Curriculum for Undergraduate Degree (B.Tech.) in Artificial Intelligence and Machine Intelligence (w.e.f. AY: 2021-22)

Part III: Detailed Curriculum

Fifth Semester

Course Name:	**Probability and Statistics**			
Course Code:	BS-M501	**Category:**	Basic Science Course	
Semester:	Fifth	**Credit:**	2	
L-T-P:	2-0-0	**Pre-Requisites:**	School mathematics, BS-M101	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	Provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.
2	Gain proficiency in using statistical software for data analysis.
3	Defining the type and quantity of data need to be collected
4	Design experiments and carry out statistical analysis of their data.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Basic Probability:** Probability spaces, conditional probability, Bayes' theorem independence; Discrete random variables, Independent random variables, the Multinomial distribution, Poisson approximation to the Binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Variance of a sum, Correlation coefficient,	8L
2	**Continuous Probability Distributions:** Continuous random variables and their properties, Distribution functions and densities, Normal and Exponential.	3L
3	**Bivariate Distributions:** Bivariate distributions and their properties, distribution of sums and quotients, Conditional densities.	3L

4	**Basic Statistics:** Measures of Central tendency, Moments, Skewness and Kurtosis, Probability distributions: Binomial, Poisson and Normal and evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	6L
5	**Applied Statistics:** Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	8L
Total		**28L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Learn the ideas of probability and random variables, various discrete and continuous probability distributions with their properties and their applications in physical and engineering environment.
2	Understand the basic ideas of statistics with different characterisation of a univariate and bivariate data set.
3	Apply statistical tools for analysing data samples and drawing inference on a given data set.

Learning Resources:	
1	Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
2	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons
3	S. Ross, A First Course in Probability, Pearson Education India
4	W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley.
5	John E. Freund, Ronald E. Walpole, Mathematical Statistics, Prentice Hall.
6	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers
7	N.G. Das, Statistical Methods (Combined Volume), Tata-McGraw Hill

Course Name:	**Database Management System**			
Course Code:	PC-AIML501	**Category:**	Professional Core Course	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Data Structure & Algorithms and Mathematics	
Full Marks:	100			
Examination	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Scheme:			

Course Objectives:	
1	To understand the different issues involved in the design and implementation of a database system.
2	To understand the physical and logical database designs, database modeling, relational, hierarchical, and network models
3	To understand the different constraints , i.e., the candidate keys, super-keys, that exists in a given real world problem and design the entity relationship diagram to graphically represent entities and their relationships to each other, typically used in computing in regard to the organization of data within databases or information systems
4	To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.
5	To understand the different issues involved in the design and implementation of a database system.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Database Model, Schema and system architecture:** Overview of database and DBMS, Advantages of using DBMS approach, Database Users, Database Administrator, Database applications. Data Models and its categories, Schema, Instances, Database Languages, Three Schema architecture of DBMS, Data independence, Centralized and client server architecture for DBMS.	4L
2	**Entity-Relationship Model:** Basic concepts, Design Issues, Cardinality, Super Keys, Candidate keys, Entity types, Entity sets, attributes and keys. Relationship types, Relationship sets, Attributes of relationship types, Weak Entity Sets , ER diagram design issues, Extended E-R modeling: generalization, specialization, aggregation.	4L
3	**Relational Model:** Concepts of domains, attributes, tuples, relations. Operators in relational algebra: select, project, rename, Cartesian product, different types of Join, Division, Intersect, Union, Minus. Tuple relational calculus, Domain relational calculus. **Operators in relational algebra**: Select, Project, Rename, Cartesian product, different types of Join, Division, Intersect, Union, Minus. Tuple relational calculus, Domain relational calculus.	4L
4	**Query processing**: Concept of DDL, DML, and DCL. Query structure, concept of sub query, group functions. View. PL/SQL basic structure, Control structure, Cursor, Triggers. .	4L

5	**Relational Database Design:** Domain constraints, entity integrity, referential integrity constraints. Concept of null and not null constraint. Basic concept of functional dependency, Axioms, Closure, Attribute closure, Equivalent set of FD, Cover, Canonical cover.	4L
6	**Normalization:** Concept of Super keys, Candidate keys, primary keys. Determining candidate keys from FD. Different anomalies in designing Database. 1NF, 2NF, 3NF and Boyce-Codd Normal Form. Normalization using multi-valued dependencies and join dependency. Dependency preservation, Lossless decomposition, De-normalization in Databases, Query Optimization.	6L
7	**Transaction processing:** ACID property, States, Concurrency control techniques, Serializability of scheduling, Locking and timestamp based schedulers, Database recovery.	6L
8	**Storage strategies:** File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .	4L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the terms related to Database Design and Management.
2	Construct and normalized conceptual database model.
3	Explain the database concept, structure and the issues related to database performance.

Learning Resources:	
1	Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2	Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.
3	Ramakrishnan: Database Management System , McGraw-Hill
4	Gray Jim and Reuter Address, "Transaction Processing: Concepts and Techniques", Moragan Kauffman . Publishers.

