AI)292	Seminar on Term Paper Leading to Project	0	2	0	1
Total		20	2	4	23

Semester - III					
Code	**Course Title**	**Hours per week**			**Credits**
		L	**T**	**P**	
PGCSE(AI)301	**Program Elective III –** [A] Computer Vision and Robotics [B] Digital Signal Processing [C] Natural Language Processing [D] Big Data Analytics	4	0	0	4
PGCSE(AI)302	**Open Elective I –** [A] Business Analytics [B] Project Management and Entrepreneurship [C] Industrial Safety [D] Operation Research	4	0	0	4
PGCSE(AI)391	Dissertation I + Defence of Project I	0	0	16	8 + (4) = 12
Total		8	0	18	20

Semester - IV					
Code	**Course Title**	**Hours per week**			**Credits**
		L	**T**	**P**	
PGCSE(AI)491	Dissertation II + Defence of Project II	0	0	32	16 + (8) = 24
PGCSE(AI)492	Comprehensive Viva	0	0	0	4
Total		0	0	0	28

Paper Name:	Artificial Intelligence
Paper Code:	PGCSE (AI) 101
Credit:	4
Duration:	36 hours

Module 1: [4 hours]

Introduction, Overview of Artificial intelligence- Problems of AI, AI technique, Tic - Tac - Toe problem.

Module 2: [4 hours]

Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents.

Module 3: [4 hours]

Problem Solving, Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.

Module 4: [6 hours]

Search techniques, solving problems by searching: problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies.

Module 5: [6 hours]

Heuristic search strategies, Greedy best-first search, A* search, Memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems.

Module 6: [4 hours]

Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alphabeta pruning, additional refinements, iterative deepening

Module 7: [4 hours]

Dempster-Shafer theory, Fuzzy sets & fuzzy logics. Planning [2], Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.

Module 8: [2 hours]
Natural Language processing, Introduction, Syntactic processing, semantic analysis, discourse & pragmatic processing

Module 9: [2 hours]

Forms of learning, inductive learning, learning decision trees, explanation based learning, learning using relevance information, neural net learning & genetic learning

Text Books:

1. A classical approach to Artificial Intelligence, Munesh Trivedi, Khanna Book Publishing, New Delhi.
2. Artificial Intelligence, Ritch & Knight, TMH
3. Artificial Intelligence A Modern Approach, Stuart Russel Peter Norvig Pearson
4. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI
5. Poole, Computational Intelligence, OUP
6. Logic & Prolog Programming, Saroj Kaushik, New Age International
7. Expert Systems, Giarranto, VIKAS
8. Artificial Intelligence, Russel, Pearson

Paper Name:	Machine Learning
Paper Code:	PGCSE (AI) 102
Credit:	4
Duration:	36 hours

Module 1: [9 hours]

Supervised Learning (Regression/Classification)

- Basic methods: Distance-based methods, Nearest- Neighbours, Decision Trees, Nave Bayes
- Linear models: Linear Regression, Logistic Regression, Generalized Linear Models
- Support Vector Machines, Nonlinearity and Kernel Methods
- Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Module 2: [8 hours]

Unsupervised Learning

- Clustering: K-means/Kernel K-means
- Dimensionality Reduction: PCA and kernel PCA
- Matrix Factorization and Matrix Completion
- Generative Models (mixture models and latent factor models)

Module 3: [6 hours]

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Module 4: [4 hours]

Sparse Modelling and Estimation, Modelling Sequence/Time- Series Data, Deep Learning and Feature Representation Learning

Module 5: [4 hours]

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi- supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

Module 6: [5 hours]

Recent trends, classification applications in various methods for learning techniques, applications of machine learning

Text Books:

1. Jeeva Jose, Machine Learning, Khanna Book Publishing, New Delhi.
2. Rajiv Chopra, Machine Learning, Khanna Book Publishing, New Delhi.
3. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
5. Christopher Bishop, Pattern Recognition and Machine, Springer, 2007

Paper Name:	Expert System
Paper Code:	PGCSE (AI) 103
Credit:	4
Duration:	36 hours

Module 1: [4 hours]

What is AI? The importance of AI, Early works in AI, AI and Related fields. Knowledge: Importance of Knowledge, knowledge-based system representation, organization, manipulation

Module 2: [4 hours]

Predicate Logic (well formed formulas, quantifiers, Prenex Normal Form, Skolemization , Unification, Modus pones, Resolution refutation – various strategies)

Module 3: [4 hours]

Handling uncertainty: Probabilistic reasoning: Bayes Net, Dempster Shafer Theory, Use of certainty factors, Fuzzy Logic, Non monotonic reasoning, Dependency directed backtracking, Truth maintenance systems, Learning : Concept of learning, Learning automation, The Genetic algorithm, Learning by induction, Neural

Networks: Hopfield Networks, Perceptrons- Learning algorithm, Back propagation Network, Boltzman Machine, Recurrent Networks

Module 4: [6 hours]

Planning: Components of Planning System, Plan Generation Algorithms: Forward state propagation, Backward state propagation, Nonlinear planning using constraint posting, Natural Language Processing: Syntactic analysis, Top down and bottom up parsing, Augmented Transition Networks, Semantic analysis, case grammars

Module 5: [6 hours]

