Related Courses

CS711  Research Methods for Computer Science
(3 cr.hrs)

Objectives
This course includes an understanding of:
- What CS researchers do, and the philosophy and ethics related to how they do it.
- Proficiency at communications, especially technical writing.
- Proficiency at designing experiments for the purpose of testing research hypotheses, and evaluating the results of those experiments.

After finishing this course a student should know how research is done at M.S. and Ph.D. levels?
A student should know how quantitative and qualitative research should be done?

Contents
Introduction
- What should CS graduate students know about the research methodology?
- The objectives and dimensions of research
- Why Research, What is research, How is research done
- Tools of research, Library, The internet, Measurements for Computer Science research, Statistics, Data analysis tools

Critiques of paper reviews
Research Methods:
- The research problems
- Finding a problem, stating the problem, identifying sub-problems
- Review of related literature
- Why review the literature, Including literature in research proposal
- Survey paper presentation
- Empirical Methods of Algorithm Analysis
- Analytic vs. empirical; deterministic and stochastic algorithms

Working with human subjects:
- Qualitative studies, Quantitative studies, Interview techniques

Paper Writing, Reviewing Publishing

Starting on Research
- What constitutes a PhD thesis?
- Expectations of publication
- Role of the thesis supervisor
- Finding a good problem, top-down approach
- New problem needing tools
- Tools looking for a problem
- Looking at future trends
- Impact
- Scalable: simplify using assumptions?
- You know of a starting point
- Online tools
  - Google, CiteSeer, ACM Digital Library, IEEE
- Survey papers, people
Grants and Research proposals
Intellectual property

**Recommended Readings**
1. Fabb, How to write essays, dissertation, and thesis in literary studies, Publisher: Longman, Copyright: 1993
3. Leedy, P. L., Practical Research, Planning and Design, Publisher: Prentice Hall, March 2004

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**CS712 Statistical Analysis**

*(3 cr.hrs)*

**Objectives**
The subject of statistics is very important in many areas including computer science.
The main objective of this course is that a student should know the basics of statistics and he/she should be able to do statistical analysis independently in his/her research work.

**Contents**
Basic Univariate Statistical Methods:
Review of basic concepts, summary measures, introduction to hypothesis testing, t-test for one and two samples, Analysis of Variance (ANOVA), Chi-squared test for count data, Regression and Correlation
Multivariate Statistical Methods:
Introduction to Multivariate Analysis, Principal Component Analysis (PCA), Factor Analysis (FA), Discriminant Analysis (DA), Cluster Analysis (CA), Multidimensional Scaling (MDS).
Special topics (with applications in Corpus Linguistics):
Hidden Markov Models (HMM), Log-linear models, Bayesian Statistics
All the techniques would be learned through a computer-integrated approach. The analysis would be carried out by using SPSS and/or Minitab (or any other special-purpose statistical software).

**Recommended Readings**

**CS713  Introduction to Mathematical Logic**

*(3 cr.hrs)*

**Objectives**
The main objective of this course includes the basic study of mathematical logic. It helps a lot in understanding several concepts in computer science.

**Contents**
Introduction, Propositional Calculus, Methods of Proof, Analysis of Arguments, Predicate Calculus and Quantifiers, Boolean Algebra to Logic, Boolean Functions, Boolean Algebra and Propositional Logic, Logic Gates, Combinational Circuits.

**Recommended Readings**

**CS731  Theory of Computation**

*(3 cr.hrs)*

**Objectives**
After the completion of this course a student will be able to have a clear understanding of:
- The processing mechanism of a computer system at abstract level
- What a computer can do and what it cannot do?
- What a computer can do more efficiently and what it can perform with less efficiency?
- The mechanism of different word processors (especially spell-checking facilities)
- The mechanism of different grammar checkers
- The mechanism of word generators
How to develop more efficient spell-checkers and parsers?

Description
Automata theory, formal languages, Turing machines, computability theory and reducibility, computational complexity, determinism, non-determinism, time hierarchy, space hierarchy, NP completeness, selected advanced topics.

Recommended Readings
4. Tao Jiang, Ming Li, and Bala Ravikumar, Formal Modals and Computability, in Handbook of computer science, CRC Press, 1996.

CS732 Advanced Algorithm Analysis
(3 cr.hrs)

Objectives
For any and every complex program, the actual programming hardly takes 20% of the time. The bulk of the time is spent in coming up with the logic including how to solve the problem, how good or bad the solution is etc. This is dependent on many factors such as the type of solution used, the methodology of storing data etc, which in turn is dependent on the solution space, i.e. possible number of solutions etc.
To develop an understanding of the concepts and complexities of algorithms, so the students can appreciate the requirement of fast and efficient algorithms. Cover different sorting and graph algorithms, along with the concept of theory of NP completeness, so that students can identify computationally intractable problems. Touch upon some advanced topics such as Genetic Programming, Visualization etc.
The main focus will be looking at the algorithms from an applied perspective, this includes coding algorithms using efficient data structures, running simulations and comparing results.