Course Name:	**Data Science**		
Course Code:	PC-AIML502	**Category:**	Professional Core Course
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Knowledge of mathematics, Analytical & logical skills
Full Marks:	100		

Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objective	
1	To familiarize the students with the basic concepts of data and data science.
2	To acquaint the students with descriptive statistics, data preparation, Exploratory Data Analysis.
3	To generate concept about supervised Learning, Regression analysis & network Analysis.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Data For the Course, Introduction to the Python Data Science Tool, Introduction to the Python Data Science Environment , Some Miscellaneous Jupyter notebooks / Spyder in Anaconda Navigator Usage Facts	4L
2	Descriptive statistics, data preparation. Exploratory Data Analysis data summarization, data distribution, measuring asymmetry. Sample and estimated mean, variance and standard score. Statistical Inference frequency approach, variability of estimates, hypothesis testing using confidence intervals, using p-values.	9L
3	Supervised Learning: First step, learning curves, training-validation and test. Learning models generalities, support vector machines, random forest. Examples.	7L
4	Regression: linear regression, simple linear regression, multiple & Polynomial regression, Sparse model. Unsupervised learning, clustering, similarity and distances, quality measures of clustering, case study.	9L
5	Network Analysis, Graphs, Social Networks, centrality, drawing centrality of Graphs, Page Rank, Ego-Networks, community Detection.	7L
Total		**36L**

Course Outcome	
After completion of the course student will be able to:	
1	Explain the basic concepts of data and machine learning.
2	Identify visual representation of data.

3	Explain the concept about supervised Learning, Regression analysis & network Analysis.

Learning Resources:	
1	Data Science by Analytics by V.K.Jain, Khanna Publishers
2	Data Science from Scratch by Joel Grus, O'Reilly
3	An Introduction to Data Science by Jeffrey S. Saltz, Jeffrey Morgan Stanton SAGE Publishers Inc.
4	Doing Data Science: Straight Talk from the Frontline by Cathy o'Neil, Rachel Schutt, O'Reilly, Kindle edition available

Course Name:	**Object Oriented Programming**		
Course Code:	PE-AIML501A	**Category:**	Professional ElectiveCourse
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	ES-CS201(Programming for Problem Solving)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn the fundamentals of object-oriented concepts
2	To implement the object-oriented concepts by a programming language
3	To be able to apply the programming skill to implement real world project

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Features of object-oriented programming, major and minor elements, relationships among classes and among objects	12L
2	**Fundamentals of OOP :**Classes and objects, polymorphism, inheritance, interfaces	8L
3	Commands as methods and as objects, Memory management, Generic types and collections, Exception Handling	8L
4	Graphical programming and Applets, Event Handling	6L
5	The software development process	6L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Specify simple abstract data types and design implementations, using abstraction functions to document them.
2	Recognize features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity
3	Apply some common object-oriented design patterns and give examples of their use
4	Design applications with an event-driven graphical user interface

Learning Resources:	
1	Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2	Ali Bahrami – "Object Oriented System Development" – McGraw Hill
3	Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4	E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH
5	Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson

Course Name:	**Operating Systems**			
Course Code:	PE-AIML501B	**Category:**	Professional ElectiveCourse	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Data Structure & Algorithms and Mathematics	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To understand the mechanisms of OS to handle processes and threads and their communication.
2	To understand the mechanisms involved in memory management in contemporary OS
3	To understand the basic concept of distributed system including Mutual exclusion, and deadlock algorithm.
4	To understand the concurrency management system.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Introduction to OS. Operating system functions, evaluation of O.S., Different types of O.S.: batch, multi programmed, time-sharing, real-time, distributed, and parallel.	4L
2	**System Structure:** Computer system operation, I/O structure, storage structure, storage hierarchy, different types of protections, operating system structure (simple, layered, virtual machine), O/S services, system calls.	4L
3	**Process Management: Processes:** Definition and Relationship, Different process states, Process state transitions Process Control Block (PCB), Context switching. **Threads:** Definition and benefits and various states of threads, user and kernel threads, concept of multithreading. **Process scheduling:** Definition and objectives Scheduling, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR and priority Multiprocessor scheduling: Real Time scheduling.	10L
4	**Deadlocks:** Definition, necessary and sufficient conditions for Deadlock, Mutual exclusion, methods for handling deadlocks, deadlock prevention and avoidance, deadlock detection, recovery from deadlock.	3L
5	**Storage Management: Memory Management:** Background, logical vs. physical address space, swapping, contiguous memory allocation, paging, segmentation, segmentation with paging. **Virtual Memory:** Background, demand paging, performance, page replacement, page replacement algorithms (FCFS, LRU), allocation of frames, thrashing. **File Systems:** File concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, and indexed), and free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance.	9L
6	**I/O Management:** Principles of I/O Software: Goals of Interrupt handlers, Device driverspolling, interrupts, DMA, application I/O interface (block and character devices, network devices, clocks and timers, blocking and non-blocking I/O); **Disk Management**: disk structure, disk scheduling (FCFS, SSTF, SCAN,C-SCAN), and disk reliability, disk formatting, boot block, bad blocks.	5L
7	**Protection & Security:** Goals of protection, domain of protection, security problem, authentication, one time password, program threats, system threats, threat monitoring, encryption.	2L
Total		**37L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply the knowledge of basic concepts of operating system.
2	Apply concepts of memory management including virtual memory, and disk management system, file management and multithreading.
3	Apply concepts to protection and security mechanisms

