RESEARCH METHODOLOGY SYLLABUS (M.Phil/M.Tech/Ph.D)


3. Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. (10%)

4. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. (10%)

5. Measurement: Concept of measurement – what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. (10%)


7. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. (10%)

8. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. (10%)

9. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. (5%)

10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism (10%)

Books Recommended:-

2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Select references from the Internet
Course Contents:

Basic background: 2D and 3D Transformations, Cyrus-Beck line clipping algorithm, Polygon clipping.

3D Viewing: Viewing pipeline, Parallel and Perspective projections, view volumes, clipping.

Representing Curves and Surfaces: Parametric, curves, continuity conditions, cubic splines, Hermite interpolation, Bezier curves and surfaces, B-spline Curves—uniform nonrational, cubic periodic, open uniform, uniform, nonuniform rational types (NURBS), Subdividing curves, Displaying spline curves using forward difference scheme, parametric bicubic surfaces.

Solid Modelling: Sweep representation, Constructive solid geometry methods, representation through Octrees, Binary Space Partitioning trees.


Introduction to Animation: Perception, Animation production, use in film and videos, orientation representation and interpolation—Euler angle representation, motion display considerations.

Animation—Low Level Control: Motion along a curve—computing are length, speed control—sine interpolation User specified distance time functions, path following, key-frame systems—shape interpolation, free-form deformations, Morphing—2D object warping.

Animation—High Level Control: Hierarchical modeling and Kinematics—inverse kinematics, Jacobian, rigid body simulation, collision detection, Particle systems—particle generation, attributes, termination, rendering, Flocking behavior—interacting with other members, leader, collision avoidance, modeling water, fire, explosions, waves, clouds.

Main Reading:

Supplementary Reading:
Course Prerequisites: Knowledge of computer graphics fundamentals and ability to program in C/C++.

Course Objectives: This course will study advanced topics in computer graphics. The focus will be on learning recent methods in rendering, modeling, and animation.

Course Contents:

Rendering concepts, lighting, reflectance, Global Illumination, rendering equation, Monte Carlo Path Tracing, Radiosity, form factors, solution methods, meshing

Visibility & Textures: Visibility events, discontinuity meshing, texture mapping, resampling

Image-Based Modeling and Rendering: Managing Scene Complexity, Occlusion culling, detail elision, imposters, plenoptic function, image-based representations

3D Modeling: Object Representations, Mesh Representations, mesh data structures, simplification, Triangle meshes, Multi-resolution meshes, progressive meshes, view-dependent simplification, Mesh Processing, Compression, streaming

Surface Modeling: Parametric surfaces, splines, piecewise polynomial surfaces, Subdivision of surfaces, subdivision schemes

Volumetric Modeling: Implicit surfaces, blobby models, skeletons, variational implicit surfaces, Volumetric Representations, voxels, volume graphics

Kinematics: Articulated figures, inverse kinematics, space-time constraints, Motion Capture, processing motion capture data, retargeting motion

Dynamics: Passive Dynamics, particle systems, spring-mass systems, Active Dynamics, controllers, learning, planning

Main Reading:

1. Alan Watt and Mark Watt, Advanced Animation and Rendering Techniques: Theory and Practice, Addison-Wesley,

Supplementary Reading:

2. Peter Shirley and Steve Marschner and other, Computer Graphics, Cengage Learning

Website Links:

http://www.cs.princeton.edu/courses/archive/fall02/cs526/
602 - Elements of Computational Geometry and Geometric Modeling

Course Prerequisites: Algorithms & Data Structures.

Course Objectives: This course will cover topics in 2D and 3D geometry and its transformations, differential geometry of curves and surfaces, 3D geometry and coordinate transformations, curves and surface design, solid modeling, meshing and computational geometry data structures and algorithms.

Course Contents:

Basics in 2D and 3D geometry and transformations: Plane co-ordinate geometry, equations of lines and plane curves, parametric equations of lines and curves, intersection of parametric lines and curves, polar coordinates, vector representation of a point, line, plane, curve, continuity, tangent and curvature

Differential Geometry of curves and surfaces: Arc length and tangent vector, Principal normal and curvature, Binomial vector and torsion, Frenet-Serret formulae, tangent plane and surface normal, first fundamental form, second fundamental form, principal curvatures, Gaussian and mean curvature, Euler’s theorem and Dupin’s indicatrix

3D Geometry and Coordinate Transformations: Translation, rotation about arbitrary axis, scaling, reflection, shear and composite transformation, homogenous coordinates, projections parallel and perspective, taxonomy of projections

Curves and surface design: Parametric space of curves, blending functions, Spline curves, Bezier curves, B-Spline curves, rational polynomials, cylindrical surface, rules surface, surface of revolution, conic surfaces, composite surfaces, Bezier surface, B-spline surface

Solid modeling: Parametric space of solid, topology of closed path, piecewise flat surfaces, topology of closed curved surfaces, generalized concept of a boundary, set theory, Boolean operation operators, Euler operators, solid modeling representations cell decomposition and spatial occupancy enumeration, sweep representation, CSG

Meshes: Polygonal mesh representation, Basic mesh descriptions, Mesh topology, Triangulations and Tessellations, Winged edge data structures for meshes, Operations on meshes like Fairing, Smoothing, Remeshing etc.

Computational geometry data structures and algorithms: Line segment intersection, orthogonal range searching, Voronoi diagrams and Delaunay triangulations, convex hull, Quadtree, orthogonal range searching kD-tree, and binary space partitioning

Main Reading:

Supplementary Reading:
Course Prerequisites: Machine Learning

Course Objectives: To be able to understand and apply a series of probabilistic models of images and objects in computer vision systems.

Course Contents:

Two-dimensional visual geometry: 2D transformation family, Homography, Estimating 2D transformations, Image panoramas

3D image geometry: The projective camera, Camera calibration, recovering pose to a plane

Multiple Cameras: The fundamental and essential matrices, Sparse stereo methods, Rectification, Building 3D models, Shape from silhouette

Vision at a single pixel: Background subtraction and color segmentations problems, Parametric, non-parametric and semi-parametric techniques, Fitting models with hidden variables

Connecting pixels: Dynamic programming for stereo vision, Markov random fields, MCMC methods, Graph cuts

Texture: Texture synthesis, super-resolution and denoising, image inpainting The epitome of an image

Dense Object Recognition: Modelling covariances of pixel regions, Factor analysis and principle components analysis

Sparse Object Recognition: Bag of words, latent dirilecht allocation, probabilistic latent semantic analysis

Face Recognition: Probabilistic approaches to identity recognition, Face recognition in disparate viewing conditions

Shape Analysis: Point distribution models, active shape models, active appearance models

Tracking: The Kalman filter, the Condensation algorithm

Main Reading:

Supplementary Reading:
2. Bayesian reasoning and machine learning by David Barber
3. Multiple view geometry in computer vision by Richard Hartley and Andrew Zisserman
4. Information theory, inference and learning algorithms by David MacKay
5. Feature extraction and image processing by Mark S. Nixon and Alberto S. Aguado
6. Pattern recognition and machine learning by Christopher M. Bishop
Course Prerequisites: C/C++ programming skills

Course Objectives: The course will cover techniques and tools for digital image processing, and finally also introduce image analysis techniques in the form of image segmentation.

Course Contents:

Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization.