Course Description
Advanced analysis including he introduction of formal techniques and the underlying mathematical theory. NP-Completeness. Search techniques. Randomized Algorithms. Heuristic and Approximating Algorithms. Topics include asymptotic analysis of upper and average complexity bound using big-O, little-O and theta notation, Fundamental algorithmic strategies (brute-force, greedy, divide-and-approximations) are covered. Also include are standard graph
and tree algorithms. Additional topics include standard complexity classes, time and space tradeoffs in algorithms, using recurrence relations to analyze recursive algorithms, non-computability functions, the halting problem, and the implications oh non-computability. Algorithmic animation is used to reinforce theoretical results. Upon completion of the course, students should be able to explain the mathematical concepts used in describing the complexity of an algorithm, and select and apply algorithms appropriate to a particular situation.

**Recommended Readings**

7. Tao Jiang, Ming Li, and Bala Ravikumar, Formal models and Computability, in Handbook of Computer Science, CRC Press, 1996.

**CS 733 Advanced Operating Systems**

*(3 cr.hrs)*

**Objectives**

- To provide in-depth coverage of modern operating system issues.
- To provide insight in the design principles of distributed systems.
- To focus on a high level functionality of operating systems, such as, file systems, security, and naming mechanisms.
- To provide experience in reading and evaluating research papers.

**Description**

The class covers advanced topics in computer operating systems with a special emphasis on distributed computing, and the services provided by distributed operating systems. Important topics include naming, security, remote procedure call, networks, concurrency, transactions, parallel computing, shared memory, message passing and scale.

**Recommended Readings**

CS734 Advanced Computer Architecture

(3 cr.hrs)

Objectives

- To investigate computer architecture with a particular focus on microprocessor design.
- To explore current trends and future directions in processor microarchitecture.
- To explore various hardware and software techniques designed to maximize parallelism and improve performance keeping in mind technology trends and limitations.
- The foci of the course will be both current practice and advanced research.

Course Description

Design and evaluation of modern uni-processor computing systems. Evaluation methodology /metrics and caveats, instruction set design, advanced pipelining, instruction level parallelism, prediction-based techniques, alternative architecture (VLIW, Vector and SIMD), memory hierarchy design and I/O. Case studies.

Recommended Readings


CS735 Middleware-I

(3 cr.hrs)

Objectives

- Understand the role and importance of middleware to integrating multiple applications.
- Articulate the key problems addressed by middleware
- Describe the Architecture of a middleware Solution
- Understand the role of connectivity data transformation and business rules processing in middleware Solution.
- Understand loosely coupled systems Publish-Subscribe architecture

Course Outline
This course introduces students to the need for communication between and among application, that middleware is itself application and how middleware applications are typically organized.

**Course Contents**

- Middleware concept, Roles and organization
  - Introduction to Middleware.
  - Background
- Management of integration
- Data transformation, Data Synchronization
- Business process modeling
- Service oriented architecture
- Web Services / B2B

**Recommended Readings**

2. Latest online available resources

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**CS736  Advanced Databases**

*(3 cr.hrs)*

**Objectives**

The objective of this course is that a student should learn the advanced level technology information in databases. A student should know different database connections available for different programming languages and learn how data is converted from a database management system to other formats and vice versa. A student should study recent research work in database technology.

**Contents**

Review of relational databases SQL in the real world: embedded SQL, data passing, status, cursor, connection, transaction, stored procedure; dynamic SQL, parameter, descriptor; JDBC; SQLJ; ODBC. Relational calculus; DB services XML databases, description and query of semi-structured, nested, complex data; XML basics, XML schema, XLST. Stylesheet, templates, evaluation. XQuery: FLWR expression, evaluation, built-in functions, user defined functions, aggregation, quantification. More XQuery: data and types; Xquery and XML schema; proj, sel, construction, group, join, recursive functions, wildcard types, XqueryX; XPath and XQuery, Materialized views.

**Recommended Readings**

CS737    Data Warehousing
(3 cr.hrs)

Objectives
The objective of this course is that a student should learn the fundamentals of data warehousing. A student should know what state-of-the-art techniques are available and how dimensional modeling is performed in data warehousing? A student should learn the design process of a data warehouse after finishing this course. The study of recent research papers is another primary objective of this course.

Contents
- Introduction to Data Warehousing: Heterogeneous information; the integration problem; the Warehouse Architecture; Data Warehousing; Warehouse DBMS.
- Aggregations: SQL and aggregations; aggregation functions; grouping.
- Data Warehouse Models and OLAP Operations: Decision support; Data Marts; OLAP vs OLTP; the Multi-Dimensional data model; Dimensional Modelling; ROLAP vs MOLAP; Star and snowflake schemas; the MOLAP cube; roll-up, slicing, and pivoting.
- Some Issues in Data Warehouse Design: monitoring; wrappers; integration; data cleaning; data loading; materialised views; warehouse maintenance; OLAP servers; metadata.