Learning Resources:	
1	Milenkovie M., "OperatingSystem: Concept & Design", McGraw Hill.
2	Tanenbaum A.S., "Operating System Design & Implementation", Practice Hall NJ.
3	Silbersehatz A. and Peterson J. L., "Operating System Concepts", Wiley.
4	Dhamdhere: Operating System TMH
5	Stalling, William, "Operating Systems", Maxwell McMillan International Editions,1992.
6	Dietel H. N., "An Introduction to Operating Systems", Addison Wesley.

Course Name:	**Image Processing**			
Course Code:	PE-AIML501C	**Category:**	Professional Elective Course	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	MATLAB programming	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To learn the basics of Image processing
2	To learn the principles of processing the different steps of Image processing
3	To build an application of Image processing

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Background, Digital Image Representation, Fundamental steps inImage Processing, Elements of Digital Image Processing- Image Acquisition, Storage, Processing, Communication, Display.	3L

2	**Digital Image Formation:** A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization-Uniform & Nonuniform.	4L
3	**Mathematical Preliminaries:** Neighbour of pixels, Connectivity, Relations, Equivalence & Transitive Closure; Distance Measures, Arithmetic/Logic Operations, Fourier Transformation, Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform.	9L
4	**Image Enhancement:** Spatial Domain Method, Frequency Domain Method, Contrast Enhancement – Linear & Nonlinear Stretching, Histogram Processing; Smoothing - Image Averaging, Mean Filter, Low-pass Filtering; Image Sharpening. High-pass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering; Enhancement in the frequency domain – Lowpass filtering, High pass filtering.	9L
5	**Image Restoration:** Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Restoration, Restoration by Homomorphic Filtering, Geometric Transformation – Spatial Transformation, Gray Level Interpolation.	8L
6	**Image Segmentation:** Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection –Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel Aggregation, Region Splitting & Merging	7L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the main concepts and key technologies of Image Processing
2	Apply different Image processing algorithms in Real Time cases.
3	Compare various Image Processing techniques.

LearningResources:	
1	Digital Image Processing, Gonzalves,Pearson
2	Digital Image Processing, Jahne, Springer India
3	Digital Image Processing & Analysis, Chanda & Majumder,PHI
4	Fundamentals of Digital Image Processing, Jain, PHI

5	Image Processing, Analysis & Machine Vision, Sonka, VIKAS
6	Getting Started with GIS- Clarke Keith. C; PE.
7	Concepts & Techniques of GIS - Lo C.P, Albert, Yeung K.W- PHI.

Course Name:	**Statistical Programming**		
Course Code:	PE-AIML501D	**Category:**	Professional Elective Course
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming Language & Statistic
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment:25	Attendance: 05

Course Objectives:	
1	To learn a programming language
2	To learn about online resources for R and import new function packages into the R workspace
3	To understand appropriate statistical tests using R

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction, How to run R, R Sessions, and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes.	6L
2	R Programming Structures, Control Statements, Loops, – Looping Over Non vector Sets,- If-Else, Arithmetic, and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quicksort Implementation-Extended Extended Example: A Binary Search Tree.	6L
3	Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability- Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Extended Example: Vector cross Product- Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /output, Accessing the Keyboard and Monitor, Reading and writer Files.	8L

4	Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot() Function – Customizing Graphs, Saving Graphs to Files.	4L
5	Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests, ANOVA.	8L
6	Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, – Poisson Regression- other Generalized Linear Models-Survival Analysis, Nonlinear Models, Splines - Decision-Random Forests.	8L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	List motivation for learning a programming language
2	Explain how data is analysed and visualized using statistic functions
3	Use data-sets to create testable hypotheses and identify appropriate statistical tests.