Expert System: Need and Justification for expert systems- cognitive problems, Expert System Architectures (Rule based systems, Non production system, knowledge acquisition, Case studies: MYCIN

Module 6: [6 hours]

Ontology and Description Logics A Description Logic, Normalisation, Structure Matching, Classification, A-box Reasoning, Extensions, ALC, Further Extensions. Inheritance Taxonomies and Inheritance, Beliefs, Credulous and Skeptical Reasoning

Module 7: [6 hours]

Default Reasoning Introduction to Default Reasoning, Circumscription, Minimal Models, The Event Calculus Revisited, Default Logic, Autoepistemc Logic. Reasoning in Multi-agent Systems Epistemic Logic: Kripke Semantics in a MultiAgent Scenario, The Muddy Children Puzzle

Text Books:

1. Joseph C. Giarratano, Gary D. Reily, Expert systems: Principles and Programming, PWS; 3rd edition
2. D. A. Waterman, A Guide to Expert Systems (Teknowledge Series in Knowledge Engineering), Addison Wesley

Paper Name:	Mathematics for Computer Science
Paper Code:	PGCSE (AI) 104
Credit:	4
Duration:	36 hours

Module 1: [7 hours]

Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains

Module 2: [7 hours]

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood

Module 3: [8 hours]

Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of overfitting model assessment.

Module 4: [3 hours]

Graph Theory: Isomorphism, Planar graphs, graph colouring, Hamilton circuits and Euler cycles, Permutations and Combinations with and without repetition, specialized techniques to solve combinatorial enumeration problems

Module 5: [7 hours]

Information Technology Applications, Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

Module 6: [4 hours]

Recent Trends in various distribution functions in the mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision

Text Books:

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Wiley
3. M. Mitzenmacher and E. Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis
4. Alan Tucker, Applied Combinatorics, Wiley
5. R. Agor, Elements of Mathematical Analysis, Khanna Book Publishing.

Paper Name:	Data Preparation and Analysis
Paper Code:	PGCSE (AI) 105A
Credit:	4
Duration:	36 hours

Topics to be covered

1. Python Programming Language
2. Data import & export
3. Data interpretation by descriptive statistics
4. Data interpretation by visualization
5. Data preprocessing
6. Dimensionality reduction
7. Training , validation, testing

8. End to end dataflow pipeline

Text Books:

1. V.K. Jain, Data Sciences & Analytics, Khanna Book Publishing.
2. W McKinney, Python for Data Analysis, O'Reilly
3. Brockwell and Davis, Introduction to Time Series and Forecasting, Springer
4. G James, D Witten, T Hastie, R Tibshirani, An Introduction to Statistical Learning, Springer
5. A Geron, Hands-on Machine Learning with Scikit-Learn and Tensorflow, O'Reilly

Paper Name:	Data Visualization
Paper Code:	PGCSE (AI) 105B
Credit:	4
Duration:	36 hours

Module 1: [2 hours]

About data visualization, The need for data visualization, Brief history of data visualization

Module 2: [4 hours]

Different types of data, Measures of Centrality, Measures of Dispersion, Measures of Association

Module 3: [6 hours]

Stem-and-Leaf Plot, Pie Chart, Bar Graph, Histogram, Line Chart, Box Plot, Analysis and drawing conclusions

Module 4: [4 hours]

Scatter Plot, Bivariate Line Chart, Hex Plot, Analysis and drawing conclusions

Module 5: [8 hours]

NumPy and its advantages, NumPy n-dimensional array (ndarray), Creating ndarrays in NumPy, Slicing ndarrays, ndarray operations, Broadcasting

Module 6: [12 hours]

Plotting with matplotlib, Univariate graphs using matplotlib, Bivariate graphs using matplotlib, Plotting through pandas, Improving plot aesthetics

Text Books:

1. Sheldon M Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier Academic Press

2. Jeeva Jose, Taming Python by Programming, Khanna Publishing House.
3. S.B. Singh, Combinatorics and Graph Theory, Khanna Book Publishing.
4. B. Lubanovic, Introducing Python, O'Reilly
5. Murray R. Spiegel, Larry J. Stephens, Schaum's Outlines on Statistics, McGraw-Hill
6. Eric Matthes, Python Crash Course, No Starch Press
7. Ivan Idris, Numpy Beginner's Guide, Packt Publishing

Paper Name:	Soft Computing
Paper Code:	PGCSE (AI) 105C
Credit:	4
Duration:	36 hours

Module 1:

Introduction to Soft Computing, Evolution of Computing, Soft Computing Constituents, From Conventional Artificial Intelligence to Computational Intelligence - Machine Learning Basics

Module 2:

Neural Networks, Biological Neuron, Artificial Neuron, Artificial Neural Network, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feed forward network, Back propagation,Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications.

Module 3:

Heuristic and Meta-heuristic Search, Genetic Algorithm (GA), different operators of Genetic Algorithm, Analysis of selection operations, Hypothesis of building Blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Tabu Search, Swarm Intelligence, Particle Swarm Optimization, Applications.

Module 4:

Fuzzy sets and Fuzzy logic, Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, Fuzzy Decision Making, Applications.

Module 5:

Hybrid Systems, Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Text Books:

1. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998.

2. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley, 1997.
3. S. Haykin, "Neural Networks", Pearson Education, 2ed, 2001.
4. S. Rajasekaran & G. A. V. Pai, Neural Networks, Fuzzy logic, and Genetic Algorithms, PHI.
5. Fuzzy Sets and Fuzzy Logic, Klir & Yuan, PHI, 1997.
6. Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran and G. A. V. Pai, PHI.
7. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.
8. Soft Computing, Ikvinderpal Singh, Khanna Book Publishing.

Paper Name:	Python and Artificial Intelligence Lab
Paper Code:	PGCSE (AI) 191
Credit:	2
Duration:	36 hours

Module 1:

Data Structures in Python
Introduction to Python Data Types, Numbers, Variable Assignments, Strings:

Module 2:

Introduction to Strings, Indexing and Slicing with Strings, Indexing and Slicing with Strings, Print Formatting with Strings

Module 3:

List in Python, Dictionaries, Tuples, Sets, Booleans, Python Objects and Data Structures, Python Comparison Operators, Chaining Comparison Operators in Python with Logical Operators, Comparison Operators

Module 4:

Python Statements and Functions
If Elif and Else Statements in Python, For Loops , While Loops, Useful operators, List Comprehensions, Functions, Function Arguments

Module 5:

Errors and Exception Handling, File Handling basics,

Module 6:

OOP & Python ecosystem for machine learning
Introduction, Attributes and Class Keyword, Class object Attributes and Methods, Inheritance, Polymorphism

Module 7:

NumPy, Scipy, Pandas, Matplotlib

Module 8:

Biological foundations to intelligent systems
Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks.

Reference Books:

1. Introduction to Computing and Problem Solving with Python, Jeeva Jose, Khanna Book Publishing Company, Delhi.
2. Learning Python, Mark Lutz, O'Reilly Media
3. Learn Python the Hard Way, Zed Shaw, Addison-Wesley
4. Python for Data Analysis, Wes McKinney, O'Reilly

Paper Name:	Machine Learning Lab
Paper Code:	PGCSE (AI) 192
Credit:	2
Duration:	36 hours

List of Practical:

1. Supervised learning
    a. Find-s algorithm
    b. Candidate elimination algorithm
    c. Decision tree algorithm
    d. Back propagation Algorithm
    e. Naïve Bayes Algorithm
    f. K nearest neighbour algorithm (lazy learning algorithm)

2. Un Supervised learning
    a. EM algorithm
    b. K means algorithm

3. Instance based learning
    a. Locally weighted Regression algorithm

Text Book:

1. Jeeva Jose, Machine Learning, Khanna Book Publishing.
2. Rajiv Chopra, Machine Learning, Khanna Book Publishing.
3. Manaranjan Pradhan and U Dinesh Kumar, Machine Learning using Python, Wiley
4. Mark Fenner, Machine Learning with Python for Everyone, Pearson
5. John Paul Mueller and Luca Massaron, Machine Learning (in Python and R) For Dummies, Wiley

Paper Name:	Knowledge Representation and Reasoning
Paper Code:	PGCSE (AI) 201
Credit:	4
Duration:	36 hours

Module 1: [4 hours]

Introduction, Propositional Logic Language, Semantics and Reasoning, Syntax and Truth Values, Valid Arguments and Proof Systems, Rules of Inference and Natural Deduction, Axiomatic Systems and Hilbert Style Proofs, The Tableau Method, The Resolution Refutation Method

Module 2: [4 hours]

First Order Logic (FOL) Syntax, Semantics, Entailment and Models, Proof Systems, Forward Chaining, Unification, Forward Chaining Rule Based Systems, The Rete Algorithm

Module 3: [4 hours]

Representation in FOL Skolemization, Knowledge Representation, Properties and Categories, Reification and Abstract Entities, Resource Description Framework (RDF), The Event Calculus: Reasoning About Change

Module 4: [4 hours]

Mapping Natural Language to FOL Understanding = Fulfilling Expectations, Conceptual Dependency (CD) Theory, Understanding Language, Conceptual Analysis: Mapping English to CD Theory

Module 5: [5 hours]

Programming in Logic Deductive Retrieval in Backward Chaining, Prolog, Depth First Search and Efficiency Issues, Controlling Search, The Cut Operator in Prolog

Module 6: [5 hours]

Theorem Proving in FOL Incompleteness of Forward and Backward Chaining, The Resolution Refutation Method for FOL, Clause Form and The Resolution Rule, FOLwith Equality, Complexity, Knowledge Structures Semantic Nets using Frames, Scripts, ScriptApplier Mechanism (SAM), Goals, Plans and Actions, Plan Applier Mechanism (PAM):Expectations and Recognition, PAM: Top Down and Bottom Up Reasoning

Module 7: [4 hours]

Ontology and Description Logics A Description Logic, Normalisation, Structure Matching, Classification, A-box Reasoning, Extensions, ALC, Further Extensions. Inheritance Taxonomies and Inheritance, Beliefs, Credulous and Skeptical Reasoning

Module 8: [6 hours]

Default Reasoning Introduction to Default Reasoning, Circumscription, Minimal Models, The Event Calculus Revisited, Default Logic, Autoepistemc Logic.

Reasoning in Multi-agent Systems Epistemic Logic: Kripke Semantics in a MultiAgent Scenario, The Muddy Children Puzzle

Text Books:

1. Schank, Roger C., Robert P.Abelson Goals, and Understanding:An Inquiry into Human Knowledge Structures.
2. R. C.Schank and C.K. Riesbeck Inside Computer Understanding: Five Programs Plus Miniatures, Lawrence Erlbaum, 1981.

