DESIGN & ANALYSIS OF ALGORITHM
(DCS501)

Objective: To understand the importance of algorithm and its complexity of an algorithm in terms of time and space complexities.	
Unit	**Topic**
I	**Introduction**: Algorithms, Analyzing algorithms, Complexity of algorithms, Growth of Functions, Recurrences, Substitution method, Iteration method, Master method, Merge Sort, Quick-Sort, Heap Sort, Shell Sort, Sorting in linear time.
II	**Advanced Data Structures:** Red-black trees, Augmenting data structures, Order-statistic tree, B-Trees, Binomial heaps, Fibonacci heaps.
III	**Dynamic Programming:** Elements of dynamic programming, Assembly-line scheduling problem, Matrix chain multiplication, finding longest common subsequence,0/1 Knapsack problem; **Greedy Algorithm:** Elements of greedy strategy, Activity selection problem, Huffman encoding, Task-scheduling problem, Knapsack problem, Amortized analysis.
IV	**Graph Algorithms:** Searching in graph, Spanning trees, Minimum cost spanning trees: Kruskal's and Prim's algorithms; Single source shortest path algorithms, Dijkstra's and Bellman Ford algorithms; All pair shortest paths algorithms, Floyd Warshal's algorithm, Network flow problem. Backtracking, Graph Coloring, n-Queen Problem, Hamiltonian Cycles and Sum of Subsets, Branch and Bound with Examples Such as Travelling Salesman Problem.
V	**String Matching Algorithms:** Naïve string-matching algorithm, Rabin-Karp algorithm, Knuth-Morris-Pratt algorithm. Introduction of NP-completeness, Randomized algorithms and Approximation Algorithms

Text Book (s):

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein, MIT Press.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman, Pearson.
3. "Algorithm Design" by Kleinberg and Tardos, Pearson.
4. Sara Baase and Allen Van Gelder ,Computer Algoritms : "Introduction to Design and Analysis", Pearson Education
5. Brassard Bratley "Fundamental of Algorithms", PHI Learning Private Limited.
6. M T Goodrich "Algorithms Design", John Wiley
7. Aho, "Design and Analysis of Computer Algorithms", Pearson Education.
8. Horowitz and Sahani ,"Fundamentals of Computer Algorithms", Galgotia Publications.
9. Tremblay & Sorenson, "An Introduction to Data Structures with Applications", TMH.
10. J. P. Tremblay and R.B. Bunt, "An Introduction of Computer Science –An Algorithmic Approach", Tata Mcgraw Hill

SOFTWARE ENGINEERING
(DCS502)

Objective: The course is aimed at enhancing skills that will enable the student to develop business software's that are simple reliable and capable of modification as per requirement.	
Unit	**Topic**
I	Introduction to Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes. Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models.
II	Software Requirement Specifications (SRS). Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modeling, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS. Software Quality Attributes, Software Quality Assurance (SQA): Verification and Validation, SQA Plans, Software Quality Frameworks, ISO 9000 Models, SEI-CMM Model.
III	Software Design: Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design. Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs.
IV	Software Testing: Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom-Up Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards.
V	Software Maintenance and Software Project Management, Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re-Engineering, Reverse Engineering. Software Configuration Management Activities, Change Control Process, Software Version Control, An Overview of CASE Tools. Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management.

Text Book (s):

1. Software Engineering: A Practitioner's Approach, Pressman Roger, TMH.
2. An Integrated Approach to Software Engineering, Pankaj Jalote. Narosa Pub.
3. Software Engineering Concepts: Richard Fairly, Tata McGraw Hill.
4. Schaum's Series, "Software Engineering", TMH
5.Ghezzi, Carlo and Others, "Fundamentals of Software Enigneering", PHI
6.Alexis, Leon and Mathews Leon, "Fundamental of Software Engineering", Vikas
7.Sommerville, Ian, "Software Engineering'', AWL

FOUNDATION OF DATA SCIENCES
(DCS503)

Objective: The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Unit	Topic
I	**Introduction to Data Science:** Why Python? - Essential Python libraries - Python Introduction- Features, Identifiers, Reserved words, Indentation, Comments, Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion- Operators. Decision Making- Looping- Loop Control statement- Math and Random number functions. User defined functions - function arguments & its types. User defined Modules and Packages in Python- Files: File manipulations, File and Directory related methods - Python Exception Handling. OOPs Concepts -Class and Objects, Constructors – Data hiding- Data Abstraction- Inheritance.
II	**Introduction to NumPy:** NumPy Basics: Arrays and Vectorized Computation- The NumPy ndarray- Creating ndarrays- Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting Unique and Other Set Logic.
III	**Mathematical Foundations: Linear Algebra:** Vectors, Matrices, Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation, Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, the Central Limit Theorem, Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Bayesian Inference
IV	**Introduction to pandas Data Structures**: Series, Data Frame, Essential Functionality: Dropping Entries Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.
V	**DATA CLEANING, PREPARATION AND VISUALIZATION:** Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots. **Case Studies of Data Science Application:** Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

Text Book (s):

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., "Data Sciences", Khanna Publishing House, Delhi.
4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.
5. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi.
6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.

MACHINE LEARNING
(DCS504)

Objective: To understand the basic building blocks and general principles that allows one to design machine learning algorithms.	
Unit	**Topic**
I	Basic Concepts, Introduction to Machine Learning, Applications of ML, Design Perspective and Issues in ML, Supervised, Unsupervised, Semi-supervised learning with applications and issues, A Formal Learning Model, The Runtime of Learning.
II	Model (or hypothesis) representation, decision boundary, cost function, gradient descent, regularization, Diagnostic: debugging a learning algorithm, evaluating a hypothesis (Model selection), training/validating/testing procedures, diagnosing bias versus variance and vice versa, regularization and bias/variance, learning curves, Accuracy and Error measures: classifier accuracy measures, predictor error measure, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, tradeoff between both, accuracy.
III	Clustering: Unsupervised learning technique, Similarity and Distance Measures, k-means and k-medoids algorithm, optimization objective, random initialization, choosing value of k, EM algorithm Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, Graphical Models, Combining Multiple Learners.
IV	Reinforcement Learning: Elements of Reinforcement Learning, Model-Based Learning, Temporal Difference Learning, Generalization, Design and Analysis of Machine Learning Experiments.
V	Genetic Algorithm, Schemata Theorem, Differential Evolution, Particle Swarm Optimization, Ant Colony Optimization, Convergence Analysis. Genetic Algorithm, Schemata Theorem, Differential Evolution, Particle Swarm Optimization, Ant Colony Optimization, Convergence Analysis.