LearningResources:	
1	The Art of R Programming, Norman Matloff, Cengage Learning
2	Siegel, S. (1956), Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill International, Auckland.
3	R Cookbook, Paul Teetor, Oreilly.
4	R in Action, Rob Kabacoff, Manning
5	Venables, W. N., and Ripley, B. D. (2000), S Programming, Springer-Verlag, New York.
6	Venables, W. N., and Ripley, B. D. (2002), Modern Applied Statistics with S, 4th ed., Springer-Verlag, New York.
7	Weisberg, S. (1985), Applied Linear Regression, 2nd ed., John Wiley & Sons, New York.
8	Zar, J. H. (1999), Biostatistical Analysis, Prentice Hall, Englewood Cliffs, NJ
9	R for Everyone, Lander, Pearson

Course Name:	**Mobile Computing**			
Course Code:	OE-EC501D	**Category:**	Open Elective Course	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Networking	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To learn the basics of mobile computing
2	To learn the different architectures of mobile computing
3	To build an application of mobile computing

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Personal Communications Services (PCS):** PCS Architecture, Mobility management, Networks signalling. Global System for Mobile Communication (GSM) system overview: GSM Architecture, Mobility management, Network signalling.	5L
2	**General Packet Radio Services (GPRS):** GPRS Architecture, GPRS Network Nodes. Mobile Data Communication: WLANs (Wireless LANs) IEEE802.11standard, Mobile IP.	5L
3	**Wireless Application Protocol (WAP):** The Mobile Internet standard, WAP Gateway and Protocols, wireless mark up Languages (WML).Wireless Local Loop(WLL): Introduction to WLL Architecture, wireless Local Loop Technologies.	7L
4	**Third Generation (3G) Mobile Services:** Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of servicesin 3G.	7L
5	**Global Mobile Satellite Systems:** case studies of the IRIDIUM and GLOBALSTAR systems. Wireless Enterprise Networks: Introduction to Virtual Networks, Bluetooth technology, Bluetooth Protocols.	8L
6	**Server-side programming in Java:** Pervasive web application architecture, Device independent example application	8L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply the basic concepts of Mobile computing
2	Apply the knowledge of various architecture in Mobile computing
3	Apply the concepts of protection and security mechanisms

Learning Resources:	
1	"Pervasive Computing", Burkhardt, Pearson
2	"Mobile Communication", J.Schiller, Pearson
3	"Wireless and Mobile Networks Architectures", Yi-Bing Lin & Imrich Chlamtac, John Wiley & Sons, 2001
4	"Mobile and Personal Communication systems and services", Raj Pandya, Prentice Hall of India, 2001.

Course Name:	**Neural Network**			
Course Code:	OE-CS501B	**Category:**	Open Elective Course	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-1-0	**Pre-Requisites:**	Knowledge of Algorithm & Mathematics	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To expose towards intelligence systems & application areas of neural networks
2	To be able to understand basic idea of learning networks
3	To be able to develop computer models using Neural Network

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Various paradigms of Learning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques.	6L
2	What is a Neural Network-Human Brain, Comparison Between Artificial and Biological Neural Network Basic Models of Neuron, Neural Networks viewed as directed graphs, Feedback, Network Architectures, Knowledge representation, Artificial Intelligence and Neural Networks.	8L
3	Single Layer Perceptrons: Introduction, Adaptive filtering problem, Unconstrained optimization techniques, Linear least-squares filters, Least-mean square algorithm, Learning curves, Learning rate annealing techniques, Perceptron, Perceptron convergence theorem, Relation between the Perceptron and Bayes classifier for a Gaussian environment.	8L

4	Multilayer Perceptrons**:** Back-propagation Algorithm, Summary of back-propagation algorithm, XOR problem, Heuristics for making the back-propagation algorithm perform better, Output representation and decision rule	8L
5	Self-Organizing Systems, Unsupervised Learning, and Pattern clustering, Topological mapping. Radial basis function networks:- Regularization theory, RBF networks for function approximation, RBF networks for pattern classification	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the use of neural nets for soft computing problems
2	Apply the concept of the application areas of neural networks
3	Design &Develop neural network models applications

Learning Resources:	
1	"Artificial Neural Networks" by B.Yegnanarayana , Prentice Hall of India
2	"Neural Networks – A Classroom Approach" by Satish Kumar Tata McGraw-Hill.
3	"Neural Networks – A Comprehensive Foundation" by S.Haykin Prentice Hall.
4	"Fundamentals of Artificial Neural Networks" by Mohamad H. Hassoun The MIT Press

Course Name:	**Pattern Recognition**			
Course Code:	OE-CS501C	**Category:**	Open Elective Course	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concept of DBMS, Statistics, Mathematics	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To familiarize about different feature extraction techniques.
2	To learn about supervised and unsupervised pattern classifiers
3	Develop prototype pattern recognition algorithms that can be used to study algorithm behavior and performance against real-world multivariate data

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction** to pattern recognition and its applications.	2L
2	**Bayesian decision theory**: Classifiers, Discriminant functions, Decision surfaces Normal density and discriminant functions. Discrete features.	7L
3	**Parameter estimation methods :** Maximum-Likelihood estimation , Gaussian mixture models, Expectation-maximization method , Bayesian estimation.	6L
4	**Hidden Markov models for sequential pattern classification**:Discrete hidden Markov models, Continuous density hidden Markov models.	7L
5	**Dimension reduction methods:** Fisher discriminant analysis, Principal component analysis, Parzen-window method K-Nearest Neighbour method.	5L
6	**Non-parametric techniques** for density estimation. Decision trees	3L
7	**Linear discriminant function based classifier:** Perceptron, Support vector machines	3L
8	**Unsupervised learning and clustering:** Criterion functions for clustering Algorithms for clustering: K-means, Hierarchical and other methods.	3L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms
2	Know the basic methods of feature extraction and feature evaluation.
3	Differentiate between supervised and unsupervised classification problem