Paper Name:	Deep Learning
Paper Code:	PGCSE (AI) 202
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

Biological neuron, artificial neuron as a computational model of a neuron, activation functions, architectures for ANNs, linear neural networks, Hebbs learning law, Non-linear neural networks: Perceptron- learning law, convergence theorem; multilayer feed forward neural networks- structure, activation functions, error back propagation learning, delta learning law, generalized delta rule, learning factors, convergence criteria, momentum factor in learning, conjugate gradient method for learning, universal approximation theorem, cross validation method for selecting the architecture, bias-variance dilemma

Module 2: [6 hours]

Statistical learning theory, principle of empirical risk minimization, Radial basis function networks: RBF networks for function approximation, RBF networks for pattern classification, Support vetcor machines: SVM for linearly separable classes, SVM for linearly non-separable classes, SVM for nonlinearly separable classes using kernels, multi-class pattern classification using SVMs

Module 3: [6 hours]

Feed forward Neural networks. Gradient descent and the backpropagation algorithm, Unit saturation, aka the vanishing gradient problem, and ways to mitigate it, RelU Heuristics for avoiding bad local minima, Heuristics for faster training, Nestors accelerated gradient descent. Regularization, Dropout

Convolutional Neural Networks: Architectures, convolution / pooling layers Recurrent Neural Networks LSTM, GRU, Encoder Decoder architectures

Deep Unsupervised Learning:

Module 4: [6 hours]

Autoencoders (standard, sparse, denoising, contractive, etc), Variational Auto encoders, Adversarial Generative Networks, Autoencoder and DBM Attention and

memory models, Dynamic memory networks, Applications of Deep Learning to NLP: Introduction to NLP and Vector Space Model of Semantics

Module 5: [6 hours]

Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning, Dialogue Generation with LSTMs, Applications of Dynamic Memory Networks in NLP

Module 6: [6 hours]

Recent Research in NLP using Deep Learning: Factoid Question Asnwering, similar question detection, Dialogue topic tracking, Neural Summarization, Smart Reply

Text Books:

1. Simon S. Haykin, Neural Networks and Learning Machines, 3rd Edition, Prentice Hall
2. Rajiv Chopra, Deep Learning, Khanna Book Publishing.
3. Sathish Kumar, Neural Networks: A Classroom Approach, 3rd Edition, Tata McGraw Hill
4. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville, Deep learning, MIT Press book
5. Bengio, Yoshua, Learning deep architectures for AI, Foundations and trends in Machine Learning

Paper Name:	Advanced Algorithms
Paper Code:	PGCSE (AI) 203
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

Sorting: Review of various sorting algorithms, topological sorting Graph: Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

Module 2: [6 hours]

Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST, Graph Matching: Algorithm to compute maximum matching.Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

Module 3: [6 hours]

Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm. Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

Module 4: [6 hours]

Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming, Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials, Application: Interpolation problem. Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm, Schonhage-Strassen Integer Multiplication algorithm

Module 5: [6 hours]

Linear Programming: Geometry of the feasibility region and Simplex algorithm NP-completeness: Examples, proof of NP-hardness and NP- completeness. One or more of the following topics based on time and interest Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm

Module 6: [6 hours]

Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, PHI Learning Pvt. Ltd. (Originally MIT Press); Third edition (2 February 2010)
2. S.B. Singh, Discrete Structures, Khanna Book Publishing.

Paper Name:	Research Methodology and IPR
Paper Code:	PGCSE (AI) 204
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Module 2: [6 hours]

Effective literature studies approaches, analysis Plagiarism, Research ethics

Module 3: [6 hours]

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Module 4: [6 hours]

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Module 5: [6 hours]

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications

Module 6: [6 hours]

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc, Traditional knowledge Case Studies, IPR and IITs

Text Books:

1. Stuart Melville and Wayne Goddard, "Researchmethodology: An introduction for science & engineering students'"
2. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 2nd Edition
3. T. Ramappa, S. Chand, "Intellectual Property Rights Under WTO", 2008
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

Paper Name:	Cloud and Edge Computing
Paper Code:	PGCSE (AI) 205A
Credit:	4
Duration:	36 hours

Module 1: [4 hours]

Introduction to Cloud Computing
Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing

Module 2: [10 hours]

Cloud Computing Architecture
Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model, Cloud Deployment Models, Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise

Module 3: [10 hours]

Security Issues in Cloud Computing
Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security, Identity and Access Management, Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management, Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS, Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud

Module 4: [6 hours]

Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT. Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc

Module 5: [6 hours]

Fog and Edge Computing Completing the Cloud, Advantages of FEC: SCALE, How FEC Achieves, These Advantages: SCANC, Hierarchy of Fog and Edge Computing, Addressing the Challenges in Federating Edge Resources. Optimization Problems in Fog and Edge Computing, Middleware for Fog and Edge Computing: Design Issues. Data Management in Fog Computing. Applications and Issues

Text Books:

1. John Rhoton, Cloud Computing Explained: Implementation Handbook for Enterprises
2. Tim Mather, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance(Theory in Practice), O'Reilly Media
3. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama

Paper Name:	Mobile Computing
Paper Code:	PGCSE (AI) 205B
Credit:	4
Duration:	36 hours

Module 1:

Fundamentals of Cellular Communications, Introduction, First- and Second-Generation Cellular Systems, Cellular Communications from 1G to 3G, Teletraffic Engineering, Radio Propagation and Propagation Path- Loss Models, Cellular Geometry, Interference in Cellular Systems, Frequency Management and Channel Assignment Issues, Multiple Access Techniques, GSM Logical Channels and Frame Structure, Privacy and Security in GSM, Mobility Management in Cellular Networks.