Text Book (s):

1. Ethem Alpaydin, Introduction to Machine Learning, PHI.
2. H. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques Morgan Kaufmann.
3. Tom Mitchell, Machine Learning, McGraw-Hill.
4. Shai Shalev-Shwartz, and Shai Ben-David, "Understanding Machine Learning", Cambridge University Press

5 . Haykin S., Neural Networks and Learning Machines, Third Edition, Prentice Hall.

6 . NPTEL lectures on Introduction to Machine Learning

CONSTITUTION OF INDIA
(HM 502)

Objective: Able to understand historical background of the constitutional making and its importance for building a democratic India, the structure of Indian government, the structure of state government, the local Administration

Unit	Topic
I	**CONSTITUTION OF INDIA** Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution, Preamble to the Indian Constitution Fundamental Rights & its limitations.
II	**FUNDAMENTAL DUTIES AND UNION EXECUTIVES** Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India
III	**STATE LEGISLATURE AND ELECTORAL PROCESS** State Executives – Governor Chief Minister, State Legislature High Court of State, Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th &91st Amendments.
IV	**HUMAN RIGHTS** Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India ,Powers and functions of Municipalities, Panchyats and Co - Operative Societies..
V	**PROFESIONAL ETHICS** Scope & Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility. Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering.

Reference Books:

1. Durga Das Basu: "Introduction to the Constitution on India", (Students Edn.) Prentice –Hall EEE, 19th / 20th Edn., 2001
2. Charles E. Haries, Michael S Pritchard and Michael J. Robins "Engineering Ethics" Thompson Asia, 2003-08-05.
3. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
4. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. Ltd. New Delhi, 2004
5. Brij Kishore Sharma,"Introduction to the Constitution of India", PHI Learning Pvt. Ltd., New Delhi, 2011.

DESIGN & ANALYSIS OF ALGORITHM LAB
(DCS551)

LIST OF EXPERIMENTS

1. Implementation of Quick Sort and Merge Sort.
2. Implementation of Linear-time Sorting Algorithms.
3. Implementation of Red-Black Tree operations.
4. Implementation of Binomial Heap operations.
5. Implementation of an application of Dynamic Programming.
6. Implementation of an application of Greedy Algorithm.
7. Implementation of Minimum Spanning Tree Algorithm.
8. Implementation of Single-pair shortest path Algorithm.
9. Implementation of All-pair shortest path Algorithm.
10. Implementation of String Matching Algorithm.

SOFTWARE ENGINEERING LAB
(DCS552)

LIST OF EXPERIMENTS

1. Introduction to Microsoft Project Professional.
2. Basic steps required to create project and prepare it for data entry (project tasks, sequence the tasks and estimate task duration).
3. Setting up a project [Eating Breakfast] and establish the basic constraints that project will use for its calculation. Analyze the project from different view [Gantt Chart, Network Diagram]
4. Setting up a project [Refurbishment of Workshop] and identifying relationship among the different task and subtask.
5. Setting up a project [Exam Cell Activities] and explain how to enter resources and specific information in Microsoft Project and resources to specific tasks.
6. Case Study: Project Windows 8 (Module works on windows Vista and now transform the module to work on Window 8).

DATA SCIENCE LAB
(DCS553)

LIST OF EXPERIMENTS

1. Introduction to Python Libraries- Numpy, Pandas, Matplotlib, Scikit
2. Perform Data exploration and preprocessing in Python
3. Implement regularised Linear regression
4. Implement Naive Bayes classifier for dataset stored as CSV file.
5. Implement regularized logistic regression
6. Create Pandas Series and DataFrame from various inputs.
7. Import any CSV file to Pandas DataFrame and perform the following:
    (a) Visualize the first and last 10 records
    (b) Get the shape, index and column details
    (c) Select/Delete the records(rows)/columns based on conditions.
    (d) Perform ranking and sorting operations.
    (e) Do required statistical operations on the given columns.
    (f) Find the count and uniqueness of the given categorical values.
    (g) Rename single/multiple columns.
8. Import any CSV file to Pandas DataFrame and perform the following:
    (a) Handle missing data by detecting and dropping/ filling missing values.
    (b) Transform data using apply() and map() method.
    (c) Detect and filter outliers.
    (d) Perform Vectorized String operations on Pandas Series.
    (e) Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots.

MACHINE LEARNING LAB
(DCS554)

List of Experiments:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.

2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.

3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.

5. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

6. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.

7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.

8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

9. Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.

10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

DATA VISUALIZATION
(DCS601)

Objective: The course is designed to enable students to know the basics of data visualization and understand the importance of data visualization and the design and use of visual components and basic algorithms.