Learning Resources:	
1	R. O. Duda, P. E. Hart and D. G. Stork: Pattern Classification, John Wiley, 2001.
2	S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.
3	C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

Course Name:	**Graph Algorithm**			
Course Code:	OE-CS501D	**Category:**	Open Elective Course	
Semester:	Fifth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic knowledge on Algorithms, and Graph theory	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	The objective of this course is to form a foundation of graph algorithms

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Graph Traversal - BFS, DFS, Topological Sorting, Applications	3L
2	Minimum Spanning Tree	3L
3	Shortest Paths	4L
4	Network Flows, Applications	5L
5	Matching on Bipartite Graph, Applications	3L
6	Eulerian and Hamiltonian Tours	3L
7	Planar Graphs, Panarity Testing	4L
8	Graph Partitioning and its Applications	4L
9	Clique Partitioning	3L
10	Connected Components and its Applications	4L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Use algorithms to explore graphs
2	Compute shortest distance
3	Compute min spanning tree
4	Compute connected components

Learning Resources:	
1	Bernhard Korte and Jen Vygen, "Combinatorial Optimization, Theory and Algorithms (KV)", Springer, 4th Edition (2008). (GMU's libraries have online versions of this book.)
2	David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning about a Highly Connected World", Cambridge University Press, (2010).
3	Douglas B. West, "Introduction to Graph Theory", 2nd Edition (2000).
4	C. H. Papadimitriou and K. Steiglitz, Englewood Cliffs, "Combinatorial Optimization: Algorithms and Complexity", Prentice Hall, c1982, Reprinted by Dover Books, (1998).
5	Jon Kleinberg and Eva Tardos, "Algorithm Design (KT)", Pearson Education, Inc. (2006).
6	T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to Algorithms", The McGraw-Hill Companies, 2nd Edition (2001).

Course Name:	**Economics for Engineers**		
Course Code:	HM-HU 501	**Category:**	Management Science & Humanities Course
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 5

Course Objectives:	
1	Understand the role and scope of Engineering Economics and the process of economic decision making along with the different concepts of cost and cost estimation techniques.
2	Familiarization with the concepts of cash flow, time value of money and different interest formulas
3	Appreciation of the role of uncertainty in future events and using different concepts from probability to deal with uncertainty
4	Understand the concepts of Depreciation and Replacement analysis along with their methods of calculation and familiarization with the phenomenon of inflation and the use of price indices in engineering Economics
5	Introduction to basic concepts of Accounting and Financial Management

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Economic Decisions Making: Overview, Problems, Role, Decision making process. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models – PerUnit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.	9L
2	Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal& Effective Interest. Cash Flow & Rate of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing an Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity and Breakeven Analysis. Economic Analysis In The Public Sector -Quantifying And Valuing Benefits & drawbacks.	9L
3	Inflation and Price Change – Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates. Present Worth Analysis: End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives. Uncertainty In Future Events - Estimates and Their Use in Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Riskvs Return, Simulation, Real Options.	9L
4	Depreciation: Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances. Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life of a New Asset, Marginal Cost, Minimum Cost Life Problems. Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	9L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Discuss fundamentals of economic analysis.
2	Describe rate of return and profitability analysis, Present, Future, Annuity, Risk and return, BEP and Sensitivity Analysis, Bayesian joint probability and quantitative decision making, basic accounting system and balance sheet and P & L accounts etc.
3	Apply decision making skills in terms of Economic, financial considerations in practice.
4	Apply knowledge to take right financial decision at the right point in time in real world situation.

Learning Resources:	
1	James L.Riggs, David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e, Tata McGraw-Hill
2	Donald Newnan, Ted Eschembach, Jerome Lavelle: Engineering Economics Analysis, OUP
3	R.PaneerSeelvan: Engineering Economics, PHI
4	Sullivan and Wicks: Engineering Economy, Pearson
5	John A. White, Kenneth E. Case, David B. Pratt : Principle of Engineering Economic Analysis, John Wiley

Course Name:	**Database Management System Lab**			
Course Code:	PC-AIML591	**Category:**	Professional CoreCourse	
Semester:	Fifth	**Credit:**	2	
L-T-P:	0-0-4	**Pre-Requisites:**	Basic concepts of Data Structure & Algorithms and Mathematics	
Full Marks:	100			
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05	

