Curriculum for Undergraduate Degree (B.Tech.) in Computer Science and Engineering (Data Science) (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Fifth Semester

Course Name:	**Machine Learning**		
Course Code:	PC-CS(D) 501	**Category:**	Professional Elective
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	BSM 301, BSM 40404
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn the concepts of data and patterns
2	To design and analyze various machine learning algorithms.
3	Explore supervised and unsupervised machine learning
4.	Explore Deep Learning Techniques and various feature extraction.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Supervised Learning: - Distance based methods, Nearest Neighbor. Learning Techniques with Decision Tree and Naïve Bayes Classifier.	6
2	Supervised Learning (Regression/Classification):- Linear Regression, Logistic Regression, Linear Models optimization SVM, Dealing with Non Linearity and Kernel Methods. Multi class classification, Ranking	8
3	Introduction to Unsupervised Learning:- K-Means Clustering, Kernel K-Means, Dimensionality Reduction with PCA and Kernel PCA. Preliminary idea of Factorization and generative models (Mixture model and Latent factor model).	8
4	Evaluating Machine Learning Algorithms model selection, Introduction to statistical learning theory and Ensemble Methods (Bagging, Boosting and Random Forests).	6
5	Model Estimation, Modeling Time Series Data, Deep Learning and Feature Extraction Techniques. Shallow Neural Network and Deep Neural Network.	7
6.	Case Study: - Selection from a Technique and implementation with Model Selection.	1
Total		**36**

Course Outcomes:	
1.	Explain different supervised Learning Techniques
2.	Identify the difference between Linear and Non Linear Models
3.	Understand different unsupervised learning techniques.
4.	Understand the concept of model estimation and deep learning techniques.

Learning Resources:	
1	Machine Learning, Tom Mitchell, McGraw Hill, 1997.
2	Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
3	Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4	Hastie, Tibshirani, Friedman The Elements of Statistical Learning Springer 2007

Course Name:	**Object Oriented Programming**		
Course Code:	PC-CS502	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	ES-CS 101 (Programming for Problem Solving), PC-CS 392 (IT Workshop (Using Python) Lab)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Gain knowledge about basic Java language syntax and semantics to write Java programs and use concepts such as variables, conditional and iterative execution methods etc.
2	Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, invoking methods etc and exception handling mechanisms.
3	Understand the principles of inheritance, packages and interfaces.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Object-oriented design Concepts of object-oriented programming language, Major and minor elements, Object, Class, relationships among objects, aggregation, links, relationships among classes-association, aggregation, using, instantiation, meta-class, grouping constructs.	10
2	Object-oriented concepts Difference between OOP and another conventional programming – advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism	04
3	Class & Object proprieties Basic concepts of java programming – advantages of java, byte-code & JVM, data types, access specifiers, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, garbage collection, nested & inner classes, basic string handling concepts. command line arguments, basics of I/O operations – keyboard input using BufferedReader & Scanner classes.	06
4	Reusability Properties Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, use of abstract classes & methods, interfaces. Creation of packages, importing packages, member access for packages.	06

5	Exception handling & Multithreading Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter- thread communication, deadlocks for threads, suspending & resuming threads.	06
6	Applet Programming (using swing) Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applets, concept of delegation event model and listener, I/O in applets, use of repaint(), getDocumentBase(), getCodeBase() methods, layout manager (basic concept), creation of buttons (JButton class only) & text fields.	04
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify classes, objects, members of a class and relationships among them, needed for a specific problem.
2	Demonstrate the concepts of polymorphism and inheritance.
3	Implement Java collection API as well as the java standard class library.
4	Implement error handling techniques using exception handling.
5	Implement the concept of Multithreading and Applet programing.