Recommended Readings

CS738    Data Mining
(3 cr.hrs)

Objectives
With the unprecedented rate at which data is being collected today in almost all fields of human endeavor, there is an emerging economic and scientific need to extract useful information from it. Data mining is the process of automatic discovery of patterns, changes, associations and anomalies in massive databases. This course will provide an introduction to the main topics in data mining and knowledge discovery, with a special emphasis on Data mining & Web mining

Contents
Introducing Data Mining: Why data mining?; What is data mining?; A View of the KDD Process; Problems and Techniques; Data Mining Applications; Prospects for the Technology.
The CRISP-DM Methodology: Approach; Objectives; Documents; Structure; Binding to Contexts; Phases, Task, Outputs.
Data Mining Inputs and Outputs: Concepts, Instances, Attributes; Kinds of Learning; Providing Examples; Kinds of Attributes; Preparing Inputs. Knowledge Representations; Decision Tables and Decision Trees; Classification Rules; Association Rules; Regression Trees and Model Trees; Instance-Level Representations.
Data Mining Algorithms: One-R; Naïve Bayes Classifier; Decision Trees; Decision Rules; Association Rules; Regression; K-Nearest Neighbour Classifiers.
Evaluating Data Mining Results: Issues in Evaluation; Training and Testing Principles; Error Measures, Holdout, Cross Validation; Comparing Algorithms; Taking Costs into Account; Trade-Offs in the Confusion Matrix

**Recommended Readings**

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**CS739 Database Security**

(3 cr.hrs)

**Objectives**
The objective of this course is that a student should learn the state-of-the-art in database security. Different database security models and data access control mechanisms are taught in this course. A student should practically implement different database security techniques using a database management software. The study of recent research papers in database security is another objective of this course.

**Contents**
Data protection: basic concepts.
- Access control policies: discretionary access control policies; mandatory access control policies; role-based access control (RBAC); Chinese wall access control policies.
- Administration policies - Access control in relational database systems: Grant and Revoke statements; grant operation and delegation; revoke operations recursive revocation with timestamps and without timestamps; non-cascading revoke operations; views and content-based authorization; RBAC.
- Advanced access control models: temporal authorization models; temporal RBAC; the BFA model for workflow systems; access control and integrity for XML data; the Author-X system; XACML and SAML; access control for web services.
- Trust negotiation systems: preliminary concepts; TrustBuilder; Trust-X.

**Recommended Readings**
1. Hassaan A. Afyouni, Database Security and Auditing: Protecting Data Integrity and Accessibility, Publisher: Course Technology 2005
2. Silvana Castano, Database Security, Publisher Addison-Wesley 1995
3. B. Fernandez, Rita C. Summers, Christopher Wood, Database Security and Integrity, Publisher: Addison-Wesley Longman Publishing Co, Inc. 1881

CS740  Distributed System Components

(3 cr.hrs)

Objectives
• Present the principles underlying the functioning of distributed systems;
• Create an awareness of the major technical challenges in distributed systems design and implementation;
• Expose students to modern and classic technology used in distributed systems and their software;
• Expose students to past and current research issues in the field of distributed systems;

Contents
Components of a distributed systems, Distributed systems, End to End Protocols and Networking. Distributed Operating system, Distributed databases, Communication Mechanism, Message Passing, Stream oriented communications, Remote procedure call, Remote Method Invocation, DCE RPC, Java RMI, SOAP, Naming, Clock Synchronization, Process Synchronization, Distributed Processes, Code Migration Content distribution, Distributed Object systems, CORBA, DCOM - .NET, Distributed Coordination, Fault Tolerance, Distributed Systems Security

Recommended Readings
3. Research papers based.

CS741  Advanced Networking

(3 cr.hrs)

Objectives
Aim of the course is to understand the principles of networking and the protocols in the different layers, and their interactivity between each other. Students should understand the problem in the
current Internet architecture new study new QoS architectures such as Integrated services and Differential services. Also students should know the problem with the IPv4 and need for IPv6 protocols.

Additionally students will be expected to read all of the papers assigned for the course others may be added based on class interest. Students will have to write of papers provide during the class. Students submitting reviews for a paper will be expected to be active in the discussion of that paper.

Course Description


Recommended Readings

CS742 Network Security
(3 cr.hrs)

Objectives
- Understand the design and implementation of advanced cryptographic algorithms for wired and wireless computing environments including the design and implementation of RSA and ECC
- Achieve sound knowledge of network security components including the design, implementation, and configuration of Firewalls, Intrusion Detection Systems (static and dynamic checking of programs, anomaly detection, large-scale (Internet-wide) distributed intrusion detection, early sensing, complex attack scenario analysis, and automated response), Prevention Systems, Firewalls, IDSs, VPNs and prevention systems together
- Develop knowledge of advanced network security architectures to allow better network protection, load balancing and recovery from attacks
• Achieve sound knowledge of wireless network security
• Understand security in trusted-based computing environments
• Understand Quantum cryptography

Students will be expected to read all of the papers assigned from the course reading list others may be added based on class interest. Students will have to write at least two reviews of papers on the reading list. These will be submitted at the beginning of class. Students submitting reviews for a paper will be expected to be active in the discussion of that paper.