Course Objectives:	
1	Creating database objects
2	Modifying database objects
3	Manipulating the data
4	Retrieving the data from the database server
5	Experiment with implementing event oriented programming using PL/SQL TRIGGER and CURSOR, and also implement user defined functions to solve real world problem.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Creating Database objects:** Creating a Table, Specifying Relational Data Types, Specifying Constraints, DROP, ALTER statements, Creating an object structure from another existing structure.	4P
2	**Table and Record Handling:** INSERT statement, DELETE, UPDATE, TRUNCATE statements, Populating data from other tables using insert and select together	12P
3	**Retrieving Data from a Database:** The SELECT statement, Using the WHERE clause, Using Logical Operators in the WHERE clause ,Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING Clause, Using Aggregate Functions , Combining Tables Using JOINS , Sub-queries.	12P
4	**Database Management:** Creating Views, Creating Column Aliases, Creating Database Users, Using GRANT and REVOKE.	4P
5	**Writing Oracle PL / SQL Stored Procedures:** Conditional /Iterative Statements, Introduction to Functions and Stored procedures Exception Handling.	8P
6	**Cursors in Oracle PL / SQL:** Cursor and its application.Triggers.	8P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Design and implement a database schema for a given problem-domain
2	Create and maintain tables using PL/SQL
3	Populate and query a database.

Learning Resources:	
1	SQL, PL/SQL the Programming Language of Oracle by Ivan Bayross.
2	SQL in 10 Minutes, Sams Teach Yourself (4th Edition)
3	SQL The Complete Reference by Groff James.
4	SQL: Quick Start Guide – The Simplified Beginner's Guide To SQL by Clydebank Technology
5	Oracle PL/SQL Programming by Feuerstein, Steven.

Course Name:	**Data Science Lab**			
Course Code:	PC-AIML592	**Category:**	Professional Core Course	
Semester:	Fifth	**Credit:**	2	
L-T-P:	0-0-4	**Pre-Requisites:**	Python & Statistics	
Full Marks:	100			
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05	

Course Objectives:	
1	To provide the students with the concepts of basic process of data science , Python & Data Science Most Used Packages
2	To develop the ability to apply knowledge of exploratory Data Analysis, supervised learning, regression analysis, network analysis etc.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Interactive commands in Python, data operations, simple programs for writing into files and reading from files. Data file manipulations programs.	4P
2	Plotting the data using X-Y graph, Bar- chart, and using other plotting techniques.	4P
3	Write programs to perform exploratory data analysis: variance, standard derivation, summarization, distribution, and statistical inference.	8P
4	Plotting the various distributions for given data sets.	8P
5	Classifying and presentation of data using support vector machine.	8P
6	Write programs for k-means clustering and presentation for given data sets.	8P
7	Write programs on graphs of social networks for community detection.	4P
8	Write programs for analysis of graphs to find centrality and page-rank	4P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate the concept of Data Science with Python Data Science Tool & IDE
2	Describe the statistics, data preparation, Exploratory Data Analysis
3	Explain the concept of Supervised Learning, Regression analysis & network Analysis

Learning Resources:	
1	Dr. Jeeva Jose, Begineer's Guide for Data Analysis Using R Programming, Khanna Publishing House, New Delhi
2	Python Data Science Handbook By Jake Vander Plas; Publisher: Oreilly
3	Python for Everybody By Dr Charles R. Severance
4	Mastering python for data science, Samir Madhavan

Course Name:	**Object Oriented Programming Lab**		
Course Code:	PE-AIML591A	**Category:**	Professional ElectiveCourse
Semester:	Fifth	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	ES-CS201(Programming for Problem Solving)
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To learn the fundamentals of object-oriented concepts
2	Toimplement the object-oriented concepts by a programming language
3	To be able to apply the programming skill to implement real world project

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Assignments on class, constructor, overloading, inheritance, overriding	16P
2	Assignments on Wrapper classes and Arrays	4P
3	Assignments on Interfaces - multiple inheritance, extending interfaces	8P
4	Assignments on creating and accessing Packages	4P
5	Assignments on Exception Handling	4P
6	Assignments on Graphics and Applet Programming	12P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Specify simple abstract data types and design implementations, using abstraction functions to document them.
2	Recognize features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity
3	Apply some common object-oriented design patterns and give examples of their use
4	Design applications with an event-driven graphical user interface

Learning Resources:	
1	Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2	Ali Bahrami – "Object Oriented System Development" – McGraw Hill
3	Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4	E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH
5	Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson

Course Name:	**Operating Systems Lab**			
Course Code:	PE-AIML591B	**Category:**	Professional ElectiveCourse	
Semester:	Fifth	**Credit:**	2	
L-T-P:	0-0-4	**Pre-Requisites:**	Basic concepts of Data Structure & Algorithms and Mathematics	
Full Marks:	100			
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05	