Unit	Topic
I	**INTRODUCTION TO VISUALIZATION:** Visualizing Data-Mapping Data onto Aesthetics, Aesthetics and Types of Data, Scales Map Data Values onto Aesthetics, Coordinate Systems and Axes- Cartesian Coordinates, Nonlinear Axes, Coordinate Systems with Curved Axes, Color Scales-Color as a Tool to Distinguish, Color to Represent Data Values, Color as a Tool to Highlight, Directory of Visualizations- Amounts, Distributions, Proportions, x–y relationships, Geospatial Data.
II	**VISUALIZING DISTRIBUTIONS:** Visualizing Amounts-Bar Plots, Grouped and Stacked Bars, Dot Plots and Heatmaps, Visualizing Distributions: Histograms and Density Plots- Visualizing a Single Distribution, Visualizing Multiple Distributions at the Same Time, Visualizing Distributions: Empirical Cumulative Distribution Functions and Q-Q Plots-Empirical Cumulative Distribution Functions, Highly Skewed Distributions, Quantile Plots, Visualizing Many Distributions at Once-Visualizing Distributions Along the Vertical Axis, Visualizing Distributions Along the Horizontal Axis
III	**VISUALIZING ASSOCIATIONS & TIME SERIES:** Visualizing Proportions-A Case for Pie Charts, A Case for Side-by-Side Bars, A Case for Stacked Bars and Stacked Densities, Visualizing Proportions Separately as Parts of the Total, Visualizing Nested Proportions- Nested Proportions Gone Wrong, Mosaic Plots and Tree maps, Nested Pies, Parallel Sets. Visualizing Associations Among Two or More Quantitative Variables-Scatterplots, Correlograms, Dimension Reduction, Paired Data. Visualizing Time Series and Other Functions of an Independent Variable-Individual Time Series, Multiple Time Series and Dose–Response Curves, Time Series of Two or More Response Variables
IV	**VISUALIZING UNCERTIANITY:** Visualizing Trends-Smoothing, Showing Trends with a Defined Functional Form, Detrending and Time-Series Decomposition, Visualizing Geospatial Data-Projections, Layers, Choropleth Mapping, Cartograms, Visualizing Uncertainty-Framing Probabilities as Frequencies, Visualizing the Uncertainty of Point Estimates, Visualizing the Uncertainty of Curve Fits, Hypothetical Outcome Plots.
V	**VISUALIZATION OF VOLUMETRIC DATA**: Vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations

Text Book (s):

1. Ward, Grinstein Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick: A K Peters, Ltd.
2. E. Tufte, The Visual Display of Quantitative Information, Graphics Press.
3. Claus Wilke, “Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures”, 1st edition, O’Reilly.
4. Tony Fischetti, Brett Lantz, R: Data Analysis and Visualization,O’Reilly.
5. Ossama Embarak, Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems,Apress

DEEP LEARNING
(DCS602)

Objective: To teach fundamentals of neuro computing with applications to computer engineering problems.

Unit	Topic
I	**NEURAL NETWORK:** Mechanics of Machine Learning-Neuron-Linear Perceptron-Feed-Forward Neural Networks-Sigmoid, Tanh, and ReLU Neurons- Training Feed-Forward Neural Networks-Fast-Food Problem-Gradient Descent Delta Rule and Learning Rates.
II	**CONVOLUTIONAL NEURAL NETWORKS:** TensorFlow: Creating and Manipulating TensorFlow Variables-TensorFlow Operations-Neurons in Human Vision-Convolutional Layer-Building a Convolutional Network-Visualizing Learning in Convolutional Networks-Learning Lower Dimensional Representations-Principal Component Analysis- Autoencoder Architecture- Implementing an Autoencoder in TensorFlow.
III	**RECURRENT NEURAL NETWORKS:** Recurrent Neural Networks- Challenges with Vanishing Gradients- Long Short-Term Memory (LSTM) Units- TensorFlow Primitives for RNN Models- Implementing a Sentiment Analysis Model-Solving seq2seq Tasks with Recurrent Neural Networks-Memory Augmented Neural Networks: Neural Turing Machines, Attention-Based Memory Access, Differentiable neural Computers (DNC) -Memory Reuse - Temporal Linking - DNCController Network – Visualizing – Implementing the DNC in TensorFlow.
IV	**DEEP REINFORCEMENT LEARNING:** Deep Reinforcement Learning - Masters Atari Games-Markov Decision Processes-Policy Versus Value Learning, Pole-Cart with Policy Gradients-Q-Learning and Deep Recurrent Q-Networks.
V	**APPLICATIONS:** Applications in Object Recognition and Computer Vision-Unsupervised or generative feature learning Supervised feature learning and classification- Applications in Multimodal and Multi-task Learning-Multimodalities: Text and image-Speech and image- Multi-task learning within the speech, NLP or image domain.

Text Book (s):

1. Simon Haykin,"Neural Network – A Comprehensive Foundation", Macmillan Pub.
2. K.Mahrotra, C.K. Mohan and Sanjay Ranka, Elements of Artifical Neural Network, MIT
3. J.M. Zurada," Introduction to Artificial Neural network", Jaico Publihers.
4. Limin Fu. "Neural Networks in Computer Intelligence", TMH.
5. Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly Media.

BIG DATA ANALYTICS
(DCS603)

Objective: Student to Understand the Big Data Platform and its use cases.	
Unit	**Topic**
I	Introduction - distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce.
II	Big Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -, Data Serialization.
III	HDFS-Overview, Installation and Shell, Java API; Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper , how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.
IV	Introduction to Data Analysis with Spark, Downloading Spark and Getting Started, Programming with RDDs, Machine Learning with MLlib, What is it?, Where It is Used Types of NoSQL databases, Why NoSQL?, Advantages of NoSQL, Use of NoSQL in Industry, SQL vs NoSQL, NewSQL.
V	Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents , MongoDB Query Language.

Text Book (s):

1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich,"Professional Hadoop Solutions", Wiley.
2. Chris Eaton,Dirk derooset al. , "Understanding Big data ", McGraw Hill.
3. Big Data and Analytics , Sima Acharya, Subhashini Chhellappan, Willey.
4. MongoDB in Action, Kyle Banker,Piter Bakkum , Shaun Verch, Dream tech Press.
5. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph".
6. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press

ENTREPRENEURSHIP
(AS601)

Objective: Understanding the concept and process of entrepreneurship - its contribution in and role in the growth and development of individual and the nation.	
Unit	**Topic**
I	**Entrepreneurship:** definition, growth of small scale industries in developing countries and their positions vis-a-vis large industries; role of small scale industries in the national economy; characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry; stages in starting a small scale industry.
II	**Project identification:** assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.
III	**Accountancy:** Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases, advertisement, wages and incentive, inventory control, preparation of financial reports, accounts and stores studies.
IV	**Project Planning and control**: The financial functions cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. Profit planning and programming, planning cash flow, capital expenditure and operations. Control of financial flows, control and communication.
V	Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes and workman compensation act. 5 Role of various national and state agencies which render assistance to small scale industries.