Course Description
Introduction: Cryptology and simple cryptosystems; Conventional encryption techniques; stream and block ciphers; DES; More on block Ciphers; The Advance Encryption Standard. Confidentiality & Message Authentication: Hash functions; Number theory and algorithm complexity; Public Key Encryption. RSA and discrete Logarithms; Elliptic Curves; Digital Signatures. Key management Schemes; Identification Schemes; Dial-up Security. Email Security, PGP,S-MIME; Kerberos and directory Authentication. Emerging Internet security standards; SET; SSL and IPsec; VPNs; Firewalls; Viruses; Miscellaneous topics.

Recommended Readings

CS743  Computer Networking-I

(3 cr.hrs)

Objectives
This course will cover the principles of networking with a focus on algorithms, protocols, and implementations for advanced networking services. We will begin with a brief retrospection on the design of the Internet, its basic mechanisms and protocols. We will examine a variety of ideas that were proposed to enhance the Internet, why some of these enhancements were successful while others were not. Subsequently we will move on to a select set of advanced topics in networking, primarily at recent and ongoing advances in "the edges" of the Internet.
All topics in this course will be covered through research papers. In each class I will lead a discussion on one or two papers. In order to have a discussion, students will be expected to have read these papers prior to class.

Each student in the class will be expected to do a research project. However, students are encouraged to define their own ideas for research projects. For each research project, a student should submit a written project plan, a summary at the end of the semester and an oral presentation on the project.

Course Description
This course offers an advance introduction and research perspective in the areas of switch/router architectures, scheduling for best effort and guaranteed services, QoS mechanisms and architectures, web protocols and applications, network interface design, optical networking, and network economics. The course also includes a research project in computer networking involving literature survey, critical analysis, and finally, an original and novel research contribution. Typical topics can be listed below:


Recommended Readings

CS744 Wireless Networks
(3 cr.hrs)

Objectives
To introduce history of wireless Networks, application domains, platforms, and the limitations of current platforms.

To cover fundamental techniques in design and operation of first, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocol (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, CDMA 2000 etc).

To explore Wireless LANs Standards, wireless LANs, Wi-Fi, WiMAX, Bluetooth, sensor networks,

To read a large number of research papers, writing critiques, class presentations.

**Course Description**

This course covers fundamental techniques in design and operation of first, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocol (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, CDMA 2000 etc), Wireless LANs Standards, wireless LANs, Wi-Fi, WiMAX, Bluetooth, sensor networks, physical layer specifications in wireless LANs, radio resource and network management. As an example for third generation interfaces, WCDMA is discussed in detail since is intended for graduate students who have some background on computer networks.

**Recommended Readings**


**CS745 Network Performance Evaluation**

**(3 cr.hrs)**

**Objectives**

In this course students will study Analytical, simulation and experimental methods to evaluate and design networks. Will also use and Investigate network management tools and techniques such as OPNET and NS-2.

**Course Description**

This is an advance course in networks and protocols. Analytical, simulation and experimental methods should be used to evaluate and design networks and protocols. Investigate network management tools and techniques. OPNET, NS, and REAL.
Recommended Readings

CS746   Semantic Web
(3 cr.hrs)

Course Description
As the volume of Web resources grows exponentially, researchers from industry, government, and academia are now exploring the possibility of creating a Semantic Web in which meaning is made explicit, allowing machines to process and integrate Web resources intelligently. How will this Web of the future be effectively built? This course attempts to address this problem by covering most of the proposed approaches. This course provides a succinct account of this new Web, its principles, concepts, and related tools. Its main contribution lies in the ability to demonstrate how Semantic Web technologies may be integrated and realized in several application domains.

Course Objectives
According to the general objective, students should be able:
- To understand the limitations of the present web and the importance of metadata in solving the problem
- To identify and resolve real world problems by applying these technologies successfully
- To build systems in different domains (for instance, knowledge management, biomedicine, e-commerce, e-learning, etc.) and applications for those areas
- To integrate applications developed with semantic web technologies with other software and hardware systems
- To assimilate technological changes

Course Contents

Recommended Readings
CS747  Information Architecture  
(3 cr.hrs)  

Course Description  
The post-Ajaxian Web 2.0 world of wikis, folksonomies, and mashups makes well-planned information architecture even more essential. How to present large volumes of information to people who need to find what they're looking for quickly? This course will enable information architects, designers, and web site developers to build large-scale and maintainable web sites that are appealing and easy to navigate. This course will cover emerging technologies with recent examples, new scenarios, and information on best practices.  