Module 2:

Wireless Transmission Fundamentals,Spread Spectrum (SS) and CDMA Systems, Wireless Medium Access Control, IEEE 802.11 Architecture and Protocols, Issues in Ad Hoc Wireless Networks (Medium Access
Scheme), Routing, Multicasting, Transport Layer Protocols, QoS Provisioning, Energy Management and Energy Consumption Models, Traffic Integration in Personal, Local, and Geographical Wireless Networks, Bluetooth, Technologies for High-Speed WLANs, Third-Generation Cellular Systems: UMTS.

Module 3:

Mobile Adhoc Networks, Introductory Concepts. Different models of operation, Various applications of MANET, Destination-Sequenced Distance Vector protocol - overview, Route Advertisement, Extending Base Station Coverage, Properties of DSDV protocol, Dynamic Source Routing protocol - overview and properties, DSR Route Discovery, Route Maintenance, Support for Heterogeneous Networks and Mobile IP, Multicast routing with DSR, Ad Hoc On-Demand Distance-Vector protocol - properties, Unicast Route Establishment, Multicast Route Establishment, Broadcast Optimizations and Enhancements, Link Reversal Routing - Gafni-Bertsekas Algorithm, lightweight mobile routing algorithm, Temporally Ordered Routing Algorithm, Preserving battery life of mobile nodes - Associativity Based Routing, Effects of beaconing on battery life.

Module 4:

Wireless Sensor Networks, Sensor networks overview: introduction, applications, design issues, requirements, Sensor node architecture, Network architecture: optimization goals, evaluation metrics, network design principles, Sensor network operating systems and brief introduction to sensor network Programming, Network protocols: MAC protocols and energy efficiency, Routing protocols: data centric, hierarchical, location-based, energy efficient routing etc, Sensor deployment, scheduling and coverage issues, Self Configuration and Topology Control, Querying, data collection and processing, collaborative information processing and

group connectivity, Target tracking, localization and identity management, Power management, Security and privacy.

Module 5:

Topology Control and Clustering in Adhoc Networks, Algorithms for Graphs Modeling Wireless Ad Hoc Networks, Clustering and Network Backbone, Dominating-Set-Based Routing in Ad Hoc Wireless Networks, Formation of a Connected Dominating Set, Backbone-Formation Heuristics.

Module 6:

Mobile, Distributed and Pervasive Computing, Pervasive Computing Applications, Architecture of Pervasive Computing Software, Indoor Wireless Environments, Challenges for the Future: Nomadic Computing.

Text Books:

1. Gabrilovska, Prasad, "Adhoc Networking Towards Seamless Communication", Springer.
2. Azzedine Boukerche, "Handbook of Algorithms for Wireless Networking and Mobile Computing", Chapman and Hall/CRC, New York.
3. Wagner, Wattenhofer (Eds.), "Algorithms for Adhoc and Sensor Networks: Advanced Lectures", Springer Lecture Notes in Computer Science.
4. Mukherjee, Bandopadhyay, Saha, "Location Management and Routing in Mobile Wireless Networks", Artech House, London.
5. Redl, S.M., Weber, M.K., Oliphant, M.W.: An Introduction to GSM. Artech House, London.
6. Mehrotra, A.: GSM System Engineering. Artech House, London.
7. Ivan Stojmenovic, "Handbook of Wireless Networking and Mobile Computing", Wiley Inc, New York.
8. XiangYang Li, "Wireless Adhoc and Sensor Networks", Cambridge University Press.
9. Dr. Brijesh Gupta, Mobile Computing, Khanna Book Publishing.

Paper Name:	Advanced Data Mining
Paper Code:	PGCSE (AI) 205C
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

Introduction, Incremental & Stream Data Mining, Incremental Algorithms for Data Mining, Characteristics of Streaming Data, Issues and Challenges, Streaming Data Mining Algorithms, Any time stream Mining

Module 2: [6 hours]

Distributed computing solutions for data mining

- MapReduce/Hadoop and Spark
- Cluster Computing

Module 3: [6 hours]

Mining Complex Structures
- Algorithmic Development Issues
- Mining trees
- Tree Model Guided Framework
- TMG framework for mining ordered & unordered subtrees o Tree Mining Applications
- Mining Graphs o Approaches to graph mining

Module 4: [6 hours]

Sequence Mining
- Characteristics of Sequence Data
- Problem Modelling
- Sequential Pattern Discovery
- Timing Constraints
- Applications in Bioinformatics

Module 5: [6 hours]

Text Mining
- Text Classification
- Vector Space Model
- Flat and Hierarchical Clustering.