Learning Resources:	
1	Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2	E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH
3	Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4	Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson
5	Ivor Horton's Beginning Java 2 SDK – Wrox

Course Name:	**Formal Language and Automata Theory**		
Course Code:	PC-CS503	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Mathematics II (BS M 201), Mathematics III (BS M 301), Digital Electronics (ES EC 302), Discrete Mathematics (PC-CS404)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To give an overview of the theoretical foundations of computer science from the perspective of formal languages
2	To acquire insights into the relationship among formal languages, formal grammars, and automata
3	To illustrate finite state machines to solve problems in computing
4	To develop the ability to design of PDA and Turing Machine

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Fundamentals:** Introduction: Basic Mathematical Notation and techniques, Strings, Alphabet, Language, Grammar, Productions and Derivation, Chomsky hierarchy of languages. Basic definition of sequential circuit, block diagram, concept of transition table and transition diagram (Relating of Automata concept to sequential circuit concept), Design of sequence detector, Finite state machine: Definitions, capability & state equivalent, kth-equivalent concept	4L
2	**Finite Automata:** Finite automaton model, acceptance of strings, and languages, Deterministic finite automaton and non deterministic finite automaton. Transition diagrams and Language recognizers. NFA with λ transitions - Significance, acceptance of languages. Conversions and Equivalence: Equivalence between NFA with and without λ transitions, NFA to DFA conversion, minimisation of Finite Automata, Finite Automata with output- Moore and Mealy machines	7L
3	**Regular Languages and Regular Grammar:** Regular sets, Regular expressions, identity rules. Arden's theorem state and proof, Constructing finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and FA Closure properties of regular languages, pumping lemma for regular languages	7L

4	**Context-free languages and Pushdown Automata:** Context Free Grammars, Parse three, Ambiguity in context free grammars, Minimization of Context Free Grammars. Chomsky and Greibach normal forms. Pumping Lemma for Context Free Languages, Closure property of CFL Push down automata: Definition, Acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence, equivalence of CFL and PDA, interconversion. (Proofs not required), introduction to DCFL and DPDA	10L
5	**Context Sensitive Languages:** Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	2L
6	**Turing Machine:** Turing Machine, definition, model, Design of TM, Computable functions, Recursively Enumerable Languages, Unrestricted Grammar, Church-Turing thesis, Variants of Turing machines, Universal Turing Machine, Halting problem	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the concept of abstract machines and their power to recognize the languages
2	Construct automata for any given pattern and find its equivalent regular expressions
3	Design context free grammars for formal languages.
4	Design PDA and Turing Machine.

Learning Resources:	
1	Peter Linz, "An Introduction to Formal Language and Automata", Third Edition, Narosa Publishers, New Delhi, 2002.
2	Mishra K L P and Chandrasekaran N, "Theory of Computer Science – Automata, Languages and Computation", Third Edition, Prentice Hall of India, 2004.
3	Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", Second Edition, Prentice Hall of India, Pearson Education, New Delhi, 2003.
4	Hopcroft H.E. and Ullman J. D., "Introduction to Automata Theory Language and Computation", Pearson Education.
5	John C Martin, "Introduction to languages and the Theory of Computation", TMH
6	C.K.Nagpal, "Formal Languages and Automata Theory", Oxford
7	ZVI Kohavi, "Switching & Finite Automata", Tata McGraw Hill

Course Name:	**Introduction to Data Science**		
Course Code:	PC-CS(D)504	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Knowledge of mathematics, Analytical & logical skills
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To familiarize the students with the basic concepts of data and data science.
2	To acquaint the students with basic machine learning principles.
3	To generate concept about data visualization & recommendation system
4	To create awareness about ethical & unethical use of data

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction** Data, Information & Data Science, Statistical inference, modelling, probability distribution, fitting a model. Basic tools of Data Analysis: Plot, graphs, and summary statistics.	6
2	**Feature selection, Data Visualization** Introduction to Feature Generation & feature selection methods. Basic Principles of Data Visualization, ideas and tools for data visualization, relevant case study.	7
3	**Machine Learning and Recommendation System** Supervised and unsupervised learning, Basic Machine Learning algorithms Introduction to Recommendation system, Recommendation Engine, Dimensionality reduction.	7
4	**Data Science & Ethical Issue** Discussions on privacy, security & ethics. Ethical and unethical data analysis: intruding in personal domain for data acquisition & analysis, Social media analytics.	4
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the basic concepts of data and machine learning.
2	Understand visual representation of data.
3	Understand recommendation system.
4	Understand ethical & unethical use of data.

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

Course Name:	**Economics for Engineers**		
Course Code:	HM-HU 501	**Category:**	Management Science & Humanities
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.	9
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.	9
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 &	9

	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, Risk vs Return, Simulation, Real Options.	
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.	9
Total		**36**

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.Paneer Seelvan: 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:	**Software Engineering**		
Course Code:	PE-CS(D)501A	**Category:**	Professional Elective
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming for Problem Solving
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Exposer of the challenges of large scale software development and the ideas of how to overcome those.
2	To provide the idea of decomposing the given problem into Analysis, Desing, Implementation, Testing and Maintenance phases.
3	To provide an idea of using various process models in the software industry according to given circumstances.
4	To gain the knowledge of how Analysis, Design, Implementation, Testing and Maintenance processes are conducted in a software project.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Module I:** Overview of System, System Development Life Cycle, Waterfall Model , Iterative Waterfall Model, V Model, Spiral Model, Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model, SRS.	8
2	**Module II:** System Design – DFD, Top-Down And Bottom-Up design; Decision tree, Decision table and structured English; Functional vs. Object- Oriented approach.	10
3	**Module III:** Coding & Documentation guidelines, Errors, Faults and Failures. Testing – Levels of Testing, Unit Testing, Integration Testing, System Testing, Validation & Verification in Testing, Black Box Testing, White Box Testing Strategies.	10
4	**Module IV:** UML diagrams: Class diagram, interaction diagram, collaboration diagram, sequence diagram, state chart diagram, activity diagram.	8
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Compare and apply the software development models.
2	Apply the data flow model, relational model and unified model to visualize the design of a system.
3	Know the degree of functionality and the relationship of modules of a software system.
4	Illustrate the validation and verification types of testing techniques and the steps of project management and scheduling.

Learning Resources:	
1	Rajib Mall, Fundamental of Software Engineering, PHI Learning Pvt. Ltd.
2	Roger S. Pressman, Bruce R. Maxim, Software Engineering : A practitioner's approach– Pressman, McGraw Hill Education
3	Pankaj Jalote , Software Engineering: A Precise Approach, Wiley

Course Name:	**Advanced Algorithm**		
Course Code:	PE-CS501B	**Category:**	**Professional Elective**
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Design and Analysis of Algorithm, Data Structure, Discrete Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Introduce students to the advanced methods of designing and analyzing algorithms.
2	The student should be able to choose appropriate algorithms and use it for a specific problem.
3	To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
4	Students should be able to understand different classes of problems concerning their computation difficulties.
5	To introduce the students to recent developments in the area of algorithmic design.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Sorting:** Review of various sorting algorithms, Topological sorting **Lower Bound Theory:** O(n log n) bound for a comparison sort. **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.	5
2	**Matroids:** Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. **Disjoint Set Manipulation:** Set manipulation algorithm like union-find, union by rank, path compression. **Graph Matching:** Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.	6
3	**String matching problem:** Different techniques – Naive algorithm, string matching using finite automata, and Knuth, Morris, Pratt (KMP) algorithm with their complexities **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.	6

4	**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 the complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm.	5
5	**Computational Geometry:** Robust geometric primitives, Convex Hull, Triangulation, Voronoi diagrams, Nearest neighbor search, Range search, Point location, Intersection detection, Bin Packing, Medial-axis transform, Polygon partitioning, Simplifying Polygons, Shape Similarity, Motion Planning, Maintaining line arrangements, Minkowski sum.	5
6	**Linear Programming:** Geometry of the feasibility region and Simplex algorithm **NP-completeness:** Examples, proof of NP-hardness and NP-completeness.	5
7	Recent trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.	4
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain lower bound theorem, various graph algorithms along with analysis of different sorting algorithms.
2	Understand matroids, disjoint set manipulation, graph matching algorithm, different string-matching algorithms, and operations on Strassen's matrix manipulation etc.
3	Understand different DFT algorithms and Modulo representation of Integer/ Polynomial.
4	Explain Convex hull, Voronoi diagram, Range search, Bin packing and other methods under computational geometry.
5	Understand Linear programming, NP-completeness and recent activities in the field of advanced data structure.

Learning Resources:	
1	"Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2	"The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3	"Algorithm Design" by Kleinberg and Tardos.
4	Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi.

Course Name:	**Computer Graphics**		
Course Code:	PE-CS501C	**Category:**	Professional Elective
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To familiarize the students with the basic concepts of computer graphics and scan conversion algorithms.
2	To acquaint the students with transformation, clipping algorithms and their application areas.
3	To develop the ability to compare shading models and hidden surface removal algorithms.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to computer graphics & graphics systems:** Overview of computer graphics, Visualization & image processing; RGB color model, direct coding, lookup table; display devices, Plotters, printers, digitizers, light pens etc.; Computer graphics software. Scan conversion algorithms: Points & lines; DDA & Bresenham's line algorithm, Circle generation algorithm; Ellipse generating algorithm; scan line polygon, boundary fill & flood fill algorithm.	9
2	**2D & 3D Transformation**: Basic transformations: Translation, Rotation, Scaling; Matrix representations & homogeneous coordinates, transformations between coordinate systems, Composite Matrix Transform; Reflection, Shear; Transformation of points, lines and related problems , 3D transformations: Translation, Rotation, Scaling.	8
3	**2D & 3D Clipping**: Viewing pipeline, Window to view port co-ordinate transformation, clipping operations, point clipping, line clipping algorithms:. Cohen and Sutherland, Liang Bersky, Cyrus-Beck line clipping algorithms; Polygon Clipping: Sutherland-Hodgeman Polygon clipping algorithm, 3D viewing & Projection: Parallel & Perspective projection, vanishing point	9
4	**Curves, Hidden surface removal algorithm & Shading models** Curves: Curve representation, surfaces, Bezier curves, B-spline curves, conditions for joining two Bezier Curve segments and related problems. Hidden surface removal algorithms: Depth comparison, Z-buffer algorithm, Backface detection, BSP tree method, the Painter's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods , Fractal - geometry. Color & shading models: Lighting conditions: Ambient, diffuse etc.; Shading models: Flat, Gouraud & Phong shading models, comparison.	10
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand contemporary graphics hardware componemts.
2	Implement different algorithms for drawing basic graphics structures like straight line, circle & ellipse.
3	Demonstrate working of clipping algorithms and distinguish between different clipping methods.
4	Analyze methods of transformations and solve problems on them.
5	Use spline properties, shading models and hidden surface removal algorithms for creating real world object.

Learning Resources:	
1	Hearn, Baker – "Computer Graphics (C version 2nd Ed.)" – Pearson education
2	Z. Xiang, R. Plastock – " Schaum's outlines Computer Graphics (2nd Ed.)" – TMH
3	D. F. Rogers, J. A. Adams – "Mathematical Elements for Computer Graphics (2nd Ed.)" – TMH
4	Anirban Mukhopadhyay, Arup Chattopadhyay, "Introduction to Computer Graphics & Multimedia"

Course Name:	**Machine Learning**		
Course Code:	PC-CS(D)591	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	BSM 301, BSM 404
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To learn the concepts of data and patterns
2	To design and implement various machine learning algorithms.
3	Implement supervised and unsupervised machine learning
4.	Implement Deep Learning Techniques and various feature extraction with case study.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	Implementation of Linear Regression , logistic regression, multivariate logistic regression	9
2	Decision Tree and Ensemble Techniques, Bagging, Boosting	6
3	LSTM algorithm-Time Series Analysis	3
4	Clustering Techniques Implementation – Different Techniques, SVM implementation	6
5	Simple neural network implementation, Deep Learning techniques – Shallow and Deep Neural network Concept of Keras , Tensor Flow	9
6.	Factorization and Generative Model implementation	3
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Implement different regression and classification algorithms.
2.	Implement different clustering algorithms.
3.	Implement Deep Learning Techniques.

Learning Resources:	
1	Practical Machine Learning Released January 2016, Publisher(s): Packt Publishing ISBN: 9781784399689 – Sunita Gollapudi
2	Hands-On Machine Learning with Scikit-Learn and TensorFlow- Aureillen Garon O Reilley
3	Hands-On Deep Learning Algorithms with Python-Sudharsan Ravichandiran Packt Publishing
4	Introduction to Machine Learning with Python,by Andreas C. Müller, Sarah Guido Released October 2016, Publisher(s): O'Reilly Media, Inc., ISBN: 9781449369415

Course Name:	**Object-Oriented Programming Lab**		
Course Code:	PC-CS592	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Basic understanding of object-oriented paradigm
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To build software development skills using java programming for real-world applications.
2	To understand and apply the concepts of classes, packages, interfaces, array list, exception handling and file processing.
3	To develop applications using generic programming and event handling.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Assignments on class, constructor, overloading, inheritance, overriding	3
2	Assignments on wrapper class, arrays	3
3	Assignments on developing interfaces- multiple inheritance, extending interfaces	6
4	Assignments on creating and accessing packages	6
5	Assignments on multithreaded programming	9
6	Assignments on generic class and arraylist	6
7	Assignments on applet programming	3
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Implement Java programs for simple applications that make use of classes, packages and interfaces.
2	Implement Java programs with arraylist, exception handling and multithreading.
3	Design applications using generic programming, applet and event handling.

Learning Resources:	
1	P. J. Deitel, H. M. Deitel, "Java for Programmers", Pearson Education, PHI, 4th Edition, 2007.
2	P. Radha Krishna, "Object Oriented Programming through Java", Universities Press, 2nd Edition, 2007
3.	Bruce Eckel, "Thinking in Java", Pearson Education, 4th Edition, 2006.
4.	Sachin Malhotra, Saurabh Chaudhary, "Programming in Java", Oxford University Press, 5th Edition, 2010.

Course Name:	**Introduction to R Programming**		
Course Code:	PC-CS593	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Programming for Problem Solving, Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	Design real life problems of handling mathematical and statistical manipulations and think creatively about solutions through a free software R.
2	To be exposed to advanced applications of mathematics, engineering and natural sciences.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**UNIT-I:** Introduction to mechanism for statistics, data analysis, and machine learning; Introduction of R Programming, install and run R, use of R help files, R Sessions, R Objects – Vectors, Attributes, Matrices, Array, Class, List, Data Frames etc. Operators, control statements in R.	6
2	**UNIT-II:** R Programming Structures, Control Statements, Loops, Repeat and Break, R-Function, R-Vector Function, Recursive Function in R.	6
3	**UNIT-III:** R Packages (Install and Use), Input/Output Features in R, Reading or Writing in File. Data Manipulation in R. Rearranging data, Random Number and Simulation, Statistical methods like min, max, median, mean, length, Linear Regression, Normal Distribution, Decision tree.	6
4	**UNIT-IV:** Graphics, Creating Graphs, The Workhorse of R Base Graphics, Graphical Functions – Customizing Graphs, Saving Graphs to Files, Pie chart, Bar Chart, Histogram.	6
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the basics structure of R programming in terms of control statements, object, vector, matrix, functions.
2	Understand the use of R for Statistical analytics
3	Visualize the data with R Graphics.

Learning Resources:	
1	Daniel Bell, R Programming A Step-by-Step Guide for Absolute Beginners by, KDP Amazon Publishing.
2	Dr. Jeeva Jose, Begineer's Guide for Data Analysis Using R Programming, Khanna Publishing House,New Delhi
3	*Joseph Adler*, R IN A NUTSHELL, O'Reilly Media, Inc

Course Name:	**Soft Skill Development Lab**		
Course Code:	HM-HU591	**Category:**	HM
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 an 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.	4
2.	Group Discussion - Group Discussion & Debates, Do's & Don'ts, etc., Intensive Practice Sessions.	8
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.	6
4.	Presentations: Fundamentals of presentation skills, Secrets of an effective presentation, Presentation Practice Sessions with the help of PowerPoint presentations and other audio-visual aids, Face question-answer sessions at the end of their presentation.	6
Total		**24**

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 Courses**
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, Mensuration and Logarithm.	**5L**
4	Logical Reasoning: Number Series, Alpha Numerical, Letter & Symbol Series, Numerical and Alphabet Puzzles, Seating Arrangement, Blood Relation and Calendars.	**7L**
5	Data Interpretation	**2L**
Total		**24L**

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