Text Book (s):

1. Ramachandran, Entrepreneurship Development, Mc Graw Hill
2. Katz , Entrepreneurship Small Business, Mc Graw Hill
3. Byrd Megginson,,Small Business Management An Entrepreneur's Guidebook 7th ed, McGraw Hill
4. Fayolle A Entrepreneurship and new value creation. Cambridge, Cambridge University Press
5. Hougaard S. The business idea. Berlin, Springer
6. Lowe R & S Mariott Enterprise: Entrepreneurship & Innovation. Burlington, Butterworth Heinemann
7. Léo-Paul Dana, World Encyclopedia of Entrepreneurship, , Edward Elgar
8. Forbat, John, "Entrepreneurship" New Age International.
9. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International
10. Joseph, L. Massod, "Essential of Management", Prentice Hall of India.

Data Visualization Lab
(DCS651)

List of Experiments:

1. Data Representation: chart types: categorical, hierarchical, relational, temporal & spatial;
2. 2-D: bar charts, Clustered bar charts, dot plots, connected dot plots, pictograms, proportional shape charts, bubble charts, radar charts, polar charts, Range chart,
3. Box-and-whisker plots, univariate scatter plots, histograms word cloud, pie chart, waffle chart, stacked bar chart, back-to-back bar chart, treemap and all relevant 2-D charts.
4. 3-D: surfaces, contours, hidden surfaces, pm3d coloring, 3D mapping;
5. multi-dimensional data visualization; manifold visualization;
6. graph data visualization; Annotation

DEEP LEARNING LAB
(DCS652)

LIST OF EXPERIMENTS

1. Write a program in Python to Calculate the output of a simple neuron
2. Construct a Perceptron for the classification of data in Python
3. Develop the Python code to Classify the 4-class problem with Multi-layer Perceptron
4. Implement the back propagation algorithm for neural networks and apply it to the task of handwritten digit recognition.
5. Build a simple deep neural network with many layers in Python using TensorFlow
6. Implement binary classification for medical diagnosis for a single medical condition like say disease vs. no disease based on a battery of tests.
7. Explore multi-class with Rock Paper Scissors dataset
8. Implement an Autoencoder in TensorFlow.
9. Implementing a Sentiment Analysis Model in TensorFlow
10. Solve seq2seq Tasks with Recurrent Neural Networks using TensorFlow
11. Implementing the DNC in TensorFlow
12. Implement a policy-gradient agent to solve pole-cart-reinforcement learning problem.
13. Implementing Experience Replay in Q-Network using TensorFlow
14. Build a model to classify movie reviews as positive or negative using TensorFlow
15. Develop the CNN Model for Image Classification

Big Data Lab
(DCS653)

List of Experiments:

1. Program involving Resilient Distributed Datasets
2. Program involving Transformations and Actions
3. Program involving Key-Value Resilient Distributed Datasets
4. Program involving Local Variables, Broadcast Variables and Accumulators
5. Program involving Filter, Join, GroupBy, Agg operations
6. Viewing and Querying Temporary Tables
7. Transferring, Summarizing and Analysing Twitter data
8. Program involving Flume, Kafka and Kinesis
9. Program involving DStreams and Dstream RDDs
10. Linear Regression
11. Decision Tree Classification
12. Principal Component Analysis
13. Random Forest Classification
14. Text Pre-processing with TF-IDF
15. Naïve Bayes Classification
16. K-Means Clustering

Elective Course – I
(DCS051-054)
DIGITAL IMAGE PROCESSING
(DCS051)

Objective: The purpose of this course is to impart knowledge on various Digital Image Processing Techniques and their Applications.

Unit	Topic
I	**Introduction and Fundamentals:** Motivation and Perspective, Applications, Components of Image Processing System, Element of Visual Perception, A Simple Image Model, Sampling and Quantization. Image Enhancement in Spatial Domain: Introduction; Basic Gray Level Functions – Piecewise-Linear Transformation Functions: Contrast Stretching; Histogram Specification; Histogram Equalization; Local Enhancement; Enhancement using Arithmetic/Logic Operations – Image Subtraction, Image Averaging; Basics of Spatial Filtering; Smoothing - Mean filter, Ordered Statistic Filter; Sharpening – The Laplacian.
II	**Image Enhancement in Frequency Domain:** Fourier Transform and the Frequency Domain, Basis of Filtering in Frequency Domain, Filters – Low-pass, High-pass; Correspondence Between Filtering in Spatial and Frequency Domain; Smoothing Frequency Domain Filters – Gaussian Low-pass Filters; Sharpening Frequency Domain Filters – Gaussian High-pass Filters; Homomorphic Filtering.
III	**Image Restoration:** A Model of Restoration Process, Noise Models, Restoration in the presence of Noise only-Spatial Filtering – Mean Filters: Arithmetic Mean filter, Geometric Mean Filter, Order Statistic Filters – Median Filter, Max and Min filters; Periodic Noise Reduction by Frequency Domain Filtering– Band-pass Filters; Minimum Mean-square Error Restoration.
IV	**Color Image Processing:** Color Fundamentals, Color Models, Converting Colors to different models, Color Transformation, Smoothing and Sharpening, Color Segmentation. Morphological Image Processing: Introduction, Logic Operations involving Binary Images, Dilation and Erosion, Opening and Closing, Morphological Algorithms – Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening.
V	**Image Compression:** Fundamentals, image compression models, Compression methods: Huffman coding, Golomb Coding, Arithmetic Coding, LZW coding, Run-Length coding, Symbol based coding.error-free compression, lossy predictive coding, image compression standards. **Image Segmentation:** Fundamentals, Point, Line and edge detection. Thresholding: foundation, Basic Global Thresholding, Otsu's Method, Image smoothing to improve global thresholding.

Text Book (s):

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Tata McGraw Hill Pvt. Ltd.
2. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning.
3. M.A. Ahmed, Image Processing, TMH.
4. Earl Gose, Richard, Johnsonbaugh, Pattern Recognition & Image Analysis, PHI.