Web Search
- Crawling & Indexing
- Hyperlink Analysis
- Page Rank algorithm
- Web Search and Information Retrieval
- Case Study: Query Recommender System

Module 6: [6 hours]

Multivariate Time Series (MVTS) Mining
- Importance of MVTS data
- Sources of MVTS data
- Mining MVTS data
- Sign Language Data
- Agro-meteorological Data

Text Books:

1. Hadzic F., Tan H. & Dillon T. S., Mining data with Complex Structures, Springer
2. Yates R. B. and Neto B. R, Modern Information Retrieval, Pearson Education

Paper Name:	Geographical Information System
Paper Code:	PGCSE (AI) 205D
Credit:	4
Duration:	36 hours

Module 1: [7 hours]

Introduction, Geographical concepts and Terminology, Difference between Image, Processing system and GIS, Utility of GIS

Module 2: [9 hours]

Various GIS packages and their salient features, Essentials components of GIS, Data acquisition through scanners and digitizers

Module 3: [10 hours]

Raster and Vector Data: Introduction, Descriptions: Raster and Vector data, Raster Versus Vector, Raster to Vector conversion, Remote Sensing Data in GIS, Topology and Spatial Relationships, Data storage verification and editing

Module 4: [5 hours]

Data preprocessing, Georeferencing, Data compression and reduction techniques, Runlength encoding, Interpolation of data, Database Construction, GIS and the GPS, Data Output Database structure, Hierarchical data, Network systems, Relational database, Database management, Data manipulation and analysis

Module 5: [5 hours]

Spatial and mathematical operations in GIS, Overlay, Query based, Measurement and statistical modelling, Buffers, Spatial Analysis, Statistical Reporting and Graphing Programming languauges in GIS, Virtual GIS, Web GIS Application of GIS to various natural resources mapping and monitoring and engineering problems.

Text Books:

1. Burrough P.A. and Mc Donnel R.A, Principles of Geographic Information System, Oxford University Press, 2000
2. Chrisman, Nicholas R, Exploring Geographic Information Systems, John Wiley, 2002

Paper Name:	Cyber Law and Security Policies
Paper Code:	PGCSE (AI) 205E
Credit:	4
Duration:	36 hours

Module 1: [7 hours]

Introduction: Introduction to Cyber Security, Importance and challenges in Cyber Security, Cyberspace, Cyber threats, Cyber warfare, CIA Triad, Cyber Terrorism,

Cyber Security of Critical Infrastructure, Cyber security – Organizational Implications.

Module 2: [9 hours]

Hackers and Cyber Crimes: Types of Hackers, Hackers and Crackers, Cyber-Attacks and Vulnerabilities, Malware threats, Sniffing, Gaining Access, Escalating Privileges, Executing Applications, Hiding Files, Covering Tracks, Worms, Trojans, Viruses, Backdoors.

Module 3: [10 hours]

Ethical Hacking and Social Engineering: Ethical Hacking Concepts and Scopes, Threats and Attack Vectors, Information Assurance, Threat Modelling, Enterprise Information Security Architecture, Vulnerability Assessment and Penetration Testing, Types of Social Engineering, Insider Attack, Preventing Insider Threats, Social Engineering Targets and Defence Strategies.

Module 4: [5 hours]

Cyber Forensics and Auditing: Introduction to Cyber Forensics, Computer Equipment and associated storage media, Role of forensics Investigator, Forensics Investigation Process, Collecting Network based Evidence, Writing Computer Forensics Reports, Auditing, Plan an audit against a set of audit criteria, Information Security Management System Management. Introduction to ISO 27001:2013

Module 5: [5 hours]

Cyber Ethics and Laws: Introduction to Cyber Laws, E-Commerce and E-Governance, Certifying Authority and Controller, Offences under IT Act, Computer Offences and its penalty under IT Act 2000, Intellectual Property Rights in Cyberspace. at Network Layer-IPSec.

Text Books:

1. Cyber security , Nina Gobole & Sunit Belapune; Pub: Wiley India.
2. Information Security & Cyber Laws, Gupta & Gupta, Khanna Publishing House (AICTE Recommended - 2018)
3. Information Security and Cyber Laws, Pankaj Agarwal
4. Donaldson, S., Siegel, S., Williams, C.K., Aslam, A., Enterprise Cybersecurity -How to Build a Successful Cyberdefense Program Against Advanced Threats, A-press
5. Nina Godbole, SumitBelapure, Cyber Security, Willey
6. Hacking the Hacker, Roger Grimes, Wiley
7. Cyber Law By Bare Act, Govt Of india, It Act 2000.

Paper Name:	Knowledge Representation and Reasoning Lab
Paper Code:	PGCSE (AI) 291
Credit:	2
Duration:	36 hours

Topics to be covered:

1. Getting started with Prolog, Data objects in Prolog terms
2. Clauses, Predicates and variables
3. Unification, Evaluating Goals, backtracking, Satisfying goals
4. Equality and logical operator
5. Input/ Output
6. Loops and recursion
7. List processing
8. String processing

Reference Book:

1. Logic and Prolog Programming, Saroj Kaushik, New Age International Publishers
2. Logic Programming with Prolog, Max Bramer, Springer, 2005 (Free available online)

Paper Name:	Computer Vision and Robotics
Paper Code:	PGCSE (AI) 301A
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