Course Objectives:	
1	To understand the mechanisms of OS to handle processes and threads and their communication.
2	To understand the mechanisms involved in memory management in contemporary OS
3	To understand the basic concept of distributed system including Mutual exclusion, and deadlock algorithm.
4	To understand the concurrency management system.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Managing Linux O.S.:** Creating a bash shell script, making a script executable, shell syntax (variables, conditions, control structures, functions, and commands). Partitions ,Device files, Raw and Block files, Formatting disks, Making file systems, Superblock, I-nodes, File system checker, Mounting file systems, Logical Volumes, Network File systems, init and the inittab file, Run-levels, Run level scripts. Password file management, Password security, Shadow file, Groups and the group file, Shells, restricted shells, user-management commands, homes andpermissions, default files, profiles, locking accounts, setting passwords, Switching user,Switching group, Removing users &user groups..	16P
2	Process: Starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.	4P
3	Signal: Signal handling, sending signals, signal interface, signal sets.	4P
4	Semaphore: Programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).	8P
5	POSIX Threads: Programming with pthread functions (viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel).	8P
6	Inter-process communication: Pipes (use functions pipe, popen, pclose), named pipes (FIFOs, accessing FIFO).	8P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply the practical knowledge of the different functions types and structures of Unix OS.
2	Apply the necessary knowledge various process management concepts like scheduling, synchronization etc.
3	Apply the necessary knowledge and skills for developing and debugging C and other programs in UNIX environment.

Learning Resources:	
1	Unix Shell Programming by Yashvant Kanetkar
2	Unix & Shell Programming by Behrouz A. Forouzan
3	Lab Manual

Course Name:	Image Processing Lab			
Course Code:	PE-AIML591C	Category:	Professional Elective Course	
Semester:	Fifth	Credit:	2	
L-T-P:	0-0-4	Pre-Requisites:	MATLAB Programming	
Full Marks:	100			
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05	

Course Objectives:	
1	To learn the basics of Image processing
2	To learn the principles of processing the different steps of Image processing
3	To build an application of Image processing

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Display of Grayscale Images.	4P
2	Histogram Equalization.	4P
3	Non-linear Filtering.	4P
4	Edge detection using Operators.	4P
5	2-D DFT and DCT.	4P
6	Filtering in frequency domain.	4P
7	Display of color images.	4P
8	Conversion between color spaces.	4P
9	DWT of images.	8P
10	Segmentation using watershed transform.	8P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Analyze images in the frequency domain using various transforms
2	Develop image processing application
3	Apply different techniques employed for the enhancement of images.

LearningResources:	
1	Digital Image Processing, Gonzalves, Pearson
2	Digital Image Processing, Jahne, Springer India
3	Digital Image Processing & Analysis, Chanda & Majumder,PHI
4	Fundamentals of Digital Image Processing, Jain, PHI
5	Image Processing, Analysis & Machine Vision, Sonka, VIKAS
6	Getting Started with GIS- Clarke Keith. C; PE.
7	Concepts & Techniques of GIS - Lo C.P, Albert, Yeung K.W- PHI.

Course Name:	**Statistical Programming Lab**		
Course Code:	PE-AIML591D	**Category:**	Professional Elective Course
Semester:	Fifth	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Knowledge of programming
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment:35	Attendance: 05

Course Objectives:	
1	To familiarize the students with the installation of R Programming Environment.
2	To utilize R data types for developing programs.
3	To familiarize the students with the use of different R Data Structures.
4	To develop programming logic using R Packages.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Implementation of vector data objects operations	4P
2	Implementation of various operations on matrix, array and factors in R	4P
3	Implementation and use of data frames in R	4P
4	Create Sample (Dummy) Data in R and perform data manipulation with R	4P
5	Study and implementation of various control structures in R	4P

6	Data Manipulation with dplyr package	4P
7	Data Manipulation with data.table package	4P
8	Study and implementation of Data Visualization with ggplot2	4P
9	Study and implementation of data transpose operations in R	4P
10	Create a data set and do statistical analysis on the data using R.	4P
11	Study and Implementation of T-Test, F- Test and Chi-Square Test	8P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain different R Data Structures.
2	Apply programming logic using R Packages.
3	Analyze the datasets using R programming capabilities.

LearningResources:	
1	Norman Matloff, The Art of R Programming, UC Davis 2009.
2	Siegel, S. (1956), Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill International, Auckland.
3	R Cookbook, PaulTeetor, Oreilly.
4	R in Action, Rob Kabacoff, Manning
5	Venables, W. N., and Ripley, B. D. (2000), S Programming, Springer-Verlag, New York.
6	Venables, W. N., and Ripley, B. D. (2002), Modern Applied Statistics with S, 4th ed., Springer-Verlag, New York.
7	Weisberg, S. (1985), Applied Linear Regression, 2nd ed., John Wiley & Sons, New York.
8	Laboratory Manual

Course Name:	**Project-I**		
Course Code:	PW-AIML581	**Category:**	Sessional Course
Semester:	Fifth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Knowledge of engineering, science and management subjects
Full Marks:	100		
Examination Scheme:	Semester Examination: 20		Continuous Assessment: 80

Course Objectives:	
1	In depth knowledge gain in the domain of the assigned topic.
2	To be able to formulate the problem in the assigned topic.
3	To be able to execute the action plan for conducting the project as a team work.
4	To be able to perform development of product/process, testing, analysing the results and future scope.