AGENT BASED INTELLIGENT SYSTEMS
(DCS052)

Objective: The purpose of this course is to impart knowledge on various Agent Based intelligent systems and their Applications.	
Unit	**Topic**
I	**INTRODUCTION** Definitions - Foundations - History - Intelligent Agents-Problem Solving-Searching - Heuristics -Constraint Satisfaction Problems - Game playing.
II	**KNOWLEDGE REPRESENTATION AND REASONING** Logical Agents-First order logic-First Order Inference-Unification-Chaining- Resolution Strategies Knowledge Representation-Objects-Actions-Events.
III	**PLANNING AGENTS** Planning Problem-State Space Search-Partial Order Planning-Graphs-Nondeterministic Domains Conditional Planning-Continuous Planning-MultiAgent Planning.
IV	**AGENTS AND UNCERTAINITY** Acting under uncertainty – Probability Notation-Bayes Rule and use - Bayesian Networks-Other Approaches-Time and Uncertainty-Temporal Models- Utility Theory - Decision Network – Complex Decisions.
V	**HIGHER LEVEL AGENTS:** Knowledge in Learning-Relevance Information-Statistical Learning Methods-Reinforcement Learning Communication-Formal Grammar-AugmentedGrammars-FutureofAI

Text Book (s):

1. Stuart Russell and Peter Norvig, “Artificial Intelligence - A Modern Approach”, 2nd Edition, PHI
2. Michael Wooldridge, “An Introduction to Multi Agent System”, John Wiley.
3. Patrick Henry Winston, Artificial Intelligence, III Edition, AW.
4. Nils.J.Nilsson, Principles of Artificial Intelligence, Narosa Publishing House.

CLOUD COMPUTING
(DCS053)

Objective: This module gives students the skills and knowledge to understand how Cloud Computing Architecture can enable transformation, business development and agility in an organization. It also provide the concept of cloud security system and cloud infrastructure.

Unit	Topic
I	Introduction - Shift from distributed computing to cloud computing; principles, and characteristics of cloud computing- IaaS, PaaS, SaaS; service oriented computing and cloud environment.
II	Cloud Computing Technology - Client systems, Networks, server systems andsecurity from services perspectives; Accessing the cloud with platforms and applications; cloud storage.
III	Working with Cloud- Infrastructure as a Service – conceptual model and working Platform as a Service – conceptual model and functionalities Software as a Service – conceptual model and working Technologies and Trends in Service provisioning with clouds.
IV	Using Cloud Services- Cloud collaborative applications and services – technology, applications and case studies with calendars, schedulers and event management; cloud applications in project management.
V	Case studies-Microsoft Azure, Google App Engine and Open source clouds-Open-Nebula and Eucalyptus , Current trends and research.

Text Book (s):

1. Gautam Shroff, Enterprise Cloud Computing Technology Architecture Applications, Cambridge.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach.
3. Dimitris N. Chorafas, Cloud Computing Strategies.
4. Cloud Computing Bible, Barrie Sosinsky, Wiley-India.
5. Cloud Computing, Thomas Earl, Pearson.
6. Cloud Computing: Principles and Paradigms, RajkumarBuyya, James Broberg, Andrzej Goscinski, Wiley.
7. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer.
8. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India.

HUMAN COMPUTER INTERFACE
(DCS054)

Objective: The purpose of this course is the study, planning and design of the interaction between people and computers.	
Unit	**Topic**
I	Introduction: The human, The computer, The interaction, Paradigms, Usability of Interactive Systems, Guidelines, Principles, and Theories.
II	Design Process- Interaction design basics, HCI in the software process, Design rules, Implementation support, Evaluation techniques, Universal design, User support.
III	Models and Theories Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration models,Task analysis, Dialogue notations and design, Models of the system, Modelling rich interaction.
IV	Interaction Styles- Direct Manipulation and Virtual Environments, Menu Selection, Form Filling and Dialog Boxes, Command and Natural Languages, Interaction Devices, Collaboration and Social Media Participation.
V	Design Issues- Quality of Service, Balancing Function and Fashion, User Documentation and Online Help, Information Search, Information Visualization, Outside the Box- Group ware,Ubiquitous computing and augmented realities, Hypertext, multimedia, and the world wide web.

Text Book (s):

1, Human Computer Interaction by Alan Dix, Janet Finlay , Pearson Education.
2. Designing the User Interface - Strategies for Effective Human Computer Interaction, by Ben Schneiderman, Pearson Education.
3. Johnson P, Human Computer Interaction: psychology, task analysis and software, PHI
4. Faulkner, The essence of Human-Computer Interaction, Prentice Hall.
5. Norman DA, The design of everyday things, Doubleday.
6. Barfield L, The user interface: concepts & design, Addison Wesley.
7. Cox K and Walker D, User Interface Design, Prentice Hall.

Elective Course – II
(DCS061-064)

ROBOTICS
(DCS061)

Objective: The objective of this course is to impart knowledge about industrial robots for their control and design.

Unit	Topic
I	Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and openloop control systems, Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.
II	Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modelling: Equations of motion: Euler-Lagrange formulation
III	Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc, Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.
IV	Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID, Non-linear and advanced controls, Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.
V	Control Hardware and Interfacing :Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

Text Book (s):

1. Saha, S.K., "Introduction to Robotics, McGraw-Hill Higher Education, New Delhi.
2. Ghosal, A., "Robotics", Oxford, New Delhi.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi.

EMBEDDED SYSTEM
(DCS062)

Objective: To introduce the basic concepts of Embedded Systems and the various techniques used for Embedded Systems with real time examples.

Unit	Topic
I	Hardware Concepts -Application and characteristics of embedded systems, Overview of Processors and hardware Units in an embedded system, General purpose processors, Microcontrollers: 8051.
II	Application- Specific Integrated Circuits (ASICs), ASIP, FPGA, ARM-based System on a Chip (SoC), Network on Chip (NoC), Levels of hardware modelling, Verilog, Sensors, A/D-D/A converters, Actuators, Interfacing using RS-232, UART, USB, I2C, CAN bus, Flexray, SRAM and DRAM, Flash memory.
III	Real-Time Operating Systems- Real-Time Task Scheduling: Some important concepts, Types of real-time tasks and their characteristics, Task scheduling, Clock-Driven scheduling, Hybrid schedulers, Event-Driven scheduling, Earliest Deadline First (EDF) scheduling, Rate monotonic algorithm (RMA).
IV	Commercial Real-time operating systems: Time services, Features of a Real-time operating system, Unix-based Real-time operating systems, POSIX-RT, A survey of contemporary Real- time operating systems, Microkernelbased systems, Benchmarking real-time systems.
V	Embedded Application Development - UML 2.0, State charts, General language characteristics, MISRA C, Hardware/Software Co- design, Hardware/software partitioning, Testing embedded systems, Design for testability and Self-test.