Image Formation Models
• Monocular imaging system • Orthographic & Perspective Projection • Camera model and Camera calibration • Binocular imaging systems, Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto- calibration. Apparel, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto- calibration. Apparel, Stereo vision

Module 2: [6 hours]

Feature Extraction
• Image representations (continuous and discrete) • Edge detection, Edge linking, corner detection, texture, binary shape analysis, boundary pattern analysis, circle and ellipse detection, Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Module 3: [6 hours]

Shape Representation and Segmentation • Deformable curves and surfaces • Snakes and active contours • Level set representations • Fourier and wavelet descriptors • Medial representations • Multi-resolution analysis, Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation

Module 4: [6 hours]

Motion Detection and Estimation • Regularization theory • Optical computation • Stereo Vision • Motion estimation, Background Subtraction and Modelling, Optical Flow, KLT, Spatio- Temporal Analysis, Dynamic Stereo; Motion parameter estimation • Structure from motion, Motion Tracking in Video

Module 5: [6 hours]

Object recognition • Hough transforms and other simple object recognition methods • Shape correspondence and shape matching • Principal component analysis • Shape priors for recognition

Module 6: [6 hours]

Applications of Computer Vision
Automated Visual Inspection, Inspection of Cereal Grains, Surveillance, In-Vehicle Vision Systems, CBIR, CBVR, Activity Recognition, computational photography, Biometrics

Text Books:

1. D. Forsyth and J. Ponce, Computer Vision
2. R.S. Salaria, Computer Fundamentals, Khanna Book Publishing.
3. N.S. Gill, Handbook of Computer Fundamentals, Khanna Book Publishing.

Paper Name:	Digital Signal Processing
Paper Code:	PGCSE (AI) 301B
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

LTI Discrete-Time Systems in the Transform Domain: Types of Linear-Phase transfer functions, Simple digital filters, Complementary Transfer Functions. Realization of Structures for Filters and Design: All pass filters, Tunable IIR Digital filter, IIR tapped Cascaded Lattice Structures, FIR Cascaded lattice Structures, Parallel All pass realization of IIR Transfer Functions, State Space Structures, Computational Complexity of Digital filter Structures, Design of IIR filter using pade' approximation, Design of computationally Efficient FIR Filters.

Module 2: [6 hours]

DSP Algorithms: Fast DFT algorithms based on Index mapping, Sliding Discrete Fourier transform, DFT Computation Over a narrow Frequency Band, Split Radix FFT, and Linear filtering approach to Computation of DFT using Chirp Z-Transform

Module 3: [6 hours]

DSP Processor TMS 320C67XX: TMS 320C67XX, Architecture, overview, memory management, I/O management, On-chip resources, programming considerations, Real-time implementations, Application using ALP on TMS 320C67XX for basic DSP algorithms (preferably fixed point).

Module 4: [6 hours]

Analysis of Finite Word length Effect in Fixed-Point DSP Systems: The Quantization Process and errors, Quantization of fixed-point Numbers, Analysis of Coefficient quantization effects, A/D conversion Noise Analysis, Analysis of Arithmetic Round of errors, Dynamic range scaling, Signal to Noise ratio in Low-order IIR Filters, Limit cycle in IIR Digital filters, Finite word length effects in IIR & FIR digital filters, Round of errors in FFT algorithms.

Module 5: [6 hours]

Analysis of Finite Word length Effect in Fixed-Point DSP Systems: The Quantization Process and errors, Quantization of fixed-point Numbers, Analysis of Coefficient quantization effects, A/D conversion Noise Analysis, Analysis of Arithmetic Round of errors, Dynamic range scaling, Signal to Noise ratio in Low-order IIR Filters, Limit cycle in IIR Digital filters, Finite word length effects in IIR & FIR digital filters, Round of errors in FFT algorithms.

Module 6: [6 hours]

Applications of Digital Signal Processing: Dual Tone Multi- frequency Signal Detection using Goertzel algorithm, Spectral Analysis of Non-stationary Signals, Musical Sound Processing, Over Sampling A/D Converter, Over Sampling D/A Converter, Clock recovery for data communication.

Text Books:

1. Sanjit K Mitra, Digital Signal Processing, Tata McGraw Hill Publications
2. J.G. Proakis, D.G. Manolokis, D. Sharma, Digital Signal Processing Principles, Algorithms, and Applications, Pearson Education
3. Munesh Trivedi, Digital Signal Processing, Khanna Book Publishing.

Paper Name:	Natural Language Processing
Paper Code:	PGCSE (AI) 301C
Credit:	4
Duration:	36 hours

Module 1: [6 hours]
Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes.

Module 2: [6 hours]
Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK. Regular expressions, Finite State Automata, word recognition, lexicon.

Module 3: [6 hours]
Morphology, acquisition models, Finite State Transducer. N- grams, smoothing, entropy, HMM, ME, SVM, CRF. Part of Speech tagging- Stochastic POS tagging, HMM.

Module 4: [6 hours]
Handling of unknown words, named entities, multi word expressions. A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax. Parsing- Unification, probabilistic parsing, TreeBank.

Module 5: [6 hours]
Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary based approaches. Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure.

Module 6: [6 hours]
Applications of NLP- Spell-checking, Summarization Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation– Overview.