Spatial Domain Filtering: Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian

Filtering in the Frequency domain: Hotelling Transform, Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering


Image Compression: Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, Golomb Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, FAX compression (CCITT Group-3 and Group-4), Symbol-based coding, JBIG-2, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation


Morphological Image Processing: Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

Image Segmentation

Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

Main Reading:

Supplementary Reading:

Website Links:
http://www.ece.arizona.edu/~dial/
605 - Data Visualization

**Course Prerequisites:** C/C++ programming skills

**Course Objectives:** To study important approaches in the field of Data Visualization and its techniques.

**Course Contents:**

What is Visualization, the visualization process, Data Foundations, types of data – continuous data, sampled data, discrete datasets, Human Perception and Information Processing, Visualization Foundations

Visualization Techniques for Spatial Data: 1D, 2D and 3D, Dynamic Data, Geospatial Data, Visualizing Point, Line and Area Data, Visualization Techniques for Multivariate Data, Visualization Pipeline

Visualization Techniques Graphs, Text and Document: Visualizing Trees, Graphs, and Networks, Displaying Hierarchical Structures, Arbitrary Graphs/Network, Levels of Text Representation, the Vector Space Model, Single Document Visualization, Document Collection Visualization,

Scientific Visualization: Scalar, Vector, Tensor Visualization, Domain Modeling Technique, Image and Volume Visualization


**Main Reading:**
1. Mathew Ward, Georges Grinstein, Daniel Keim, Interactive Data Visualization Foundation, Techniques and Applications, A K Peters 2010

**Supplementary Reading:**
2. Visualization Design and Analysis: Abstractions, Principles, and Methods by Tamara Munzner.
Course Prerequisites: - C/C++ programming skills

Course Objectives: The recent advances in the field of Visual Computing thrives on inputs from multiple disciplines, which are traditionally taught in separate courses in the University such as Computer Graphics, Computer Vision and Image Processing. This course on Visual Computing will attempt to provide a unified perspective to the underlying algorithms and data structure involved in modeling shape of the objects, its interactions with the light source in synthesizing imagery and retrieving 3D information from 2D images.

Course Contents:


Image synthesis: Understand the concepts - Captured image in 2D v/s synthesized image via modeling & rendering. Capturing of 3D data using scanning technology and reverse engineering the shape of the object

Geometric modeling: Data structures for object representation, Volume representation, Sweep representation, Cell decomposition, CSG, Boundary representation, Euler Operators, Bezier & B-Spline curves and surfaces

Meshes: Polygonal mesh representation, Basic mesh descriptions, Mesh topology, Triangulations and Tessellations, Winged edge data structures for meshes, Operations on meshes like Fairing, Smoothing, Remeshing etc.

Coordinate pipeline: Transformation principles, Geometry pipeline, Graphics pipeline, Vision pipeline, Advanced Coordinate pipeline

Image geometry: Sampling and Quantization, Region and edges, Image filtering, Edge detection, Contours, Textures, Warping and morphing of images, Interpolations, Colors, Half-toning and Dithering, High-dynamic range imaging, Image pyramids

Motion capture: Motion tracking, randomized incremental algorithms, computational geometry algorithms Delaunay triangulations, Voronoi diagrams, kD-trees, Clustering by kMeans

Main Reading:

Supplementary Reading:
607 – Image Processing and Computer Vision

Course Contents:

Introduction: Image formation model, representation, spatial and Gray Level resolution, Colour models - RGB, CMY and HIS models


Image Enhancement In Frequency Domain: 2D Discrete Fourier transform and its inverse, filtering in frequency domain, Ideal and Gaussian Low pass filters, high pass filtering, separability property of 2D Fourier transform, Fast Fourier Transform.

Image Segmentation: Line detection, Edge detection, Edge linking and boundary detection, Hough Transform, Thresholding, Region based segmentation

Morphological Image Processing: Logic operations involving binary images, Dilation and Erosion, Opening and closing. Applications to Boundary extraction, region filling, connected component extraction.


Image Representation: Boundary description, Shape numbers, Fourier descriptors, Texture, principal Components based description.

3D Vision: Projective geometry, single perspective camera, stereopsis, the fundamental matrix – its estimation from image point correspondences, applications of epipolar geometry in vision, correlation based and feature based stereo correspondence, shape from motion, optical flow.

Main Reading:

Supplementary Reading:
Course contents:

Fundamentals of Multimedia: What is multimedia? Components of multimedia, Overview of multimedia applications and multimedia authoring tools

Graphics and Image Representation: Fundamentals of image formation and data representations, Sampling and quantization, Contrast & brightness, Histogram methods, Simple image processing operations: Point processing,

Spatial filtering, Edge detection, Popular file formats: BMP, GIF, JPG, PNG etc.


Fundamental of Video: Different types of video signals – component, composite and S-video, Analog TV transmission systems - NTSC, PAL, Chroma sub-sampling, Display technology fundamentals – interlacing & progressing scanning, Digital video - HDTV

Fundamentals of Audio: Digitization of sound, Psychoacoustics – frequency & temporal masking, Unit of sound measurement - Signal-to-Noise Ratio (SNR), Linear and non-linear quantization, Audio filtering and transmission, Coding of audio – PCM, DPCM, ADPCM, Audio quality versus data rate, Synthetic sounds, Popular file formats – MIDI system, WAV, MPEG etc.


Multimedia Information Management – Multimedia database design, Content based information retrieval: image retrieval, video retrieval etc.

Main Reading:
2. Supplementary Reading
4. Sayood Khalid “Title: Introduction To Data Compression” 3rd Edition, Publisher: Morgan Kaufmann Publishers Inc
The video game development is currently a big business, bigger than the movie industry. Today, some of the highly paid programmers work in gaming industry. There is a high demand for people who know about various aspects of game programming. No Universities in India are currently offering a course on game programming. Teaching a course on game programming is a challenge because it’s an ultimate course, integrating all the concepts learnt in Computer Science & Software Engineering. This course will be offered by practicing game developer who has over 10 years experience in Game development with some of the titles such as X-Men Legends, Star Wars: Jedi Knight, Doom 3 and Quake IV. The course will have lab associated with it and it will be a hands-on course.

**Course Contents:**

Introduction to Game Development: History of Computer Games, Input Devices and User Interfaces, Commercial Game Systems, Software Tools and Technology, Modeling, Simulation, Graphics, Game Main Loop, Programming and Common APIs, Games and Society, Future of Games

Game Engines: 2D/3D Game engines and the underlying technologies, Development of game using game engines, Typical functionality provided by a game engine, Hardware abstraction and Middleware, Console programming

Mathematics & Geometry: Vectors, Matrices, Transformations, Homogeneous Coordinates, Triangle Mathematics, Intersection Issues, Fixed-point Real Numbers, Parametric Curves


Game Physics: Rigid body motion, Collision Detection and Resolution, Deformable bodies

Character Motion: Inverse Kinematics, Character Animation, Key framing , Principles of Traditional Animation

Motion Capture, Motion Blending, Motion Retargeting

Terrain Modeling & Scene Management: Ground / Building / Static models / Dynamic models, Polygon mesh, Grids-2D, Quadtree, Height map, Procedural height map, Terrain Formats, Triangular mesh, Procedurally generated, Created by artists, Culling, Level of detail, Draw order, Off-screen rendering, Paging

Game Control System & AI: Search, Path Finding, Finite State Machines, Steering Behavior, Blind search, Heuristic search, A* search, Adversary search, Minmax search


Current Issues: Consistency, Cheating in Games, Cheat Proofing, Massive Multiplayer Online Games (MMOGs)

**Main Reading:**

1. 3D Games: Volume 1: Real-Time Rendering and Software Technology, Alan Watt and Fabio Policarpo, Addison-Wesley
2. 3D Games, Volume 2: Animation and Advanced Real-time Rendering, Alan Watt and Fabio Policarpo, Addison-Wesley
3. Advanced Game Development with Programmable Graphics Hardware, Alan Watt and Fabio Policarpo, A K Peters
4. Game Programming Gems 1-6, Mark DeLoura, Charles River Media
5. AI Game Programming Wisdom 1-3, Steve Rabin, Charles River Media
611 - Natural Language Processing

Course Prerequisites:
1. A previous course on Artificial Intelligence will help.
2. Courses of Data Structures and Algorithms should have been done.
3. Exposure to Linguistics is useful, though not mandatory.

Course Objectives: To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from algorithmic viewpoint.

Course Contents:


Probabilistic parsing; Sequence labelling, PCFG, Probabilistic parsing: Training issues, Arguments and Adjuncts, Probabilistic parsing: inside-outside probabilities.

Speech : Phonetics, Hidden Markov Model, Morphology, Graphical Models for Sequence Labelling in NLP, Consonants (place and manner of articulation) and Vowels.

Forward Backward probability; Viterbi Algorithm, Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses, Text Alignment, POS Tagging.

Phonology; ASR, Speech Synthesis, Hidden Markov Model and Viterbi, Precision, Recall , F-score, Map, Semantic Relations; UNL; Towards Dependency Parsing.

Universal Networking Language, Semantic Role Extraction, Baum Welch Algorithm; HMM training.

Main Reading:
4. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical

Supplementary Reading:

Website Links: http://nptel.iitm.ac.in/courses/106101007/
612 - Computational Linguistics

Course Prerequisites:
1. A previous course on Artificial Intelligence will help.
2. Courses on Natural Language Processing should have been done.
3. Exposure to Linguistics is useful, though not mandatory.

Course Objectives: To introduce the advanced concepts in computational linguistics, modern grammar formalisms, Natural Language generation, etc.

Course Contents:


Main Reading:
1. Alexander Clark, Chris Fox, and Shalom Lappin (Editors): The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics).

Supplementary Reading:
613 - Speech Processing

Course Prerequisites:
1. A previous course on Artificial Intelligence will help.
2. Courses of Data Communication and Digital Signal Processing should have been done.

Course Objectives: To study the fundamental concepts of Speech processing.

Course Contents:


Introduction, Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.


Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System.

Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMs, Adapting to variability in speech (DTW), Language models.

Issues in speaker recognition and speech synthesis of different speakers. Text to speech conversion, Calculating acoustic parameters, synthesized speech output performance and characteristics of text to speech, Voice processing hardware and software architectures.

Main Reading:
1. Digital processing of speech signals - L.R Rabiner and S.W. Schafer. Pearson Education.

Supplementary Reading:
3. Speech Recognition - Claudio Becchetti and Lucio Prina Ricotti, Wiley
614 - Sentiment analysis

Course Prerequisites: A previous course on Artificial Intelligence and Natural Language Processing will help.

Course Objectives: The objective is to study concepts of Sentiment analysis and opinion mining. Sentiment analysis and opinion mining is the field of study that analyzes people's opinions, sentiments, evaluations, attitudes, and emotions from written language. It is one of the most active research areas in natural language processing and is also widely studied in data mining, Web mining, and text mining.

Course Contents:

Sentiment Analysis Applications, Sentiment Analysis Research, Sentiment Analysis Research, and Opinion Spam Detection.
Problem of Sentiment Analysis: Problem Definitions, Opinion Summarization, Different Types of Opinions, Subjectivity and Emotion, Author and Reader Standing Point.

Sentiment Classification Using Supervised Learning, Sentiment Classification Using Unsupervised Learning, Sentiment Rating Prediction, Cross-Domain Sentiment Classification, Cross-Language Sentiment Classification
Sentence Subjectivity: Subjectivity Classification, Sentiment Classification, Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Cross-language Subjectivity and Sentiment Classification, Using Discourse Information for Sentiment Classification.


Problem Definitions, Identify Comparative Sentences, Identifying Preferred Entities.

Web Search vs. Opinion Search, Existing Opinion Retrieval Techniques

Types of Spam and Spammers, Supervised Spam Detection, Unsupervised Spam Detection, Group Spam Detection.

Quality as Regression Problem, Other Methods.

Main Reading:
1. Sentiment Analysis and Opinion Mining, Bing Liu.

Supplementary Reading:
Course Prerequisites:
1. A previous course on Artificial Intelligence and Natural Language Processing will help.
3. Exposure to Linguistics is useful, though not mandatory.

Course Objectives: To study important approaches to the automatic translation between natural languages.

Course Contents:

Language Similarities and Differences-The Transfer Metaphor-Syntactic Transformations Lexical Transfer.


Main Reading:

Supplementary Reading:

Website Links:
http://www.statmt.org/
616 – Compiler Design

Course Content:


Syntax directed translation: Syntax directed translation schemes, Implementation of syntax directed translation schemes, Intermediate codes, Post fix notation parse trees & syntax trees, three address codes, quadruples, triples, Translation of assignment statements, Boolean expression, statements that after flow of control, Post fix translation, Translation with Up down parsing.

Error detection & recovery: Errors, lexical phase errors, Syntactic phase errors, semantic errors.

Code Optimization : Loop optimization, DAG representation of basic block, value numbers & algebraic laws, Global data flow analysis, Dominators, Reducible flow graph, Depth first search, Loop invariant computation, Induction variable elimination.


Code Generation : A simple code generation, code generation from DAG & labeled trees.

Register allocation : Coloring by implication, coalescing, graph coloring implementation, Register allocation for Trees.

Main Reading:
3. Andrew W. Appel, “ Modern Compilers Implementation in Java”.
4. Dhamdhere “ Compiler Principles”.
Course Contents:

Automata and Language Theory: Finite automata, regular expressions, push-down automata, context free grammars, pumping lemmas.

Computability Theory: Turing machines, Church-Turing thesis, decidability, halting problem, reducibility, recursion theorem.

Complexity Theory: Time and space measures, hierarchy theorems, complexity classes P, NP, L, NL, PSPACE, BPP and IP, complete problems, P versus NP conjecture, quantiers and games, provably hard problems, relativized computation and oracles, probabilistic computation, interactive proof systems.

Main Reading:
621 - Instructional Design for e-Learning

Course Objectives:
1. Apply the Understanding by Design framework to course design.
2. Investigate modern computer-based design tools.
3. Explore instructional methods and principles of design

Course Contents:

Personal Learning Environments, Instructional Design Foundations, Learning Outcomes Assessment
Content Creation: graphics
Cognitive Load Theory
Content Creation: audio and podcasting
Evaluation of Tools and Methods
Content Creation: video
Learning Management Systems, Designing for Accessibility
Content Creation: web-based tools

Main Reading:
Course Objectives: This course is an introduction to the classroom applications of educational technologies. The course includes a survey of educational hardware and software.

Course Contents:

Technology in Education: Meaning, Evolution and Development

Traditional Educational Technology/Materials: Cone of Experiences: Direct and Purposeful (Games & Experiments), Contrived Experiences (Three Dimensional, Mock up, Diorama), Dramatized Experiences (Pageant, Socio-Drama), Demonstration Boards (chalkboard, peg board etc.), Field Trips, Exhibits, Still Pictures (drawings, graphs, cartoon, etc.)


ICT in Education: Computer, Internet, Multimedia/Hypermedia

Educational Technology in Instructional Planning: Multiple Intelligence, Learning Styles, Blooms Taxonomy

Technology and Student Assessment: Rubrics, Checklist, Blogs

Main Reading:

623 - Educational Game Design

**Course Objectives:** Understand Game design and to apply it for e-Learning.

**Course Contents:**

What is Gamification? : Introduction, Gamification defined, Why study gamification? History of gamification, Categories and examples

Games: Gamification in context, What is a game? Games and Play, Video games

Game Thinking: Why Gamify, Thinking Like a Game Designer, Design rules, Tapping the Emotions, Anatomy of Fun, Finding the Fun

Game Elements: Breaking Games Down, The pyramid of elements, The PBL Triad, Limitation of Elements, Bing Gordon interview

Psychology and Motivation: I: Behaviorism :Gamification as motivational design, Behaviorism, Behaviorism in gamification, Reward structures, Reward schedules; Beyond Behaviorism :- Limits of behaviorism, Dangers of behaviorism, Extrinsic and intrinsic rewards, How rewards can de-motivate, Self-determination theory

Gamification Design Framework: Design Thinking, Business objectives/target behaviors, Players, Activity loops, Don’t forget the fun and deploy

Design Choices: Two approaches to gamification, Is Gamification right for me?, Designing for collective good, Designing for happiness

Applying gamification for learning domains: declarative knowledge, conceptual knowledge, rules-based knowledge, procedural knowledge, soft skills, affective domain, psychomotor domain

Social Good and Behavior Change: Gamification for good? Social good applications, Social good techniques, Behavior change

Critiques and Risks: Pointification, Exploitationware, Gaming the game, Legal issues, Regulatory issues

Beyond the Basics: Going beyond the basics, Inducement prizes, Virtual economies, Collective action, The future of gamification

**Main Reading:**

2. The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education, Pfeier Pub.
631- Distributed Databases

Course Objectives: This course will introduce principles and foundations of distributed databases, including architecture, design issues, integrity control, query processing and optimization, transactions, and concurrency control.

Course Contents:

Features of Distributed versus Centralized Databases, Principles Of Distributed Databases , Levels Of Distribution Transparency, Reference Architecture for Distributed Databases , Types of Data Fragmentation, Integrity Constraints in Distributed Databases.

Translation of Global Queries to Fragment Queries, Equivalence Transformations for Queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate Function Evaluation, Parametric Queries.


Concurrency Control, Foundation of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control based on Timestamps, Optimistic Methods for Distributed Concurrency Control.

Reliability, Basic Concepts, Nonblocking Commitment Protocols, Reliability and concurrency Control, Determining a Consistent View of the Network, Detection and Resolution of Inconsistency, Checkpoints and Cold Restart, Distributed Database Administration, Catalog Management in Distributed Databases, Authorization and Protection.


Database Integration, Scheme Translation, Scheme Integration, Query Processing Query Processing Layers in Distributed Multi-DBMSs, Query Optimization Issues, Transaction Management Transaction and Computation Model Multidatabase Concurrency Control, Multidatabase Recovery, Object Orientation And Interoperability Object Management Architecture CORBA and Database Interoperability Distributed Component Model COM/OLE and Database Interoperability, PUSH-Based Technologies

Main Reading:

Supplementary Reading:
**Course Objectives:** This course will introduce principles and foundations of distributed systems, including architecture, functional models, distributed operating systems, distributed resource management, introduction to distributed algorithms, and resource security and protection.

**Course Contents:**


**Main Reading:**

Course Objectives: The objective of this course is to understand the fundamental concepts of computer system performance evaluation. This will include introduction to mathematical modelling techniques (Markov Chains, Queuing Theory and Networks of Queues), workload characterization, measurement of performance metrics, Linear Regression Models.

Course Contents:


Linear Regression Models – Distributions: Bernoulli, Binomial, Chi-Square, Exponential, Geometric, Normal, Pareto, Poisson, Student’s t, Continuous and Discrete Uniform – Relationships among distributions – Queuing Theory – Notation – Rules – Little’s Law Birth-Death Processes – M/M/1, M/M/m, M/M/m/B queues – Queuing Network Models for Computer Systems.

Main Reading:

Course Objectives: To study important approaches in the field of Cloud and Utility Computing.

Course Contents:


Main Reading:

635 - Data Analytics

Course Objectives: To Learn about the most effective data analytics methods to solve problems and achieve insight.

Course Contents:

Data: types of data, data quality, data preprocessing, measures of similarity and dissimilarity, Exploring data: Iris dataset, summary statistics, visualization.

Data Warehousing and OALP: Aggregation Operations, models for data Warehousing, star schema, fact and dimension tables Life cycle of data warehouse development, data warehouse architecture, efficient methods of data cube computation, relationship between data warehouse and data mining.


Association Analysis: advanced topics: handling categorical and continuous attributes, Handling concept hierarchy, sequential patterns, subgraph patterns, infrequent patterns.

Classification: general approach, decision tree induction, model overfitting, evaluating performance of a classifier, methods of comparing classifiers.

Classification: alternative techniques: rule based classifier, nearest neighbor classifier, Bayesian classifier, ANN, SVM, ensemble methods.

Cluster Analysis: K-means, agglomerative hierarchical clustering, DBSCAN, cluster evaluation, density based clustering, BIRCH, CURE.

Anomaly detection: statistical approaches, proxy-based outlier detection, density-based outlier detection, cluster based techniques.

Main Reading:

1. Peng-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining, Pearson Education.
**636 - Information Retrieval**

**Course Objectives:** Basic and advanced techniques for text-based information systems: efficient text indexing; Boolean and vector based retrieval models; Web search including crawling.

**Course Contents:**

Overview of Information Retrieval: Function of an IR system, Kinds of IR systems, Components of an IR system, Problems in designing an IR system. The nature of unstructured and semi-structured text.


Matching techniques: Similarity between documents and queries. Parametric or fielded search. Document zones. The vector space retrieval model, tf.idf weighting. Scoring documents, vector space scoring, the cosine measure, efficiency considerations, reduced dimensionality approximations, Latent Semantic Indexing (LSI), random projection, Page Ranking and HITS.

Information Extraction: Information extraction, Named entity extraction, Question Answering. Summarization - Qualities of good summary, summary types, extract summary.

Evaluation of IR systems: Assessment of the performance of IR systems - Precision, Recall, F-Measure. Criteria for evaluation, measuring 'goodness', tests of IR systems. Presentation of search results, display of search results, manipulation of search results.

Relevance feedback: User modeling and information need: user profiling, Relevance judgments. Additional term selections to the system, Dynamic respond ally to judgments and selections, Personalization of search.

Taxonomy and Ontology: Creating domain specific ontology, Ontology life cycle.

Distributed and Parallel IR: Relationships between documents, Identify appropriate networked collections, Multiple distributed collections simultaneously.


Multimedia IR: Techniques to represent audio and visual document, Query databases of multimedia documents, Display the results of multimedia searches.

**Main Reading:**

Course Objectives: Data warehousing and data mining are the essential components of decision support systems for the modern day industry and business. These techniques enable the knowledge worker (analyst, manager, executive) to make better and faster decisions. The objective of this course is to introduce the student to various Data Warehousing and Data Mining concepts and techniques. A database perspective has to be used throughout the course to introduce principles, algorithms, architecture, design and implementation of data mining and data warehousing techniques.

Course Contents:

Introduction and Background: Introduction to the multidisciplinary field of data mining. Discussion on the evolution of database technology that has led to the need for data warehousing and data mining. Stress on importance of its application potential. Introduction to the different key words and techniques.

Data Warehousing And OLAP: Insight of data warehouse and on-line analytical processing. Aggregation Operations, models for data Warehousing, star schema, fact and dimension tables Conceptualization of data warehouse and multidimensional databases. Life cycle of data warehouse development. Relationship between data warehouse and data mining.

Data Mining Primitives: Data preprocessing including data cleaning, data integration, data transformation. Definition and Specification of a generic data mining task. Description of Data mining query language with few example queries.

Association Analysis: Different methods(algorithms) for mining association rules in transaction based data bases. Illustration of confidence and support. Multidimensional and multilevel association rules. Classification of association rules. Discussion on few association rule algorithms e.g. Apriori, frequent pattern growth etc.

Classification and Predictions: Different Classification algorithm, including C4.5, CART etc., use of genie index, decision tree induction, Bayesian classification, neural network technique of back propagation, fuzzy set theory and genetic algorithms.

Clustering: Partition based clustering, Hierarchical clustering, model based clustering for continuous and discrete data. Discussion on scalability of clustering algorithms. Parallel approaches for clustering.

Web Mining: Web usage mining, web content mining, web log attributes. Use of web mining in efficient surfing and personalization

Mining Complex Type of Data: Data mining issues in object oriented data bases, spatial data bases and multimedia data bases, time series data bases, and text data bases.

Applications of Data Warehousing And Data Mining: Exploration of web sites on data ware housing and data mining applications including bibliography data bases, Corporate Houses and Research labs.

Main Reading:

Supplementary Reading
638 – Geographical Information Systems

Course Objective: This course will provide introduction to Geographical Information Systems from the point of view of software developers. The underlying technology and how to apply GIS in decision making will be discussed. At the end of the course, the Learner should be able to understand the spatial terminology and build applications using open source GIS tools.

Course Contents:

Introduction to GIS: GIS definition, key components, functions of GIS, benefits, relationship with other disciplines, issues, application areas.

Spatial Data Structures: spatial data models- Raster and vector data models, Quad-tree, R-tree- searching, insertions, deletion algorithms. Topology and topological models- 9 Intersection model.

Spatial data base fundamentals: Extended ER diagram for spatial entities. Spatial data model, object relational mode, ex. Oracle spatial data model.

Spatial data models: ISO 19101 data model, geometry classes, basic element types, SDO-GEOMETRY structure and operations.

Spatial indexing: principles, benefits, index types, implementation in Oracle.

Spatial SQL: (operators and functions) terminology, principles, set based operations, topological operations. Spatial joins. Spatial functions.

Network modelling: motivation, general network concepts, Network data model and metadata, spatial indexes on NM, shortest path and other functions. Directed and undirected networks, Traveling salesperson problem, reachability analysis, spanning tree.

Spatial data infrastructure and OpenGIS: introduction, components of SDI. Standards.

Main Reading:
1. Geographic Information Systems and Science, Longley, Goodchild, Rhind, Wiley & Sons
2. The Design and Analysis of Spatial Data Structures by Hanan Samet, Addison Wesley
4. Pro Oracle Spatial, R. Kothuri & Beinat, E, APRESS, USA.
Course Contents:

Introduction: Principles of Language Design, Programming Paradigms and Application Domains, Pragmatic Considerations, A Brief History of Programming Languages, Programming Language Qualities, What's in a Name?

Goals of This Study

Syntax: Formal Methods and Language Processing, Syntactic Analysis, Linking Syntax and Semantics

Type Systems and Semantics: Type Systems, Semantic Domains and State Transformation, Operational Semantics, Axiomatic Semantics, Denotational Semantics

Imperative Programming: Von Neumann Machines and Imperative Programming, Naming and Variables, Elementary Types, Values and Expressions, Syntax and Semantics of Statements in Real Languages, Scope, Visibility, and Lifetime, Syntax and Type System for Methods and Parameters

Object-Oriented Programming: Data Abstraction and Modular Programming, The Object-Oriented Model, Example: Expression Evaluation, Concordance, Backtracking, Correctness

Functional Programming: Functions and the Lambda Calculus, Scheme: An Overview, Debugging, Example: Scheme Applications, Program Correctness, Applications of Functional Programming Languages

Logic Programming: Logic, Predicates, and Horn Clauses, Prolog: Facts, Variables, and Queries, Lists, Practical Aspects of Prolog,


Concurrent Programming: Concepts, Communication, Deadlocks and Unfairness, Semaphores, Monitors, Java Threads, Synchronization in Java

Main Reading:

2. Programming Languages: Design and Implementation by Terrence W. Pratt, Marvin V Zelkowitz
Course Contents:

Overview Python Language: Lexical Conventions and Syntax, Types and Objects, Operators and Expressions, Flow Control and Exceptions, Modules

Python's Programming Paradigms: Imperative/Procedural/Scripting, Functional Programming, Object Oriented Programming

Working with Python: Tools and Environment

The Python Library: String and Text Handling, Data Structures and Algorithms, Threading, Networking, Web Programming, Graphical Programming, Database Access

Main Reading:

2. Wesley J. Chun, Core Python Programming, 2/E
642 – Parallel Programming

Course Contents:

Processes and processors Shared memory, fork join constructs, Basic parallel programming techniques, loop splitting, spin locks, contention barrier and row conditions.
Variations in splitting self and indirect scheduling. Data dependency, forward and backward block scheduling.
Linear recurrence relations, backward dependency, Performance tuning overhead with number of processes, effective use of cache.
Parallel programming examples, Average, mean squared deviation, curve fitting, numerical integration, travelling salesman problem, gaussian elimination, Discrete event time simulation.
Parallel Programming constructs in HPF, FORTRAN 95, Parallel programming under UNIX.

Main Reading:
643 – Java Programming

Course Contents:

An overview of object oriented programming and Terminology : Abstraction variable and methods, encapsulation interfaces, messages : object communicating with objects, modularity, classification, inheritance.

Overview of JAVA Language, Java development environment, Language fundamental: How Java differs from C: Programs structure and environment, name space: Packages, classes and members, commands, no pre-processor, Unicode and character escape, primitive data types, reference data types objects, array, strings, operators, statement, exceptions and exception handling.

Classes and Objects in Java : Introduction to Class and Objects, object creation, class variables class methods, object destruction, subclass and inheritance overriding methods, data hiding and encapsulation, abstract class and interface.

String and Arrays : Strings arrays and Utility classes.

Input/Output : Streams standard system streams. IO streams, filtered stream.

Abstract windowing toolkit : AWT overview, graphics, fonts, colors, images, java controls, layout components, new AWT features.

Applets Introduction to Applets: Applet designing basics, drawing graphics, handling events, reading applet parameters, images and sounds, JAR files, applet security restriction, signed applet-weaving Applet into web pages.

Threads : Using thread in applets, creating threaded objects, threaded attributes, thread priority, multithreaded programs.

Events : Java 1.0 Event model, Java 1.1 Event model.

Object serialization, Java beans, Internalization, reflection.

Main Reading:
1. A complete reference for Java “ Herbert Schmidt.
2. Java in Nutshell” David Flanagan, - O’Reilly
3. Java Programming, Balaguruswamy
Course Description:
Students will learn programming and fundamentals of app development by building a series of Android apps during this course. The class will be project based, and will employ a "learning by doing" approach. Students will work on apps using the App Inventor visual programming platform originally developed by Google and now hosted and maintained by MIT Media Labs. Class projects will include development of apps based on the embedded TinyDB database, and location sensitive apps based on GPS inputs. The class will culminate in group projects involving the development of apps of local relevance.

Course Contents:

Introduction to App Inventor: The architecture of a smartphone app. Event handlers and event driven programming.


Creating apps with data and forms: Storing and retrieving persistent data in an app.

Main Reading:
1. App Inventor: Create Your Own Android Apps, by David Wolber
650 - Human Computer Interaction

Course Objectives: To build human-centered design skills, so that you have the principles and methods to create excellent interfaces with any technology.

Course Contents:

Needfinding: Participant Observation, Interviewing, Additional Needfinding
Rapid Prototyping: Paper Prototyping and Mockups, Video Prototyping, Creating and Comparing Alternatives
Direct Manipulation and Representations: Direct Manipulation, Mental Models, Representations Matters, Distributing Cognition
Visual Design and Information Design: Visual Design, Typography, Grids and Alignment, Reading and Navigating
Designing experiments: Designing Studies That You Can Learn From, Assigning Participants To Conditions, In-Person Experiments, Running Web Experiments, Comparing Rates.

Main Reading:
651 - Agile Software Engineering

**Course Objectives:** The objective of the course is to provide students with a theoretical as well as practical understanding of agile software development practices and how small teams can apply them to create high-quality software.

**Course Contents:**

Introduction to Agile Software Development: Understanding how traditional software development works and it’s problems; Role of Agile practices in the world of software development & Tools used


Coding and testing practices: Practicing TDD and pair programming as alternative to traditional documentation; Configuring Continuous Integration tools; Automated function testing in detail, Source Control

Agile Software development and deployment: Iterative and incremental software development, Automated and scripted deployment strategies, Handling change requests

**Main Reading:**

1. Agile Software Development with Scrum, Ken Schwaber, Mike Beedle, Prentice Hall
2. Agile Estimating and Planning by Mike Cohn, Prentice Hall PTR
4. Leading Lean Software Development: Results Are not the Point Mary Poppendieck , Tom Poppendieck
652 – Software Architecture, Design Patterns and Frameworks

Course Contents:

Principles of good OO design: Inheritance versus delegation, program to an interface.

Design patterns: Motivation, reusability, extendibility, cataloging patterns, “GoF” patterns

Software architecture: Definition, advantages, components and connectors, views, documenting, evaluating, mining

Architectural patterns: Layered, pipe & filter, MVC, broker, microkernel, broker, peer to peer, plug-in, event bases software, SOA, middleware architectures

Frameworks: Enterprise frameworks, EJBs

Software product lines: Economies of scope, product line development, product development

Model driven architecture: PIM, PSM, transformation, software factories

Anti-patterns: Case studies

Main Reading:

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Pearson Education
2. Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, Pearson Education
3. Frank Buchmann, Regine Munier, Hans Rohnert, Peter Sommerland, Michael Stahl, Pattern Oriented Software Architecture-I, Pearson Education
4. Christine Hofmeister, Robert Nord, Dilip Soni, Applied software architecture, Pearson Education
5. Jack Greenfield, Keith Short, Software Factories, Wiley DreamTech
653 – Software Project Management

Course Contents:


Managing the systems life cycle, requirements determination, logical design, physical design, testing implementation, system and database Integration issues, metrics for project management and systems performance evaluation, managing expectations, superiors users, team members and other related to the project: determining skill requirements and staffing the project, cost effectiveness analysis: reporting and presentation techniques and effective management of both behavioral and technical aspects of the project.

Main Reading:
Objective:
To provide a detailed study of testing software and automated tools.

Course Contents:


Testing process: Comparison of different techniques- Test Plan – Test case Design Procedure Specification – Test Case Execution and Analysis - Test Documentation - Reporting test results - Final test reporting, Test Driven Development & Refactoring


Testing Tools: Need for automated testing tools - Selection of testing tool – Tools used at various phases.

Main Reading:
4. Testing Applications on the Web, by H. Nguyen, R. Johnson, and M. Hackett
7. Web resources: http://www.softwareqatest.com
Course Contents:

Fundamentals of middleware: Introduction to middleware, MW definition, styles of MW, key players;

Distributed systems characteristics; System models- architectural and fundamental models. RPC, Distributed objects-RNI, .NET Remoting, Name services-DNS, Time and global states, synchronization, Coordination and agreement, distributed transactions and recovery, Consistency & Replication, Fault Tolerance, Security.

Asynchronous communication and Event based systems: Notifications, message Queuing systems, peer to peer systems

Middleware and enterprise services in J2EE: Servlets and EJBs.

SOA & Web services: XML, SOAP, WSDL, UDDI & other protocols;

Reflective middleware: Introduction to reflective middleware, Middleware oriented architectural patterns for enterprise systems.

Main Reading

656 – Component Technology

Course Contents:

Motivation for components: Introduction covering experience from software development - market vs. technology standards.

Foundation: Definition of a component, important issues: components, interface and re-entrance; polymorphism, objects vs. class composition; Scale and granularity of components- architecture (patterns and frameworks) ;

Component Technologies: Wiring standards (how to connect components); Approaches: OMG CORBA, Microsoft .NET, Sun: Javabeans, J2EE & EJBs, ;

Service Oriented Architecture and web services: Component architecture, component frameworks, component development ,component distribution and acquisition , component assembly

Main Reading:
660 – Advanced Computer Architecture

**Objective**
This course is designed for students who are already familiar with the fundamentals of the working principle of a Digital Computer and the various sub-units. The main objective of the course is to expose the students to the working of current high performance processors and systems.

**Course Contents:**


Pipelining: Linear pipeline processor, Nonlinear pipeline processor, Instruction pipeline design, Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch handling techniques, Arithmetic Pipeline design: Computer arithmetic principles, Static arithmetic pipelines, Multifunctional arithmetic pipelines

Storage and Memory Hierarchy: Register file, Virtual memory, Cache memories, Cache memory working principles, Cache coherence issues, Cache performance analysis, High bandwidth memories.


Instruction Level Parallelism: Super-scalar processors, VLIW architecture

Parallel Computer Models and Program Parallelism: Classifications of Machines, SISD and MIMD, condition of parallelism, data and resource dependencies, hardware and software parallelism program partitioning and scheduling, grain size latency, program flow mechanism, control flow versus data flow, data flow architecture, demand driven mechanisms, comparison of flow mechanisms.

Vector Processor And Synchronous Parallel Processing: Vector instruction types, vector-access memory schemes, vector and symbolic processors, SIMD architecture and programming principles: SIMD parallel algorithms, SIMD computers and performance enhancement.

System Interconnect Architectures: Network properties and routing, static interconnection networks, dynamic interconnection networks, multiprocessor system interconnects: Hierarchical bus systems, Crossbar switch and multiport memory, Multistage and combining network.

**Main Reading:**

**Supplementary Reading:**
661 – Advanced Operating Systems

Course Contents:

Overview: Design approaches, synchronization, mechanisms, axiomatic verification of parallel programs.

Process Deadlocks: Models of deadlocks, models of resources, Graph theoretic model of a system, state, systems with single-unit resources, consumable resources, reusable resources.

Architectures of Distributed systems: Types, issues, communication primitive, limitations of a distributed system, lamport’s logical clock, vector clocks.

Distributed Mutual Exclusion: Classification of algorithms, solution to ME, token and non-token based algorithms, comparisons

Distributed deadlock Detection: Resource versus communication Deadlocks, deadlock handling strategies, centralized and distributed deadlock detection algorithms.

Distributed file systems: Mechanisms for building DFS, Design issues, case studies. Distributed shared Memory – algorithms, coherence protocols, design issues.

Distributed scheduling: Issues in load distribution, load distribution, load Distribution algorithms.

Failure Recovery and Fault Tolerance: Backward and forward error recovery, checkpointing, recovery in distributed database system.

Protection and Security: Access and Flow Control,

Case studies: Amoeba, Andrew, Unix,

Main Reading:

1. Advanced concepts in Operating systems – Singhal and Shivaratri - Tata McGraw Hill
2. Distributed Operating Systems – Andrew Tanenbawn, Prentice Hall
Course Contents:


Programming applications: Time and date routine, Ping, Trivial file transfer protocol.

Main Reading:

Supplementary Reading:
1. Microsoft Software Developers Network Documentation.
2. Davis R., Win32 Network Programming, Addison Wesley
Course Contents:


Advanced I/O: Nonbloking I/O, Record locking. Stream, I/O multiplexing, Memory mapped I/O, Asynchronous I/O.

Inter-process communication: Pipes, Message queues, Semaphores and shared memory.

Main Reading:

Supplementary Reading:
1. Unix man pages and Standard C library (libc) Documentation
664 - Biomechanics (2 credits)

Course Information:
Basic Biomechanics is a first course in undergraduate biomechanics that provides background in musculoskeletal anatomy and principles of biomechanics. The course applies and builds on the concepts of Statics and, Dynamics for human activities, and Mechanics of Materials and tissues.

Course Objective:
The course provides an overview of musculoskeletal anatomy, the mechanical properties and structural behavior of biological tissues, and biodynamics. The course is meant to provide basic background in biomechanics for science, engineering and biotechnology students fields, and for those planning to attend graduate school in biomedical engineering. For those interested in industrial positions, this course provides a foundation for careers as design engineers in medical device companies and exercise equipment companies, as laboratory/testing technician in research facilities, and as a clinical engineer in the hospital environment. While these positions are available with a Bachelor's degree, most companies (or positions) will require continued training to improve skills in specific areas.