Text Book (s):

1. Embedded Systems Design – A Unified Hardware /Software Introduction, by Frank Vahid and Tony Givargis, John Wiley.
2. An Embedded Software Primer, by David E. Simon, Pearson Education Asia.
3. Wayne Wolf, “Computers as Components: Principles of Embedded Computer System Design”, Elsevier.
4. Michael J. Pont, “Embedded C”, Pearson Education.
5. Steve Heath, “Embedded System Design”, Elsevier.
6. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, “The 8051
7. Microcontroller and Embedded Systems”, Pearson Education, Second edition.

3D PRINTING AND DESIGN
(DCS063)

Objective: The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Unit	Topic
I	**3D Printing (Additive Manufacturing):** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.
II	**CAD for Additive Manufacturing :** CAD Data formats, Data translation, Data loss, STL format, **Additive Manufacturing Techniques:** Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Process, Process parameter, Process Selection for various applications, Additive Manufacturing Application Domains: Aerospace, Electronics, HealthCare, Defense, Automotive, Construction, Food Processing, Machine Tools
III	**Materials:** Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties, Support Materials
IV	**Additive Manufacturing Equipment:** Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design
V	**Post Processing:** Requirement and Techniques **Product Quality:** Inspection and testing, Defects and their causes

Text Book (s):

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher.
3. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific.
4. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science.
5. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press.

VIRTUAL REALITY
(DCS064)

Objective: The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications.	
Unit	**Topic**
I	**Introduction to Virtual Reality:** Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark **3D Computer Graphics:** Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Color theory, Simple 3D modeling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.
II	**Geometric Modeling:** Geometric Modeling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.
III	**Virtual Environment:** Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in battening, free from deformation, particle system. **Physical Simulation:** Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.
IV	**VR Hardware and Software:** Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML
V	**VR Applications:** Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction

Text Book (s):

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia.
2. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
3. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill.
4. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science
5. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann.
6. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science.

Elective Course – III
(DCS065-068)

DISTRIBUTED SYSTEM
(DCS065)

Objective: To introduce the fundamentals of distributed computer systems, assuming the availability of facilities for data transmission.

Unit	Topic
I	**Characterization of Distributed Systems.** Examples of distributed systems, Resource sharing on the web, challenges. **System Models:** Introduction, Architectural model fundamental model. **Networking and Internetworking:** Types of network, Network Principles, Internet Protocols**.** Ethernet, WiFi, Bluetooth and ATM.
II	**Interprocess Communication:** API for the internet protocols, External data representation and marshalling, client-server communication, Group communication, Interprocess communication in Unix. **Distributed Objects and Remote Invocation:** Communication between distributed objects, Remote Procedure calls, Events and notifications, Java RMI, Sun network File system.
III	**Operating System Support:** Operating system Layer, Protection, Processes and threads, Communication and Invocation, Operating system Architecture. **Security:** Overview of security techniques, Cryptographic algorithms, Digital signatures, Cryptography pragmatics.
IV	**Time and Global states:** Clocks, events and process states, synchronizing physical clocks, logical time and logical clocks. **Coordination and agreement:** Distributed mutual exclusion, elections, multicast communication, consensus and related problems.
V	**Transactions and concurrency control:** Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering, Comparison of methods for concurrency control. **Distributed Transactions:** Flat and Nested transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery.

Text Book (s):

1. Distributed Systems, S. Ghosh, Chapman & Hall/CRC, Taylor & Francis Group.
2. Distributed Systems Concepts and Design, G Coulouris, J Dollimore and T Kindberg, Pearson Education
3. Singhal & Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill
4. Ramakrishna,Gehrke," Database Management Systems", McGraw Hill
5. Vijay K.Garg Elements of Distributed Computing, Wiley
6. Tenanuanbaum, Steen," Distributed Systems", PHI

CLUSTER COMPUTING
(DCS066)

Objective: This course teaches solving large-scale science, engineering, and commercial applications.	
Unit	**Topic**
I	Basic concepts in Distributed Systems: Notion of time Distributed Mutual exclusion, Consensus, Failure models Paradigms for process interaction in distributed programs, Programming Paradigms, Shared memory, Message passing, Workflows.
II	Introduction to Cluster Computing, Cluster Middleware: An Introduction, Early Cluster Architecture and High Throughput Computing Clusters, Networking, Protocols and I/O for Clusters, Setting Up and Administering a Cluster.
III	Cluster Technology for High Availability, Performance Models and Simulation, Process Scheduling, Load Sharing and Load Balancing, Distributed Shared Memory.
IV	Introduction to Grid Architecture, Characterization of Grid, and Grid related standard bodies, Grid types, Topologies, Components and Layers, Comparison with other approaches.
V	System Infrastructure, Traditional paradigms for distributed computing, Web Services, Grid standards: OGSA and WSRF, Case Studies of Cluster Systems: Beowulf, COMPaS, NanOS and PARAM.

Text Book (s):

1. High Performance Cluster Computing: Architectures and Systems, Prentice Hall.
2. Grid and Cluster Computing, Prabhu C.S.R, PHI Learning Private Limited.
3. J.J. Jos & R.K. Buyya, High Performance Cluster Computing: Architecture and Systems, PHI.
4. P. Jalote, Fault Tolerance in Distributed Systems, Prentice Hall

BLOCK CHAIN
(DCS067)

Objective: The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes. The course covers the technological underpinning of block Chain operations in both theoretical and practical implementation of solutions using block Chain technology.