Course Objectives  
- To understand the fundamental components of an architecture, illustrating the interconnected nature of these systems  
- To know about the latest concepts of the social web including Tagging, Folksonomies, Social Classification, and Guided Navigation  
- To understand the tools, techniques, and methods that takes from research to strategy and design to implementation  
- A series of short essays that provide practical tips and philosophical advice for those who work on information architecture  
- The business context of practicing and promoting information architecture, including recent lessons on how to handle enterprise architecture  
- Case studies on the evolution of large information architectures, illustrating best practices along the way  

Course Contents  

Recommended Readings  
2. Duane Nickull, Dion Hinchcliffe and James Governor, Web 2.0 Architectures: What Entrepreneurs and Information Architects Need to Know, O'Reilly Media, Inc., 2009.

CS749 Information Retrieval

(3 cr.hrs)

Course Description
A multibillion-dollar industry has grown to address the problem of finding information. Commercial search engines are based on information retrieval: the efficient storage, organization, and retrieval of text. This course covers both the theory and practice of text retrieval technology. A practical approach is emphasized and students will complete several programming projects to implement components of a retrieval engine.

Course Objectives
- Students will learn the underlying technology of search engines
- Gain practical experience building simple, but true-to-practice retrieval software
- Appreciate topics in the broad area of information retrieval, including evaluation, classification, cross-language retrieval, and computational linguistics

Course Contents
Introducing IR, IR and IE, Page ranking algorithms, Search engine architecture, Crawling Techniques, Crawler algorithms, Role of query engine and its interface between the search index, the user and the web, Modeling, Retrieval Evaluation: Models, Languages, Indexing, Searching, Query Languages and Operations, Text and Multimedia, Indexing and Searching, Parallel and Distributed IR, UI Visualization, Libraries and Bibliographical Systems, Digital Libraries

Recommended Readings
CS750   Web Mining
(3 cr.hrs)

Course Description
The accessibility and ubiquity of content on the WWW has changed how we perceive information. Web mining aims to discover useful information or knowledge from Web hyperlinks, page contents and usage data. Due to the richness and diversity of information and other Web specific characteristics, Web mining is not just an application of data mining. Web mining has developed many of its own methods, ideas, models and algorithms. This course provides an in-depth coverage of how to extract and discover information within the Web and how we use the Web.

Course Objectives
- To introduce Web mining technology from a practical point of view and to obtain a solid grasp of how techniques in Web mining technology can be applied to solve problems in real-world applications
- To provide students with a sound basis in Web data mining tasks and techniques
- To ensure that students are able to read, and critically evaluate Web mining research papers
- To ensure that students are able to implement and to use some of the important Web mining algorithms
- To design and develop a large scale web crawler and a mini search engine

Course Contents
Data Mining and Knowledge Discovery, Web Usage Mining, Privacy Issues, Web Content Mining, Web Structure Mining and Link Analysis, Social Network Analysis, Web Mining Applications - Data integration for e-commerce and Web personalization and recommender systems, Web data warehousing, Review of tools, applications, and systems

Recommended Readings
CS751 Ontology Engineering  
(3 cr.hrs)

Course Description
The general objective is to provide students with a sound grounding of scientific, methodological and technological fundamentals in Ontological Engineering and the Semantic Web areas. This knowledge will be later used to build applications that can integrate, combine and infer heterogeneous and distributed information.

Course Objectives
By the end of the course, as a minimum, the student will be able to:

- Build and implement a small ontology that is semantically descriptive of their chosen problem domain
- Write JAVA code that can access, use and manipulate the ontology
- Represent data from a chosen problem in XML with appropriate semantic tags obtained or derived from the ontology
- Depict the semantic relationships among these data elements using Resource Description Framework (RDF)
- Write a web services application that “discovers” the data and/or other web services via the semantic web (which includes the RDF, data elements in properly tagged XML, and the ontology)

Course Contents
Ontology: Introduction, Components, Types, Design Principles
Outstanding Ontologies:
   Knowledge Representation Ontologies: OKBC, RDFS, DAML+OIL, OWL
   Top-Level Ontologies: Cyc, SUMO
   Linguistic Ontologies: WordNet etc.
   Domain Ontologies: PIM, eCommerce, Knowledge Representation, etc
Ontology Engineering Methodologies
Axioms, Rules and Inference
Ontology Merging, Ontology Evolution
Languages for Building Ontologies
Ontology Tools and Tool Suits

Recommended Reading

CS752 Description Logic (3 cr.hrs)

Course Description
This course presents the main motivations for the development of Description Logics (DL) as a formalism for representing knowledge, as well as some important basic notions underlying all systems that have been created in the DL tradition.