Text Books:

1. Daniel Jurafsky James H., An Introduction to Natural Language Processing, Third Edition, Tata McGraw- Hill
2. James H. Martin, Computational Linguistics, and Speech Recognition

Paper Name:	Big Data Analytics
Paper Code:	PGCSE (AI) 301D
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big

data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics

Module 2: [6 hours]

Introduction to NoSQL, aggregate data models, aggregates, key- value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peerpeer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations

Module 3: [6 hours]

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structureesonance architectures, Advances in Neural networks

Module 4: [6 hours]

MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output format

Module 5: [6 hours]

Hbase, data model and implementations, Hbase clients, Hbase examples, praxis.Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration

Module 6: [6 hours]

Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries

Text Books:

1. Hadzic F., Tan H. & Dillon T. S, Mining data with Complex Structures, Springer
2. Yates R. B. and Neto B. R., Modern Information Retrieval, Pearson Education
3. Tan P. N., Steinbach M & Kumar V, Introduction to Data Mining, Pearson Education
4. Jain V.K., Big Data and Hadoop, Khanna Book Publishing.
5. Jeeva Jose, Beginner's Guide for Data Analysis using R Programming, Khanna Book Publishing.

Paper Name:	Business Analytics
Paper Code:	PGCSE (AI) 302A
Credit:	4
Duration:	36 hours

Module 1: [6 hours]

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

Module 2: [6 hours]

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Module 3: [6 hours]

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Module 4: [6 hours]

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Module 5: [6 hours]

Decision Analysis: Formulating Decision Problems, Decision Strategies with the Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Module 6: [6 hours]

Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

Text Books:

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications, Pearson FT Press
2. James Evans, Business Analytics, Pearsons Education
3. Jeeva Jose, Beginner's Guide for Data Analysis using R Programming, Khanna Book Publishing.

Paper Name:	Project Management and Entrepreneurship
Paper Code:	PGCSE (AI) 302B
Credit:	4
Duration:	36 hours

Module 1:

What "Project Management" Means. About The Context Of Modern Project Management. How To Manage Projects Throughout The Five Major Process Groups. How The Triple Constraint Affects The Project Manager. How To Develop An Effective Project Plan. How To Gain Commitment To The Project Plan. How To Efficiently Execute The Project Plan. How To Minimize Or Eliminate Scope Creep. How To Organize And Develop Successful Project Teams. How To Develop An Effective Project Control System. How To Develop Realistic Project Schedules. How To Efficiently Close Out A Project.

Module 2:

Entrepreneurship Is An Intensive Course Involving The Study Of Journals Articles, Analysis Of Cases, To Evolve Perspective On Entrepreneurship As An Academic Discipline

Module 3:

Entrepreneurship: An Introduction, New Venture Creation, Financing Entrepreneurial Ventures And The Business Plan, Family Business Management, Managing A Growing Business, Venture Growth Strategies, Entrepreneurial Skills And Strategies, Entrepreneurial Skills And Strategies, Intrapreneurship: Entrepreneurial Ventures In A Corporate Setting, Entrepreneur As Change Agent, Sustainable Innovation And Entrepreneurship, Social Entrepreneurship

Text Books:

1. M. Y. Yoshino And U. S. Rangan, Strategic Alliances: An Entrepreneurial Approach To Globalization, Hbs Press, 1995.
2. Foster, Richard N., Innovation: The Attacker's Advantage, London, Macmillan, 1986.

3. Howard H. Stevenson, Michael J. Roberts, Amar Bhide, William A. Sahlman (Editor), The Entrepreneurial Venture (The Practice Of Management Series).
4. Udayan Gupta (Editor), Done Deals: Venture Capitalists Tell Their Stories.
5. Steve Kemper, Code Name Ginger: The Story Behind Segway And Dean Kamen's Quest To Invent A New World.
6. Paul A. Gompers And Josh Lerner, The Money Of Invention: How Venture Capital Creates NewWealth.
7. Larry Bossidy, Ram Charan And Charles Burck, Execution: The Discipline Of Getting Things Done.
8. JeffryTimmons And Stephen Spinelli, New Venture Creation: Entrepreneurship For The 21st Century With Powerweb And New Business Mentor Cd.
9. The Entrepreneur‟s Guide To Business Law, Constance E. Bagley And Craig E. Dauchy, West Educational Publishing, 1998.
10. Mary Coulter, Entrepreneurship In Action, Prentice-Hall, 2001

Paper Name:	Industrial Safety
Paper Code:	PGCSE (AI) 302C
Credit:	4
Duration:	36 hours

Module 1:

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods

Module 2:

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment

Module 3:

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods

Module 4:

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw

decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes

Module 5:

Periodic and preventive maintenance: Periodic inspection- concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Text Books:

1. Higgins & Morrow, Maintenance Engineering Handbook, Da Information Services
2. H. P. Garg, Maintenance Engineering, S. Chand and Company
3. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London
6. M.P. Poonia & S.C. Sharma, Industrial Safety and Maintenance Management, Khanna Book Publishing.

Paper Name:	Operation Research
Paper Code:	PGCSE (AI) 302D
Credit:	4
Duration:	36 hours

Module 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Module 2:

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method – sensitivity analysis - parametric programming

Module 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module 4:

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models – Geometric Programming.

Module 5:

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Text Books:

1. H.A. Taha, Operations Research, An Introduction,PHI
2. H.M. Wagner, Principles of Operations Research, PHI
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers