Elective Courses

Course Code	Course Title	Credit	Theory	Lab
CSE 804	Information Retrieval	3	2	1

Course Outline: Boolean Retrieval: Inverted Index, Processing boolean queries, extended Boolean retrieval; Term Vocabulary and Postings lists: Document delineation and character sequence decoding, Tokenization, Dropping common terms: stop words, Normalization (equivalence classing of terms), Stemming and lemmatization, skip pointers, Biword indexes, Positional indexes; Dictionaries and tolerant retrieval: Search structures for dictionaries, General wildcard queries, k-gram indexes for wildcard queries, Spelling correction; Index Construction: Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing; Scoring and Ranking: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, variant tf-idf functions; Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system; Evaluation in information retrieval: Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance, Results snippets; Relevance feedback and query expansion: The Rocchio algorithm for relevance feedback, Relevance feedback on the web, Evaluation of relevance feedback strategies, Global methods for query reformulation; Language models for information retrieval; Enterprise Information Retrieval: Explore the capacity of Apache Lucene as a text search framework.

References:

1. An Introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Online Edition, 2009, Cambridge University Press, Cambridge, England.
2. Lucene in Action by Michael McCandless, Erik Hatcher, and Otis Gospodnetić, Second Edition, Manning publications.

Course Code	Course Title	Credit	Theory	Lab
CSE 825	Data Mining and Warehousing	3	2	1

Course Outline: Introduction to Data Mining, Knowing Data (Data objects, similarities and dissimilarities, statistical descriptions and visualizations), Data Pre-processing, Data Warehousing and Online Analytical Processing, Data Cube technology, Mining frequent patterns, Classification and Cluster Analysis, Research trends in Data mining and warehousing.

References:

1. Data Mining: Concepts and Techniques. Jiawei Han, Micheline Kambar, Jian Pei [Text Book]

Course Code	Course Title	Credit	Theory	Lab
CSE 829	Pattern Recognition and Image Processing	3	2	1

Course Outline: Introduction to Image Processing; Digital Image Fundamentals - Elements of Visual Perception. Light and the Electromagnetic Spectrum. Image Sensing and Acquisition. Image Sampling and Quantization. Some Basic Relationships between Pixels. Linear and Nonlinear Operations; Image Enhancement in the Spatial Domain - Background. Some Basic Gray Level Transformations. Histogram Processing. Enhancement Using Arithmetic/Logic Operations. Basics of Spatial Filtering. Smoothing Spatial Filters. Sharpening Spatial Filters. Combining Spatial Enhancement Methods; Image Enhancement in the Frequency Domain - Background. Introduction to the Fourier Transform and the Frequency Domain. Smoothing Frequency-Domain Filters. Sharpening Frequency Domain Filters. Homomorphic Filtering. Implementation; Image Restoration - A Model of the Image Degradation/Restoration Process. Noise Models. Restoration in the Presence of Noise Only-Spatial Filtering. Periodic Noise Reduction by Frequency Domain Filtering. Linear, Position-Invariant Degradations. Estimating the Degradation Function. Inverse Filtering. Minimum Mean Square Error (Wiener) Filtering. Constrained Least Squares Filtering. Geometric Mean Filter. Geometric Transformations; Color Image Processing - Color Fundamentals. Color Models. Pseudo color Image Processing. Basics of Full-Color Image Processing. Color Transformations. Smoothing and Sharpening. Color Segmentation. Noise in Color Images. Color Image Compression; Wavelets and Multiresolution Processing - Background. Multiresolution Expansions. Wavelet Transforms in One Dimension. The Fast Wavelet Transform. Wavelet Transforms in Two Dimensions. Wavelet Packets; Image Compression - Fundamentals. Image Compression Models. Elements of Information Theory. Error-Free Compression. Lossy Compression. Image Compression Standards; Morphological Image Processing - Preliminaries. Dilation and Erosion. Opening and Closing. The Hit-or-Miss Transformation. Some Basic Morphological Algorithms. Extensions to Gray-Scale Images; Image Segmentation - Detection of Discontinuities. Edge Linking and Boundary Detection. Thresholding. Region-Based Segmentation. Segmentation by Morphological Watersheds. The Use of Motion in Segmentation; Representation and Description - Representation. Boundary Descriptors. Regional Descriptors. Use of Principal Components for Description. Relational Descriptors; Object Recognition - Patterns and Pattern Classes. Recognition Based on Decision-Theoretic Methods. Structural Methods.

References:

1. Digital Image Processing - Rafael C Gonzalez and Richard E. Woods

Course Code	Course Title	Credit	Theory	Lab
CSE 831	Computer Graphics and Multimedia	3	2	1

Course Outline: Introduction: History of computer graphics, graphics architectures and software, imaging: pinhole camera, human vision, synthetic camera, modeling vs. rendering OpenGL: architecture, displaying simple two-dimensional geometric objects, positioning systems, working in a windowed environment Color: Color perception, color models (RGB, CMY, and HLS), color transformations. Color in OpenGL. RGB and Indexed color. Input: working in a network environment, client-server computing; input measure, event, sample and request input, using callbacks, picking.

Geometric transformations: affine transformations (translation, rotation, scaling, and shear), homogeneous coordinates, concatenation, current transformation and matrix stacks. Three dimensional graphics: classical three dimensional viewing, specifying views, affine transformation in3D, projective transformations. Ray Tracing. Shading: illumination and surface modeling, Phong shading model, polygon shading. Rasterization: line drawing via Bresenham's algorithm, clipping, polygonal fill, BitBlt. Introduction to hidden surface removal (z buffer). Discrete Techniques: buffers, bitblt, reading and writing bitmaps and pixel maps, texture mapping, compositing.

References:

1. Computer Graphics, Principle and Practices – James D. Foley, Andries van Dam, Steven K. Feiner and John F. Hughes.

Course Code	Course Title	Credit	Theory	Lab
BUS 842	Strategic Management	3	3	0

Course Outline: Strategic Management Concept: Strategic Leadership, Competitive Advantage, Superior Performance, Performance in Nonprofit Enterprises, Strategic Manager, Strategy Making Process. **Industry analysis, External Environment and Internal Resources Analysis:** Industry and Sector, market segments, Porter's Five Forces Model, , Strategic Groups, Industry Life Cycle Analysis, Macroeconomic Forces, Competitive Advantage, Value Creation and Profitability, Avoiding Failures and Sustaining Competitive Advantage. **Functional and Business Level Strategy:** Achieving Superior Efficiency, Learning Effects, Materials Management, Strategy for Attaining superior Reliability, Responsiveness to Customers, Competitive Positioning and Business Level Strategy, Strategies in Fragmented Industries, Embryonic, Growth and Mature Industries. **Technological Support for Adopting Strategies and Global Strategy:** Format War, Strategies for wining in Format War, Information System Strategy, Managing Intellectual Property Rights, Capturing First-Mover Advantages, Technological Paradigm Shifts, Disruptive Technology, Profitability and Profit Growth through Global Expansion, Global Standardization Strategy. **Strategic Software Engineering:** Architecture-Centric Software Development Strategy, Software Product Lines, Software Effort and Cost Estimation Strategies, Openness of a Software, Software Supply Chain, Software Economics.

References:

1. Theory of Strategic Management (Eighth Edition) By: Hill/Jones
2. Strategic Management (Concepts and Cases) Twelfth Edition By: Fred R. David

Course Code	Course Title	Credit	Theory	Lab
EEE 202	Digital System Design	3	2	1

Course Outline:

- **Introduction:** Number System, Number Base Conversation, Complements, Signed Number. Arithmetic Operation- Binary, Octal, Hexadecimal Binary Codes e.g. BCD, ASCII, Grey etc.
- **Boolean Algebra:** Theorems & Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms and Simplification.
- **Logic Gates:** Switching Circuits, Electronic Logic Gates, Gate Symbols, Design and operation of NOT, OR, AND, NOR, NAND, XOR, XNOR Gates. Analysis of Combinational Circuits- Algebraic Method, Truth Table Method.
- **Synthesis of Combinational Logic Circuits:** AND-OR NAND Networks, OR-AND and NOR Network, AND-OR-Invert Circuits.
- **Combinational Logic Design:** Circuits (gate level), Design Hierarchy and procedures. Two-level and multi-level implementations, Arithmetic operation using gates (add, subtract, multiply), Logic Minimization, K-Map, Unate Covering, Quine McCluskey Method, CAD tools for two level minimization, ESPRESSO Algorithm and other popular (multiplexers, encoders, decoders) modules design.
- **Programmable Logic Devices:** Technologies, Performance, Classical and Mid-Complexity Architectures (PLDs, CPLDs, FPGAs) and Modern Architectures (SoPC).
- **Sequential Logic Design:** Latches, Flip-Plops, State Machine Design & Minimization (Mealy and Moore models) and Design Problems.
- Sequential Circuits: Design of Synchronous Counters, Ripple counters, parallel Load counters, Introduction of Registers and shift Register:
- **Memory Design:** Random Access Memory (RAMS), Static RAMS, Dynamic RAMS, Memory organizations and Read only Memories (ROM)

References:

1. Digital Logic Circuit Analysis and Design by Vicor P. Nelson and H. Troy Nagle, Bill D. Carroll, J. David Irwin.
2. Logic and Computer Design Fundamentals by M.M. Mano and C.R. Kime, Prentice-Hall, 4th Ed.
3. Introduction to Digital Logic Design by J.P. Hayes, Addison-Wesley, 1993.
4. Digital Systems: Principles and Applications, by Ronal J Tocci, Neal Widmer, Gregory L Moss, Prentice-Hall 1997.
5. Fundamentals of Digital Logic with VHDL Design by S. Brown and Z Vranesic, McGraw-Hill, 2nd Ed.
6. Analysis and Design of Digital Systems with VHDL by Allen Dewey, PWS Publication, 1st Ed.

Course Code	Course Title	Credit	Theory	Lab
CSE 303	Data Communication and Networking	3	2	1

Outline: Introduction: Overview of Data communication, networking and network models; Physical Layer and Media: Data and Signal, Digital Transmission, Analog Transmission, Transmission Media Data Link Layer: Error detection and Correction, Flow and error control, Medium access control protocols (ALOHA, CSMA/CD, CSMA/CA), Channelization (FDMA, TDMA, CDMA) Ethernet, Wireless LANs; Network Layer: Logical Addressing.

References:

1. Data Communications and Networking, B. A. Forouzan, 5/e

Course Code	Course Title	Credit	Theory	Lab
CSE 501	Parallel Computing	3	2	1

Course Outline: Introduction, Parallel Computer Model, the State of Computing, Flynn's Classification, Parallel/Vectors Computers, and Challenges for Parallel Computing, System Attributes to Performance, Clock Rate and CPI, Performance Factors, System Attributes, MIPS rates, Throughput rate, Implicit and Explicit Parallelism, Multiprocessors and Multicomputers, Shared Memory Multiprocessors, different types of model (UMA, NUMA, COMA), Distributed Memory Multicomputer, Multicomputer Generation, Multivector and SIMD Computers, Vector supercomputer, SIMD supercomputers, PRAM and VLSI Models, Parallel Random Access Machines, Time and Space Complexities, NP Completeness, PRAM models, VLSI complexity model and discussion about related papers, Introduction to Program and Network Properties, Condition of Parallelism, Data and Resource Dependencies, Control Dependence, Resource Dependence, Bernstein's Conditions, Hardware and Software Parallelism, The role of compiler, Program Partitioning and Scheduling, Grain Sizes and Latencies, Grain Packing and Scheduling, Static Multiprocessor Scheduling, Node duplication, Program Flow Mechanisms, Control Flow versus Data Flaw, Demand Driven Mechanisms, System Interconnect Architectures, Network Properties and Routing, Node Degree and Network Diameter, Bisection Width, Data Routing Function (Permutations, Perfect Shuffle and Exchange, Hypercube Routing Functions, Broadcast and Multi cast), Network Performance, Related Paper Studies, Static connection Networks (Linear array, Ring and Chordal Ring, Barrel Shifter, Tree and Star, Mesh and Torus, Systolic Array, Hypercube, Cube Connected Cycles), Network Throughput, Dynamic Connection Networks, Principles of Scalable Performance, Performance Metrics and Measures, Parallelism Profile in Programs, Degree of Parallelism, Average Parallelism, Available Parallelism, Asymptotic Speedup, Harmonic Mean Performance, Arithmetic Mean Performance, Geometric mean Performance, harmonic Mean Performance, Harmonic Mean Speedup, Amdahl's Law, System Efficiency, Quality of Parallelism, Scalability of Parallel Algorithms, and Speedup Performance Laws, Processors and Memory Hierarchy: Advanced processor Technology, Design Space of Processors, Instruction Pipelines, Processors and Coprocessors, Superscalar and Vector Processors, Virtual Memory Technology, Pipelining and Superscalar Techniques: Linear Pipeline Processors, Asynchronous and Synchronous Models, Speedup Efficiency and Throughput, Nonlinear Pipeline

Processors, Reservation and Latency Analysis, Collision Free Scheduling, state diagram, greedy cycles, Pipeline Schedule Optimization, Pipeline Throughput, and Instruction Pipeline Design, Branch Handling Techniques, Effects of Branch, Related Paper discussion, Multiprocessors and Multicomputer: Hierarchical Bus Systems, Crossbar Switch and Multi port Memory, Hot spot problem, Cache Coherence and Synchronization Mechanisms, cache coherence problem, process migration, snoopy bus protocols, Directory based protocols, Hardware Synchronizations Mechanisms, Software for Parallel Programming: Object Oriented Model, Functional and Logic Model, Parallel Language and Compilers.

References:

1. Kai Hwang, "Advanced Computer Architecture", McGraw-Hill.
2. Principles of Parallel Programming, by Calvin Lin and Larry Snyder, Addison-Wesley, 2009.
3. Patterns for Parallel Programming, by Mattson, Sanders, and Massingill, Addison-Wesley, 2005.
4. The Art of Multiprocessor Programming, by Herlihy and Shavit, Morgan Kaufmann, 2008.

Course Code	Course Title	Credit	Theory	Lab
BUS 602	Management Information Systems	3	1	2

Course Outline: Foundation Concepts a) Foundations of Information Systems in Business i. Foundation Concepts: Information Systems in Business ii. Foundation Concepts: The components of Information Systems b) Competing with Information Technology i. Fundamentals of Strategic Advantage ii. Using Information Technology for Strategic Advantage 2. Information Technologies a) Computer Hardware b) Computer Software c) Data Resource Management i. Technical Foundations of Database Management ii. Managing Data Resources d) Telecommunications and Networks i. The Networked Enterprise ii. Telecommunications Network Alternatives 3. Business Applications a) E-business Systems i. e-Business Systems ii. Functional Business Systems b) Enterprise Business Systems i. Management at Enterprise Level ii. Enterprise Resource Planning iii. Supply Chain Management c) E-commerce Systems i. e-Commerce Fundamentals ii. e-Commerce Applications and Issues d) Supporting Decision Making i. Decision Support in Business ii. Artificial Intelligence Technologies in Business 4. Development Process a) Developing Business / IT Strategies i. Planning Fundamentals ii. Implementation Challenges b) Developing Business / IT solutions i. Developing Business Systems ii. Implementing Business Systems 5. Management Challenges a) Security and Ethical Challenges i. Security, Ethical and Societal Challenges of IT ii. Security Management of Information Technology b) Enterprise and Global Management of Information Technology i. Managing Information Technology ii. Managing Global IT

Reference:

1. Management Information Systems, 10th edition, James O' Brien

Course Code	Course Title	Credit	Theory	Lab
CSE 802	Computer, Data and Network Security	3	1	2

Course Outline: Overview: Network Security Concepts, Security Attacks, Services and Mechanisms; Classical Encryption techniques: Symmetric Cipher Model, Substitution and Permutation Ciphers, Steganography; Block Ciphers and Data Encryption Standard: Design principles and modes of operation; Public-key cryptography: Introduction to number theory, RSA and Diffie-Hellman; Message Digest: Requirements for cryptographic hash functions,MD5 ,SHA, Message authentication codes, digital signatures; Key Management and Distribution: Symmetric Key Distribution using Symmetric Encryption, Symmetric Key Distribution using asymmetric Encryption, public key distribution, public key certificates, x.509 certificates; Network and Internet Security: Transport Layer Security, Wireless LAN security, e-mail security.

References:

1. Data and Computer Communications By Stallings, 8th Edition, Pearson Education, 2007

Course Code	Course Title	Credit	Theory	Lab
CSE 844	Applied Data Science	3	2	1

Course Outline:

Theory: Introduction to applied data science, Data cleaning/Data Publishing, Data visualization techniques, Predictive analytics, Bayesian analytics, Building efficient models from complex data, Regularization, Opportunities involving applied data science. The course will cover techniques for collecting, storing, and analyzing data in varying formats. Scientific programming, supervised and unsupervised analytics and data visualization techniques will be covered. Topics will involve learning classifiers, Bayesian, maximum a posteriori, parameter estimation, decision trees, neural networks, support vector machines, bag of words classifiers, N-gram models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers, Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering, selected applications in data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, etc.

Lab: The course lab aims to provide an introduction to various topics such as Big Data, Pattern Discovery, Data Visualization, along with a toolkit to use with data i.e., Hadoop, TensorFlow, etc..

Text Book:

Mount and Zumel (2014), Practical data science with R.

References:

1. Cathy O'Neil and Rachel Schutt, *Doing Data Science, O'Reilly, 2014*
2. Russell Jurney, *Agile Data Science, O'Reilly, 2013.*
3. Edward Tufte, *The Visual Display of Quantitative Information, Graphics Press, 2013 (2nd ed).*
4. Morgan Kaufmann, *Data Mining: Practical Machine Learning Tools and Techniques. 3 edition, 2011*
5. Matthew Russell, *Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More. O'Reilly, 2013*