DATA SECURITY
(DCS701)

Objective: To understand and apply the models of Information Security.

Unit	Topic
I	Data Privacy Ethics and Security Privacy – Reidentification of Anonymous People – Why Big Data Privacy is self-regulating? – Ethics – Ownership – Ethical Guidelines – Big Data Security – Organizational Security.
II	Security, Compliance, Auditing, and Protection Steps to secure big data – Classifying Data – Protecting – Big Data Compliance – Intellectual Property Challenge – Research Questions in Cloud Security – Open Problems.
III	Hadoop Security Design Kerberos – Default Hadoop Model without security - Hadoop Kerberos Security Implementation & Configuration.
IV	Hadoop Ecosystem Security Configuring Kerberos for Hadoop ecosystem components – Pig, Hive, Oozie, Flume, HBase, Sqoop.
V	Data Security & Event Logging Integrating Hadoop with Enterprise Security Systems - Securing Sensitive Data in Hadoop – SIEM system – Setting up audit logging in hadoop cluster.

Text Book (s):

1. Mark Van Rijmenam, “Think Bigger: Developing a Successful Big Data Strategy for Your Business”, Amazon, 1 edition

2. Frank Ohlhorst John Wiley & Sons, “Big Data Analytics: Turning Big Data into Big Money”, John Wiley & Sons.

3. Sherif Sakr, “Large Scale and Big Data: Processing and Management”, CRC Press.

4. Ben Spivey, Joey Echeverria, “Hadoop Security Protecting Your Big Data Problem”, O’Reilly

5. Peter Ryan, Steve Schneider, Michael Goldsmith, Gavin Lowe, Bill Roscoe: Modelling & Analysis of Security Protocols, Addison Wesley.

6. Stephen W. Mancini: Automating Security Protocol Analysis, Storming Media

Internet of Things
(DCS702)

Objective: The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.	
Unit	**Topic**
I	Introduction to IoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.
II	Elements of IoT Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.
III	Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.
IV	IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.
V	IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Text Book (s):

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things, "A Hands-on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

SPEECH AND NATURAL LANGUAGE PROCESSING
(DCS703)

Objective: To provide the knowledge about language and concept learning.	
Unit	**Topic**
I	Introduction to Natural Language Understanding, Language as Knowledge Base Process, Basic Linguistics, Computers & Natural Language Understanding.
II	Grammars and Parsing: Grammars and sentence Structure, Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top-Down Chart Parsing. Feature Systems and Augmented Grammars: Basic Feature system for English, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks.
III	Transition Network Grammer, Grammer and Logic Programming, Semantic Interpretation-Semantic and Logical Form, Linking Syntax and Scemantics, Ambiguity Resolution
IV	Introduction to Semantic Grammer, Template Matching, Semantically Driven Parsing Techniques Context and World Knowledge, Knowledge Representation and Reasoning
V	Local Discourse Context and Reference, Discourse Structure and Understanding Using World Knowledge, Language Learning and Concept Learning

Text Book (s):

1. Akshar Bharti, Vineet Chaitanya and Rajeev Sangal “NLP: A Paninian Perspective”, PHI.
2. James Allen “Natural Language Understanding” Pearson Education.
3. Rich & Knight, Artificial Intelligence, TMH.
4. Dan W. Patterson, Artificial Intelligence: A Modern Approach, Pearson Education.
5. Russell Norwig, Artificial Intelligence: A Modern approach, Pearson Education.

Industrial Training
(DCS751)

Contents: Four weeks of work at industry site
Supervised by an expert at the industry
Students have to maintain a written record of the assignments, progress and accomplishments. They have to submit a report at the end of this training. An oral presentation on their experiences and the knowledge gained during their work.

Mode of Evaluation

Oral viva - voce (50%)
Report (50%)

Mini Project
(DCS752)

The object of *Project Work I* is to enable the student to take up investigative study in the broad field of *Computer Science & Engineering*, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1) Survey and study of published literature on the assigned topic;
2) Working out a preliminary Approach to the Problem relating to the assigned topic;
3) Conducting preliminary
4) Analysis/Modeling/Simulation/Experiment/Design/Feasibility;
5) Preparing a Written Report on the Study conducted for presentation to the
6) Department;
7) Final Seminar, as oral Presentation before a Departmental Committee.

Major Project Work & Dissertation
(DCS851)

The object of *Project Work II & Dissertation* is to enable the student to extend further the investigative study taken up under *EC P1*, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

- In depth study of the topic assigned in the light of the Report prepared under *EC P1;*
- Review and finalization of the Approach to the Problem relating to the assigned topic;
- Preparing an *Action Plan* for conducting the investigation, including team work;
- Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as Needed;
- Final development of product/process, testing, results, conclusions and future Directions;
- Preparing a paper for Conference presentation/Publication in Journals, if possible;
- Preparing a Dissertation in the standard format for being evaluated by the Department;
- Final Seminar Presentation before a Departmental Committee.

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.