Unit	Topic
I	**Introduction:** Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain **Basic Crypto Primitives:** Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic crypto currency.
II	**Understanding Block chain with Crypto currency:** Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin**:** Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.
III	**Understanding Block chain for Enterprises:** Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.
IV	**Enterprise application of Block chain:** Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain
V	**Block chain application development:** Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda

Text Book (s):

1. Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly.
2. Daniel Drescher, "Block Chain Basics", Apress; 1st edition.
3. Mstering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos

PATTERN RECOGNITION
(DCS068)

Objective: To understand the basic building blocks and general principles that allows one to design pattern learning algorithms.	
Unit	**Topic**
I	Basics of pattern recognition, Design principles of pattern recognition system,Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test.
II	Statistical Patten Recognition: Bayesian Decision Theory, Classifiers, Normal density anddiscriminant functions.
III	Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameterestimation, Dimension reduction methods - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models.
IV	Nonparametric Techniques: Density Estimation, Parzen Windows, K-Nearest NeighborEstimation, Nearest Neighbor Rule, Fuzzy classification.
V	Unsupervised Learning & Clustering: Criterion functions for clustering, Clustering Techniques:Iterative square - error partitional clustering – K means, agglomerative hierarchical clustering, Cluster validation.

Text Book (s):

1. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer.
2. S. Theodoridis and K. Koutroumbas, “Pattern Recognition”, Academic Press.
3. T Mattson, B Sanders, B Massingill. Patterns for Parallel Programming. Addison-Wesley Professional.

Elective Course – IV
(DCS071-074)

CRYPTOGRAPHY AND NETWORK SECURITY
(DCS071)

Objective: The objective of this course is to Discover software bugs that pose cyber security threats, explain and recreate exploits of such bugs in realizing a cyber attack on such software, and explain how to fix the bugs to mitigate such threats.	
Unit	**Topic**
I	**Introduction:** Security Goals, Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services and Mechanisms, A model for Internetwork Security, Euclidian Algorithm, Modular operator, Congruence, Additive invers, Multiplicative Inverse, Cryptanalysis, Cipher and Types of Cipher, Substitution Cipher, Caeser Cipher, Affine Cipher, Mono-alphabetic and Polyalphabetic cipher.
II	**Symmetric key and Encryption:** Groups and Applications, Modern Block Ciphers, Component of Modern Bloch Ciphers, D Boxes, Straight D Boxes, Modern Stream ciphers, Encryption, Conventional Encryption Principles & Algorithms, Data Encryption Standard (DES), Des Structure, DES Function, DES Algorithm and key generation, Security of DES, Advanced Encryption Standard(AES), Criteria, Round Data Unit, Algorithm, Analysis of AES,RC4.
III	**Cryptography:** Public key and Private key in Cryptography, Role of public key in cryptography, Cipher, Types of Cipher, Mode of Operation, Cryptography Algorithms (RSA, RABIN, ELGAMAL, Diffie-Hellman, ECC), Key Distribution, Approaches of Message Authentication, Hash Functions in cryptography.
IV	**Email and Web Security:** Pretty Good Privacy (PGP) and S/MIME.IP Security Overview, IP Security Architecture, Authentication Header, Requirements, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET).
V	**Network Security**: Intruders, Viruses and related threats, Virus Countermeasures, Firewall Design principles, Trusted Systems, Intrusion Detection Systems.

Text Book (s):

1. Vincent LeVeque: Information Security: A Strategic Approach, Wiley Publication .
2. Saurabh Sharma: Information Security and cyber Law, Vikas Publication.
3. William Stallings, “Cryptography and Network Security: Principals and Practice”, Prentice Hall, New Jersy.
4. Johannes A. Buchmann, “Introduction to Cryptography”, Springer-Verlag.
5. Bruce Schiener, “Applied Cryptography”.

REAL TIME SYSTEM
(DCS072)

Objective: Real-time computer systems for the monitoring and control of laboratory and industrial processes are studied and implemented.

Unit	Topic
I	Introduction To Real-Time Computing: Characterizing Real – Time System & Task; Performance Measures of Real Time System, Estimation of Program Run Time, Real- Time System Design: Hardware Requirement, System Development Cycle.
II	Data Transfer Techniques, Synchronous & Asynchronous Data Communication, Standard Interface. Task Assignment And Scheduling: Priority Scheduling, Scheduling with Fixed Priority Dynamic Priority Scheduling.
III	Real-Time Programming Language & Tool: Desired Language Characteristics, Data Typing, Control Structure, Run Time Error- Handling, Overloading & Generics, Runtime Support, Real-Time Databases.
IV	Real-Time Communication Language Algorithm: Fault Tolerance Techniques, Causes of Failure, Fault Type, Fault Detection, Redundancy.
V	Integrated Failure Handling Reliability Evaluation Techniques: Parameter Values, Reliability Model For Hardware Redundancy, Software Error Model and Clock Synchronization.

Text Book (s):

1. Real Time System: by C.M. Krishna & K.G. Shen- Mc Graw Hill.
2. Real-Time Systems: Design Principles for Distributed Embedded Applications by Kopetz, Hermann, Springer.
3. Real Time Systems by Jane W. S. Liu, Pearson Education Publication.
4. Real-Time Systems: Scheduling, Analysis, and Verification by Prof. Albert M. K. Cheng, John Wiley and Sons Publications.

GRID COMPUTING
(DCS073)

Objective: The course is project oriented, involving hand-on exploration of existing technologies as well as development of new technologies.	
Unit	**Topic**
I	Overview. Focuses on grid computing as emerging new computing paradigm for solving complex collaborative problems that require massive resources and infinite CPU cycle. The topics included: Definition of Grid; Basic Building Blocks; Issues in Management of Grid Models; Evolution of Grid Models.
II	Architecture. Deals with grid architecture providing an anatomical look into fundamental system components and their functionalities as well as interactions. Topics: Requirements concerning abstractions, behaviours, resources, connectivity, and protocols; Open grid service architectures.
III	Environment. Talks about grid computing environments. Topics: Overview of GCE; Programming models; Middleware for building grid computing environments; Language support (MPI-G, MPI-G2, etc) for grid computing; Meta models for grid programming; Security.
IV	Applications. Deals with case studies, how the global computing infrastructure has become a reality for collaborative complex data intensive computing aid for federated database services, web services, bioinformatics. It will also include among others some selection of topics from Seti project, Sun grid engine, Skyserver and some national grid projects.
V	Monitoring and evaluation. It will include following: Monitoring; Scheduling; Performance tuning; Debugging and performance diagnostic issues.

Text Book (s):

1. Fundamentals of Grid Computing: Theory, Algorithms and Technologies.
2. Grid Computing by Joshy Joseph, Craig Fellenstein, Prentice Hall Professional.
3. Ahmar Abbas, “Grid Computing: Practical Guide to Technology & Applications”, Firewall Media.
4. Joshy Joseph and Craig Fellenstein , “Grid Computing” Pearson Education

DATA COMPRESSION
(DCS074)

Objective: To learn the basic concepts of data compressions for compression of text, image, audio, and video for efficient storage and transmission of data over network.	
Unit	**Topic**
I	Mathematical Preliminaries – Information theory, average information content, Entropy. Source models-Physical, probabilistic, Markov, Composite models. Uniquely decodable codes.
II	Huffman coding, arithmetic coding, Dictionary techniques, predictive coding. JPEG-LS, CCITT group 3, 4 recommendations, comparison of MH, MR, MMR, JBIG.
III	Lossy coding – distortion criteria, Human visual system, conditional entropy, average mutual information, differential entropy.
IV	Prediction with Partial Match (ppm) : The Basic Algorithm, The ESCAPE SYMBOL, Length of Context, The Exclusion Principle, The Burrows - Wheeler Transform: Moveto- Front Coding, CALlC, JPEG-LS, Dynamic Markov Compression.
V	Scalar and vector quantization, differential encoding, transforms, sub-band and wavelets, video compression techniques and standards. Performance metrics for compression algorithms.

Text Book (s):

1. Introduction to Data Compression, Khalid Sayood, Morgan Kaufmann pub.
2. Elements of Data Compression, Drozdek, Cengage Learning
3. Introduction to Data Compression, Second Edition, Khalid Sayood, The Morgan aufmann Series
4. Data Compression: The Complete Reference 4th Edition byDavid Salomon, Springer
5. Text Compression1st Edition by Timothy C. Bell Prentice Hall

MOOC ONLINE COURSE
(OE071-074)
CYBER LAW AND ETHICS
(OE-071)

Objective: The course has been designed to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains.

Unit	Topic
I	**Cyber Security Concepts:** Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls.
II	**Infrastructure and Network Security:** Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.
III	**Cyber Security Vulnerabilities& Safe Guards:** Internet Security, Cloud Computing &Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment.
IV	**Malware:** Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis.
V	**Cyber Laws and Forensics:** Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013. Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations.

Text Book (s):

1. William Stallings, "Cryptography and Network Security", Pearson Education/PHI.
2. Atul Kahate, "Cryptography and Network Security", McGraw Hill.
3. V.K. Pachghare, "Cryptography and Information Security", PHI Learning

QUALITY MANAGEMENT
(OE072)

Objective: The course has been designed to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains.

Unit	Topic
I	**Introduction to Quality management:** Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.
II	**Quality Management:** Organization structure and design, quality function, decentralization, designing and fitting, organization for different type products and company, economics of quality value and contribution, quality cost, optimizing quality cost, seduction program. Human Factor in quality Attitude of top management, cooperation of groups, operators attitude, responsibility, causes of apparatus error and corrective methods.
III	**Control Charts**: Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts. Attributes of Control Chart, Defects, construction and analysis of charts, improvement by control chart, variable sample size, construction and analysis of C charts.
IV	Defects diagnosis and prevention defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects,
V	Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Introduction to software quality.

Text Book (s):

1. Lt. Gen. H. Lal, "Total Quality Management", Eastern Limited, 1990.
2. Greg Bounds, "Beyond Total Quality Management", McGraw Hill, 1994.
3. Menon, H.G, "TQM in New Product manufacturing", McGraw Hill 1992

E - COMMERCE
(OE073)

Objective: To understand the various transactions which can be facilitated through the application of internet technologies.

Unit	Topic
I	Introduction to E-commerce: Definition, features & types, Forces fueling E-commerce, E-Commerce Business Models – B2C, B2B, C2C, M-Commerce, Ethical, social and political issues in e-commerce: privacy and right to information, intellectual property rights.
II	E-Commerce infrastructure: Intranet and Extranet, World Wide Web. Building of e-commerce website: SDLC, build Vs outsource, choosing software, hardware and tools.
III	E-Commerce security: security threats, technology solutions, planning for security. E-Commerce payment systems: digital payment systems, credit cards, e-cash, e-cheques, stored value systems, accumulating balance systems, electronic billing.
IV	E-Commerce marketing: Online consumer behaviour, online marketing technologies, online branding, online customer relationships, online pricing, online market research,
V	E-commerce marketing communication: online advertising, online promotions, costs and benefits of online communications, online marketing communication strategy.

Text Book (s):

1. E-Commerce, Cutting Edge of Business- Kamlesh K Bajaj, Debjani Nag, Tata McGraw Hill
2. Global Electronic Commerce, Theory and Case Studies J C Westland, T H K Clark- University Press
3. E-Commerce- an Indian perspective, P T Joseph, Prentice Hall
4. E-Commerce concepts, Models, Strategies, C S V Moorthy, Himalaya Publications

DISASTER MANAGEMENT
(OE-074)

Objective: This course objective is to meet the needs of people involved in disaster management for both sudden-onset natural disasters	
Unit	**Topic**
I	**Introduction:** Concepts and definitions: disaster, hazard, vulnerability, risks severity, frequency and details, capacity, impact, prevention, mitigation).
II	**Disasters:** Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.), hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.
III	**Disaster Impacts:** Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.
IV	**Disaster Risk Reduction (DRR):** Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response.
V	**Disasters, Environment and Development:** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

Text Book (s):

1. Pradeep Sahni, Disaster Risk Reduction in South Asia, Prentice Hall.
2. Singh B.K., Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
3. Ghosh G.K., Disaster Management, APH Publishing Corporation.
4. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214.