Course Contents:
Introduction to Biomechanics: Force Vector, Moment and Torque Vectors, Statics: Systems in Equilibrium, Applications of Statics to Biomechanics

Introduction to Dynamics: Linear Kinematics, Linear Kinetics, Angular Kinematics, Angular Kinetics, Impulse and Momentum

Introduction to Deformable Body Mechanics: Stress & Strain , Multiaxial Deformations & Stress Analyses, Mechanical Properties of Biological Tissues

Main Reading:
1. Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation
2. by Nihat Özkaya, Margareta Nordin, Dawn Leger, Publisher: Springer

Supplementary reading:
1. Fundamentals of Biomechanics by Knudson, Duane, Publisher: Springer
2. Biomechanics: Mechanical Properties of Living Tissues, by Fung, Publisher: Springer
3. Computational Biomechanics: Theoretical Background and Biological/Biomedical Problems Series: A First Course in “In Silico Medicine”, Vol. 3, Publisher: Springer
4. Biomechanics by Fung, 2nd Ed. Y.C. Publisher: Springer
Course Contents:

Introduction: Internet Architecture: Client-Server Architecture, How Domain Name Service works. How routers work.

Internet Protocols: Layered Protocol Architecture, TCP/IP, ICMP, SMTP, FTP, HTTP.

Internetworking with TCP/IP: Internet addressing, DHCP and static IP addressing, Address classes, IP subnets, IP supernets, Classless IP addressing, Routing Protocols: RIP, OSPF, IGRP, ARP and RARP protocols. Mobile IP.

IP Network QOS and Multimedia Applications: RTP, RTCP, RSVP, MPLS, VOIP, MGCP

IP Multicasting: Reverse path forwarding, Multicast addressing, Internet Group Management Protocol, Multicast Source discovery Protocol. DVMRP, CBT.


Internet Multimedia Technologies: Multimedia: Definition, requirements, Inherited constraint of Internet Audio and Video on internet, Standardized data format for multimedia, multimedia compression JPEG, MPEG, Streamed data transfer, Multicast IP and Mbone.

Main Reading:
666 - Physical Computing (2 credits)

Course Contents:

Introduction to programming in Processing: Loops, conditionals, variables & data structures, and mouse interaction. An overview of microcontrollers.

The fundamentals and use of basic electronic components: Use of resistors, diodes, LEDs, switches, relays and a variety of sensors to implement systems for physical computing. Digital and analog input and output. Serial input and output, including MIDI.


Main Reading:

1. Physical Computing: Sensing and Controlling the Physical World with Computers, Dan O'Sullivan and Tom Igoe, Thomson Course Technology
2. Making Things Talk, Tom Igoe, O'Reilly
668 - Ethical Hacking and Countermeasures

Course Contents:


Footprinting: Introduced to footprinting, Information gathering methodology, Tools used for the reconnaissance phase, countermeasures.

Scanning: Detecting 'live' systems on target network, Discovering services running/ listening on target systems, port scanning techniques, active and passive fingerprinting, Automated discovery tools.

Enumeration: Identifying valid user accounts or poorly protected resource shares, active connections to systems and directed queries, Null Session, NetBIOS Enumeration, SNMP enumeration, Applications and banners.

System Hacking: Remote password guessing, Eavesdropping, Denial of Service, Buffer overflows, Privilege escalation, Password cracking, keystroke loggers, sniffers, Remote control and backdoors, Port redirection, Covering tracks, Hiding files

Trojans and Backdoors: Defining Trojans and Backdoors, Understanding the various backdoor genre, Trojan tools, Prevention methods and countermeasures, Anti-Trojan software.

Sniffers: Active and Passive Sniffing, ARP Spoofing and Redirection, DNS and IP Sniffing and Spoofing.

Denial of Service: DOS and Distributed DOS Attacks, Types of denial of service attacks, Tools for running DOS attacks, Tools for running DDOS attacks, Denial of Service Countermeasures


Session Hijacking: Spoofing Vs Hijacking, Types of session hijacking, TCP/IP concepts, Performing Sequence prediction, ACK Storms, Session Hijacking Tools.


Web Application Vulnerabilities: Common Web Application Security Vulnerabilities, Penetration Methodologies, Input Manipulation, Authentication And Session Management, Tools and Countermeasures

Password cracking: HTTP Authentication Basic & Digest, NTLM Authentication, Certificate Based Authentication, Forms Based Authentication, Password Guessing, Password cracking Tools.

SQL injection: Exploiting the weakness of Server Side Scripting, Using SQL Injection techniques to gain access to a system, SQL Injection Scripts, Prevention and Countermeasures

Buffer Overflow: What is a Buffer Overflow, Exploitation, CPU / OS Dependency, Understanding Stacks, Stack Based Buffer Overflow, Defense against Buffer Overflows


Viruses: Types of viruses, virus signatures, Anti-virus software, few examples.
Linux Hacking: Scanning and mapping Networks, Password Cracking in Linux, Sniffing, Session Hijacking, Linux Rootkits, IP Chains and IP Tables, Linux Security Countermeasures


Main Reading


Supplementary Reading

669 – Embedded Systems (Software)

Course Contents:

Introduction to embedded system: A First Look at Embedded systems- Examples of Embedded systems-applications area-categories of embedded system – recent trends in embedded system:

Design challenge: ptimizing design metrics Common design metrics- Processor technology- General-purpose processors – software - Single-purpose processors – hardware- Application-specific processor- IC technology

Architecture of embedded system: Hardware architecture –software architecture - Programming for embedded system.


Embedded Software Development Tools: Host and Target Machines-Linker/Locators for Embedded Software-Getting Embedded Software into the Target System.

Debugging Techniques: Testing on Your Host Machine-Instruction Set Simulators-The assert Macro-Using Laboratory Tools

An Example System: What the Program Does-Environment in which the Program Operates

Task Image creation: Operating system software –target image creation for windows XP embedded-porting RTOS on a micro-controller based development board.


State machine and concurrent process models: Introduction- Models vs. languages, text vs. graphics-Models vs. languages- Textual languages versus graphical languages-An introductory example- A basic state machine model: finite-state machines (FSM)- Finite-state machines with data path model: FSMD- Using state machines- Describing a system as a state machine-Comparing the state machine and sequential program model- Capturing a state machine model in a sequential programming language-Hierarchical/Concurrent state machine model (HCFSM) and the State charts language

Program-state machine model (PSM) : The role of an appropriate model and language
Concurrent process model: Use of Esteral language for embedded software development.

Main Reading:
1. Embedded software primer by David Simon – Pearson
2. Art of embedded system by Jack Ganssle
3. Embedded systems Architecture by Tammy Noergaard – Elsevier publications
4. Embedded /Real time systems – by DR.K.V.K.Prasad. – Dreamtech
5. Esterel language by Gerard Berry ( web site reference)
6. Embedded system design by Arnold S.Berger
7. model checking by Edmund M.clark
8. Embedded Systems Building Blocks by Jean LaBrosse
9. Embedded Systems Design by Arnold Berger
Course contents:

Nature and scope of managerial economics. Objectives of the firm, Managerial and behavioral theories of the firm.
Concepts of opportunity cost, incremental, time perspective Principles of discounting and equimargins,
Demand analysis - purpose and concepts. Elasticity of demand, Methods of demand forecasting.
Product and cost analysis, short run and long run, average cost curve.
Production function - single output isoquants,
Pricing Prescriptive approach, Price determination under perfect competition, Monopoly, oligopoly and monopolistic competition. Full cost pricing, product line pricing, Pricing strategies.
Profits : Nature and measurement, policy, Break-even analysis, Case study.

Main Reading:
Course contents:

Significance of Planning, Types, Need Requisites, Corporate planning, system approach, Role of the planner, Corporate planning and budgeting.
Social responsibility, Scope, contents, corporation and society, consumers, corporation and democracy, community and government, Social responsibility versus profitability and productivity, growth Professionalism as a means of social behavior.
Mission and purpose, Business definitions - objectives and goals, Environment appraisal, Concepts, components - Scanning and appraising the environment.
Organization appraisal, Dynamics, capability factors, Considerations, Methods and techniques, Structuring, Planning gaps analysis Manager Audit, significance of gaps.

Main Reading:

Course Contents:

Source of investment information
Valuation of debt securities. Debt prices and interest rate risk. Default risk and purchasing power risk.
Market interest rates and term structure of interest rates. Valuation of warrants and convertibles. Options
pricing models.
Valuation of equity: Dividends and valuation. MMS arguments, fundamentals analysis, Earning multipliers.
Timing of purchase and sale of equity shares, estimating earnings and risk.
Portfolio theory. Efficient investments and diversification. Markowitz graphical portfolio analysis. Capital
market theory. Portfolio performances evaluation - Sharpe, Treynor, Jensen, Measures. Mutual funds –
kinds and valuation. Behavior of share prices - technical analysis. The efficient markets Hypothesis-
random walk and martingale methods.

Main Reading:
684 – Business Finance

Course Contents:

Financial and economic development, Intermediation, role and Patterns, Functions of money and capital market, Interest rates Determination, term structure.
Primary capital market, new issues, growth and trends, Financial Intermediaries, merchant bankers, managers, brokers, underwriters Secondary market - organization and functioning. Trading and Settlement. Problems relating to membership, commission, margins, arbitration and off-floor trading. Reforming the markets SEBI.
Market for government securities - the discount and finance house. Operation and managerial problems of commercial banks, Inter-bank call money market. Non-banking financial institutions, leading policies, schemes, composition and quantum of assistance of IDBI, IFCI, ICICI, UTI, LIC, GIC and state level financial corporations.
Credit rating information, Parameters, Role Agencies, CRISIL, Regulatory framework for financial markets and institutions, regulations versus deregulation, Role of RBI, Bank rate, open market operation policies.

Main Reading:

Course Contents:

The course will discuss a variety of framework for identifying information technology applications. The scope of IT applications would cover Management Information System, Decision Support System, Executive Information System and Expert System. Provide a broad understanding of the types of benefits information technology applications can provide in an organization through transaction processing management and operational control, decision support system, office automation, organizational communication and group work support. Socio-economic environment and information technology theoretical in social analysis of computing role of information systems in organization and the impact of information system on organizations markets, frameworks for information system planning information systems and competitive advantages, the new strategic role of information system, methodologies for evaluating investments in IT, framework and methodologies should be discussed and illustrated with case studies. Design reporting system including of discussion of principles in indicator design, managing information support activity in organization, concept of the business process reengineering (BPR) an how IY can enable BPR. Critical success factor in implementing IT applications including the need for managing the process of change illustrated through case students of successful/failed IT projects. Critical role of security in implementing IT applications should be discussed.
Course Contents:

Main Reading:
Course Contents:

Introduction to Organizations and Individuals:
What is an organization, components of organization, nature and variety of organization (in terms of objectives, structure etc.) models of analyzing organization, phenomena, organizational and business variables, organizations in the Indian context, institutions and structures, basic roles in an organization etc. perception, attitudes, motives, (achievement, power and affiliation), commitment, values creativity and other personality factors, profile of a manager and an entrepreneur.

Interpersonal and Group Processes:
Interpersonal trust, understanding the other person from his/her point of view, interpersonal communication, listening, feedback, counselling, transactional analysis, self-fulfilling, prophecy, etc. leadership, motivation, people, working as a member of a team, team functioning, team decision-making, team conflict resolution, team problem solving.

Organizational Structure and Integrating Interpersonal and Group Dynamics:
Elements of structure, functions of structure, determinants of structures, dys-functionality’s of structures, structure technology- environment-people relationships, principles underlying design of organizations, organizational culture, organizational politics, issues of power and authority, organizational communications, organizational change, integrating cases(s).

Case method and lectures should be supplemented with a variety of other methodologies such as feedback on questionnaires and tests, role plays, and behaviour simulation exercise.

Main Reading

Course Contents:

Simulation of Queuing Systems. Using special purpose languages for simulation of queuing systems. GPSS and / or SLAM system Dynamics.

Main Reading:

Course Contents:

Role of decision making in management, Framework, Criteria under conditions of certainty, risk and uncertain, Bays theorem, Sequential decision making, decision tree analysis.

Theory of utility, Utility function curve, Competitive game theory, Queuing models, Single channel, single phase waiting line with Poisson. Distributed arrival rates and exponentially distributed service times. Markov models.

Simulation: Monte Carlo Application to queuing and inventory Models. Application in functional areas of marketing, production, Finance, Behavioural aspects in decision making, open and closed models of decisions.

Systematic problem analysis and decision making. Decision making in functional areas-case studies.

Main Reading

Course Contents:

Assessments of undivided families, Meaning Basic condition, taxable Income, Partitions, Tax planning, Assessment of firms and Associations, Scheme of taxation types, treatment of losses, Tax Planning. Assessment of companies Types profits, depreciation, tax Planning, Section 80, Bonus issues, divided policy, Return of income and assessment procedure Types of assessment, Time limits, Reassessment Cooperatives. Collection and recovery of tax Deduction at source, rates advance payment, Modes of recovery, Refund Appeals and revision Penalties. Wealth Tax Chargeability, valuation, return, appeals, revisions, payment and recovery, gift tax chargeability, rebate, assessment, appeals, revision, payment and recovery. Central sales tax, Concept of sale and purchase, Inter-state trade, Inter-state export and import trade, State sale tax: Assessing authority, Single, Multiple point tax, Procedure for registration and cancellation, Returns payment appeals and revisions.

Main Reading:

1. Central and State tax acts.
2. Sinhania V.K., Taxman direct taxes, Taxman, New Delhi, 1996
691 – Accounting and Financial Management

Course Contents:

Financial Accounting: An Introduction
Meaning and Nature of Accounting, Accounting as language of Business and Accounting as information system. Accounting processes and final output of Accounting system. Principles of Accounting and double entry system. Recording of Transaction in Journal, Posting of transaction to Ledger and preparation of Trial Balance.

Preparation of Final Financial Statement

Analysis of Financial Statements
Horizontal (Trend) analysis and Vertical (Common-Size) analysis. Ratio Analysis – Liquidity ratio, Turnover ratio, Profitability ratio.

Cost Accounting: An Introduction

Budgeting
Meaning, Importance and Objective of budgeting in an Organization, Different types of Budgets including preparation of cash Budget, fixed and flexible budget, Zero based budgeting.

Financial Management: An Introduction

Time Value of Money and Mathematics of Finance
Time Value of Money and Opportunity cost of Money, Present value and future value and Interest rate and discount rate Annuities and their types Numerical related to the calculation of present values and future values.

Capital Budgeting Decisions

Cost of Capital and Sources of Finance

Capital Structure and Dividend Decisions

Working Capital Management

Main Reading
Course contents:

Introduction to Management
Understanding the meaning and definition of Management; Nature of Management; Importance of Management; An overview of Management processes; Evolution of management thought.

Functions of Management
Staffing: Meaning, nature and principles of staffing, Recruitment, Selection, Training, Performance Appraisal.
Controlling: Controlling - Tools, Budgeting – tools and techniques, Communication in Organization, Motivation, Leadership

Production and Operation Management
Production Planning, Inventory Management - tools and techniques, Vendor Management, EOQ, Production methods, Quality control.

Marketing Management
Overview of Marketing functions, Product, Price Promotion and distribution strategies Marketing research and its Role. Business to Business Marketing, Export, Import Management

Financial Management
Accounting Principles, Balance Sheet and profit loss statement. Working capital Management. Cost concept Break even analysis, Investment decision – Pay back period NPV, IRR

Human Resource Management
Nature and Function of HRM, Human resource planning – HR information System, Performance appraisal system, Rewards and Incentive schemes; Professions in HR – Consultancy, Outsourcing

Information Systems, Organization Management & Strategy
Information need of Management at various level of Organization, flow of information in organization: top down bottom and up and integrated.

Current Issues
Role of Internet and intranet in development of various information systems: E-Commerce, ERP, CRM, SCM.
Global Perspectives to Management; International marketing, International HR;
Essentials of Entrepreneurship – Writing a Business Plan, Funding Agencies

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