Course Objectives
After completion of this course, a student will know:
- The relationship between Description Logics and earlier systems and the key problems encountered with the older efforts
- The basic features of Description Logic languages and related reasoning techniques
- Knowledge representation using Description Logics
- The development of some implemented knowledge representation systems based on Description Logics
- How applications built with such systems are developed

Course Contents
Introduction: Knowledge Representation, From Networks to DL
Theoretical Aspects: Basic Description Logics, Complexity of Reasoning, Relationship with other formalisms, Expressive DL, Extension to DL
Implementation: From DL to KR, DL Systems, Implementation and Optimization Techniques
Applications: Conceptual Modeling with DL, Applications in Software Engineering, Medical Informatics, Digital Libraries, Web-based Information Systems, NLP, Databases, etc

Recommended Readings

CS753 Soft Computing (3 cr.hrs)

Course Description
Soft Computing refers to a collection of computational techniques in computer science, artificial intelligence and engineering disciplines which attempt to study, model and analyze complex
problems - those for which more conventional methods have not yielded low cost, analytic and complete solutions. Unlike conventional computing, soft computing techniques are tolerant of imprecision, uncertainty and approximations.

Course Objectives
The objective of the course is to design and develop intelligent systems in the framework of soft computing, and apply to some general and scientific application-driven environments. Students who successfully complete this course will be able to

- Have a general understanding of soft computing methodologies, including artificial neural networks, fuzzy sets, fuzzy logic, fuzzy clustering techniques and genetic algorithms
- Study neuro-fuzzy control and inference systems
- Have an insight into the genetic algorithms and computing, one of the powerful techniques to tackle hard optimization problems;
- Design and development of certain scientific and commercial application using computational neural network models, fuzzy models, fuzzy clustering applications and genetic algorithms in specified applications
- Study all these techniques from the point of view of the world wide web

Course Contents
Introduction, Tools, Fuzzy Reasoning, Fuzzy Inference, Genetic Algorithms and its Applications, Fuzzy Logic, Applications, Neural Networks and its Applications, Learning (Supervised/Unsupervised, etc), Clustering and Classification, Case-based Reasoning and its Applications, Hybrid Systems, Adaptivity, When to use a technique, Knowledge Management

Recommended Readings

CS754 Web Engineering
(3 cr.hrs)

Course Description
The World Wide Web has become a major delivery platform for information resources. Many applications continue to be developed in an adhoc way, contributing to problems of usability, maintainability, quality and reliability. This course examines systematic, disciplined and quantifiable approaches to developing of high quality, reliable and usable web applications. The course introduces the methodologies, techniques and tools that support their design, development, evolution, and evaluation.

Objectives
After completion of this course, a student will be able to:

- Have knowledge of web specific technologies and tools
- Understand the difference between traditional software engineering and web software engineering
- Know about the different application models and architectures of web applications
- Have in-depth knowledge of web application development and web project management

**Course Contents**

Web Applications:
- Introduction, categories, Characteristics
- Requirements Engineering for Web Applications

Web Application Modeling:
- Requirements, content modeling, hypertext modeling, presentation modeling, methods and tools
- Web Application architectures:
  - Introduction, components, layered and data-aspect architectures

Technologies for web applications:
- Client side, server side, communication, and document specific technologies

Testing, operation and maintenance of web applications

Web Project management

Web Application Development Process

Advanced Topics:
- Usability, performance, security of web applications, semantic web, semantic web services

**Recommended Readings**


**CS760 Morphology of Natural Language**

(3 cr.hrs)

Objectives
After the completion of this course a student will be able to have a strong understanding of the following:

- Morphology and its types
- Different phenomena involved in morphology
- Analyzing inflections and derivations
- Computational models for morphological analyzers and synthesizers
- Xerox tool for the implementation of morphological analyzers and synthesizers
- Implementation of morphological analyzers and synthesizers

Introduction to Morphology
What is morphology, morphemes, introduction to morphological analysis.

Words and Lexemes
What is word, types of words, inflection Vs derivation, Item-and-arrangement, Item-and-process, the lexicon.

Morphology and Phonology
Allomorphs, prosodic morphology, Morphophonology

Derivation
Derivation and lexicon, derivation and semantics

Inflection
What is inflection, inventory of Inflectional morphology types, Typology

Morphological productivity
Introduction, Productivity and structure, degrees of productivity

Practical
Regular expressions
Finite automata
FST
The XFST interface
The LEXC language
Planning and managing finite state projects

Recommended Readings
Objectives
At the end of this course, the students will be able to know about:

- The structure of phrases in a language
- The structure of sentences in a language
- The structure of phrases and sentence in local languages
- The processing of phrases and sentences by a computer

Language theory
Natural Languages, Regular languages, Formal languages

Grammar
Definition, elements, The Chomsky Hierarchy

Constituent Structure
Ambiguity, Constituency, Hierarchy, Syntactic categories, Tree diagrams,

Noun Phrases
Adjuncts, Complements and adjuncts of N, Determiners, Adjectives and Adjective Phrases (AF), Possession and recursion, English NP structure

Case and Agreement
Case, Agreement

Tense, Aspect and Modality
Tense, Aspect, Perfect Vs. Perfective Combinations of tense and aspect, Mood, Modality

Special sentence types
Direct vs. Indirect speech acts, basic word order, Commands, Questions, Negation

Subordinate clauses
Coordinate vs. subordinate clauses, complement clauses, Direct vs. Indirect speech, Adjunct clauses, Relative clauses

Indirect object and Secondary objects

The use of Syntax in Corpus development
Word classes, Part-of-Speech tagging

Parsing
Parsing with Context-Free Grammars, Unification Parsing, Lexicalized and Probabilistic Parsing
Recommended Readings

CS762   Corpus Linguistics
(3 cr.hrs)

Objectives
At the end of this course, the students will be able:
- To understand how a corpus can be developed and processed?
- To know what is in existing corpus?
- To know different types of corpora and their day to day applications

Corpus Linguistics basics
What is a corpus, Corpus-based vs. intuition-based approach, corpus-based vs. corpus-driven approaches

Corpus characteristics
Representativeness, Balancing, Sampling

Corpus Mark-up
Introduction, Rationale for corpus mark-up, corpus mark-up schemes, character encoding

Corpus Annotation
Introduction, Corpus annotation, types of corpus annotations, embedded vs. standalone annotation

Multilingual corpora
Introduction, terminological issues, corpus alignment

Using available corpora
Introduction, general corpora, specialized corpora, written corpora, spoken corpora, synchronic corpora, learner corpora, monitor corpora

Corpora and applied linguistics

How to Develop a Corpus?
Corpus development methodology, Concordancer

Practical
Recommended Readings


CS763 Machine Translation
(3 cr.hrs)

Objectives
At the end of this course, the students will be able to know about:
- The translation of natural languages by a computer
- The difficulties involved in machine translation
- The applications of machine translation

Linguistic aspects
(mainly transfer problems, ambiguities, lexical gaps etc.)

Computational problems of machine translation

Paradigm of machine translation
(direct, transfer, interlingua)

Statistical based MT

Example-based MT

Evaluation of Machine translation

Examples of MT Systems

Recommended Readings
Course Description
This course mainly addresses the problem of routing (how to direct a packet from a source machine to a destination machine), topology control (how to adjust network communication links as the environment changes such that the network capacity can be maximized), and medium access control (how to share the common resources among multiple users) in wireless mobile ad hoc networks.

Course Objectives
- To study and understand wireless mobile technologies.
- To study and understand mobile adhoc networks.

Course contents

Recommended readings
4. Extensive use of current research publications and literature.
CS765  Network Management and QoS Provisioning  
(3 cr.hrs)

Course Description
This course introduces QoS issues and management of QoS in different types of networks. This course also emphasizes on multimedia QoS issues.

Course Objectives
- To understand QoS principles.
- To study QoS issues w.r.t network management.
- To study QoS issues in multimedia management.

Course Contents
Introduction to QoS issues Course introduction and review, QoS in Frame relay, QoS routing and Admission control, Scheduling algorithms, QoS in ATM networks, Scheduling in Input Queued switches, QoS in the Internet, MPLS (Multi-Protocol Label Switching), Internet Multimedia, Network management, SDH and WDM, Capacity planning, Fault management, Voice coding, Audio coding, Video coding, RTP (and RTCP) protocol, MPEG reference documentation.

Recommended readings
2. Featuring the Internet”, Addison Wesley, 2004
   H.Chao, X.Guo, "Quality of Service Control in High-Speed Networks", John Wiley & Sons, Inc, 2001
3. Current research publications and literature

CS766  Business Intelligence  
(3 cr.hrs)

Course Description
Business Intelligence is a new field. This course discusses current issues highlighting business databases. The course will provide an insight into the business intelligence and techniques of improvement in business intelligence.

Course Objectives
- To introduce information systems and business intelligence.
- To study advance techniques in ETL process.

Course Contents
Introduction to Information Systems and Business Intelligence, Design of Relational Databases, Querying, Securing and Administrating databases, Data Transformation, Advance Techniques in ETL Process, Introduction to the Unified Dimensional Model (UDM), Dimensions, Cubes and their features, The MDX Language and KPIs, Excel Pivot Table with Analysis Server, Reporting and Visualization, Analysis with Data Mining and Excel 2007/SSAS/SAS

Recommended readings

5. Current research publications and literature

CS767 Mobile Application Development

(3 cr.hrs)

Course Description

The course is aimed to provide a thorough understanding of various mobile technologies available for creating mobile applications. This course first briefly introduces the popular technologies for mobile phones namely, JavaME (J2ME) and Python/C++ (Symbian). It then focuses on Smartphone application development using Android. The Android platform is an open source mobile and embedded device platform from Google. Currently there is rapid growth in the number of Android based mobile devices being released on all the major mobile phone carriers around the world, with a common development platform and application market for third party developer applications. The aim of this course is to teach students mobile apps development on the world’s most popular platform.