Course Outcomes:	
After completion of the course, students will be able to:	
1	Work as a team member.
2	Preparea report in the standard format.
3	Present Seminar before any standard body.

Course Name:	**Soft Skill Development Lab**		
Course Code:	HM-HU591	**Category:**	Management Science & Humanities Course
Semester:	Fifth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Students must have basic knowledge of English Language.
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To equip the students with good communication skills.
2	Enable the students to think and speak effectively on everyday topics, including topics related to technical concepts.
3	To prepare them for interviews and future job environments.
4	Developing industry-ready attitude towards professional communication.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Conversation Practice Sessions - General Conversation – Warm-up sessions – Basics of Communication, verbal and non-verbal communication.	4P
2	Group Discussion - Group Discussion & Debates, Do's & Don'ts, etc., Intensive Practice Sessions.	8P
3	Interview sessions: Principles and practices of Personal Interview. Do's and Don'ts of facing an interview. SWOC Analysis. Rigorous practices of mock-interviews.	6P
4	Presentations: Fundamentals of presentation skills, Secrets of an effective presentation, Presentation Practice Sessions with the help of power point presentation and other audio-visual aids, Face question answer sessions at the end of their presentation.	6P
Total		**24P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Honing over all Communicative Competence.
2	Develop Team Building and Leadership Quality.
3	Deliver an enthusiastic and well-practiced presentation
4	Communicate with clarity and confidence thereby enhancing employability skills of the students.

Learning Resources:	
1	Soft Skills: Key to success in Workplace and Life, Meenakshi Raman and Shalini Upadhyay
2	Communication Skills. Sanjay Kumar and PushpLata, Oxford University Press, 2011.
3	Monipally: Business Communication, Tata McGraw Hill
4	Madhukar: Business Communications; Vikas Publishing House
5	Senguin J: Business Communication; Allied Publishers
6	Business Communication: Rajendrapal & Korlahalli

Course Name:	**Aptitude Skill Development-I**		
Course Code:	MC571	**Category:**	**Mandatory Course**
Semester:	Fifth	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Basic knowledge of Mathematics and English Language
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To be familiar with the basic concepts of QUANTITATIVE ABILITY.
2	To be familiar with the basic concepts of LOGICAL REASONING Skills.
3	To be familiar with the basic concepts of PROBABILITY.
4	Acquire knowledge in VERBAL REASONING and VOCABULARY

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Basics of Quantitative Abilities: Number System, HCF and LCM, Average, Ratio, Proportion and Variations, Problems on Percentage.	4L
2	Arithmetic Quantitative Abilities: Problems on Ages, Profit and Loss, Time and Work, Problems on Simple and Compound Interest, Problems on Time, Speed and Distance.	6L
3	Permutation and Combination, Set theory, Venn Diagram, Probability	5L
4	Logical Reasoning: Number Series, Alpha Numerical, Letter & Symbol Series, Syllogisms Numerical and Alphabet Puzzles, Seating Arrangement, Blood Relation and Calendars.	7L
5	Data Interpretation	2L
6	Verbal: Analogies, Antonym, Synonym, Sentence Correction, Fill in the Blanks	3L
Total		**27L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the basic concepts of QUANTITATIVE ABILITY.
2	Understand the basic concepts of LOGICAL REASONING Skills.
3	Understand the basic concepts of PROBABILITY.
4	Acquire satisfactory competency in use of VERBAL REASONING

Learning Resources:	
1	Arun Sharma, "Quantitative abilities", McGraw-Hill
2	R.S.Agrawal, "Quantitative Aptitude for Competitive Examinations", S.Chand
3	R.S.Agarwal,"A Modern Approach to Verbal & Non-Verbal Reasoning ", S.Chand

Course Name:	**Constitution of India**		
Course Code:	MC572	**Category:**	Mandatory Course
Semester:	Fifth	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Develop an understanding of the nation's constitution.
2	Develop knowledge about the various levels of governance in the country.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Sources and Constitutional history. Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.	3L
2	**Union Government and its Administration :** Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Lok Sabha, Rajya Sabha Supreme Court	6L
3	**State Government and its Administration:** Governor**.** Role and Position, CM and Council of ministers High Court	6L
4	**Local Administration District's Administration head:** Role and Importance, Municipalities: Introduction, Mayor, and role of Elected	6L

	Representative. Pachayati raj: Introduction, Zila Pachayat, Elected officials and their roles. Importance of grass root democracy	
5	**Election Commission Election Commission:** Role and Functioning, Chief Election Commissioner	3L
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Gain an understanding of the constitution of India.
2	Become aware of the various levels of governance in the country.

Learning Resources:	
1	'Indian Polity' by Laxmikanth
2	'Indian Administration' by Subhash Kashyap
3	'Indian Constitution' by D.D. Basu
4	'Indian Administration' by Avasti and Avasti