Course Objectives

When students complete this course, they will be able to:

- Understand the evolution and capabilities of mobile phones, mobile communication technologies and mobile applications
- Learn how to design and build Android Mobile applications
- Gain a thorough knowledge and understanding of the Google Android framework and platform

Course Outline
Introduction to mobile computing, Java ME, Symbian and Smartphone, Introduction to Android OS, Android SDK and Eclipse, App Analysis, App details and lifecycle, User Interfaces, menus and dialog boxes, Graphics and sound, Saving state and internationalization, Settings and Permissions, Android Persistence, SQLite databases and custom views, Releases and Evaluation: Pre-Alpha Version, Alpha, Beta Releases
HTTP and web services, Location API: GPS and Google Maps API, Networking API
Accelerometer and other Android sensors, Background processing, Broadcast Receiver, Services, Alarms and Notifications, App widgets, Advanced user input, Testing apps, Android 3.x and beyond: the latest APIs and Android Best Practices, Selling Your Application and Advanced Android Topics, Android Vs. iPhone Vs. Others

Recommended readings
1. Programming the Mobile Web, Maximiliano Firtman. O’Reilly Media, Inc. 2010

CS768 Advanced Wireless Network Security
(3 cr.hrs)

Course Description
This course looks at misbehavior of nodes, trust and its characteristics, reputation system goals and properties, classification of trust and reputation based systems, information gathering techniques, information dissemination, detection, response, Examples: watchdog and path raters, context aware mechanism, trust aggregation scheme, trusted routing schemes, collaborative reputation based systems, cooperation based models, observation based mechanism, distributed reputation based, beacon based system.

Course Objectives
- To study the security issues related to wireless network.
- To study the techniques used to solve classic security issues in wireless network.

Course Contents
Secure device association techniques, Reputation and trust based security mechanisms, Mobile Ad hoc Networks, Wireless Sensor Networks, Wireleses mesh Networks, Countermeasure to
selfish misbehavior, countermeasure to greedy misbehavior, countermeasure to MAC layer DoS attacks, Cryptography based solutions, reputation based solutions, add-ons to existing solutions, countermeasure to specific attacks, Pre authentication and authentication models, Identity based key management schemes, Passive attacks, Active and Denial of service attacks, physical layer attacks, MAC layer security issues, Wireless Local Area Networks (WLANs): cross domain mobility adaptive authentication, AAA architecture and authentication.

Recommended readings
3. Current research publications and literature

CS769 Wireless Sensor Networks
(3 cr.hrs)

Course Description
Smart environments represent the next evolution in harnessing computing power to better our lives. Wireless Sensor Networks are collections of spatially distributed autonomous devices to monitor environments. Typically the sensor devices are small, ranging from the size of a shoe box to ones that fit on your finger tip, and are limited in their computational, power resources, and computational abilities.

Course Objectives
- To provide a hands-on introduction to wireless sensor networks.
- To study wireless communications standards and protocols
- To study higher-level network services

Course Contents

Recommended readings
4. Current research publications and literature

CS770 Empirical Methods in Software Engineering Research
(3 cr.hrs)

Course Description
Empirical software engineering is a hot topic among researchers in the field of software engineering. This course explores different research methods and techniques applied in software engineering research.

Course Objectives
- To make students understand the concepts of software engineering research and the different qualitative and quantitative research methods, their role, importance, and impact in the research.
- To introduce different methods to conduct research in software engineering so that the students can effectively and select an appropriate method for their work.

Course Contents
Concept of empirical research, concept of evidence-based software engineering, analyses methods (Qualitative, Quantitative and mixed approaches, Statistical analysis, Grounded theory), Controlled experiments (including Quasi-experiments), Case studies (both exploratory and confirmatory), Survey research (literature reviews, types, systematic literature review), Ethnographies, Action Research, Ethical issues in empirical studies of software engineering.

Recommended Readings
2. Extensive use of latest available online resources.
3. A selection from classical research papers of renowned researchers in the field of software engineering will also be used as reference to the course.
CS771  Software Requirements Engineering
(3 cr.hrs)

Course Description
This course will help the students to understand requirements quality and recognize basic types of requirements. The course is aimed at introducing the role of requirements engineering in an agile software development environment and understand the best practices. The course also discusses some of the latest tools used in requirements engineering process. It also provides latest information on best practices of requirements engineering through literature review.

Course Objectives
• To understand the principles of requirements engineering process
• To understand the role of requirements analysis in achieving successful project outcomes.

Course Contents
Basic concepts, issues and terminology, Categorizing requirements, Enterprise analysis, Identifying the sources, Coping with the real world problems, Finding the stakeholders, Eliciting requirements, Issues in requirements elicitation, user/customer oriented software requirements, developer oriented software requirements, analyzing the requirements, Documenting requirements, Standards for requirement documents, Modeling techniques, Representative requirements definition methods, Computer support tools for model development and prototyping, Agile requirements engineering, Case studies, literature Review.

Recommended Readings

CS772  Advanced Software Project Management
(3 cr.hrs)

Course Description
This course is aimed at increasing and broadens the knowledge of project management principles. The students will be able to understand how software development is integrated with other business activities and how social and environmental factors impact development. The course also provides the knowledge of agile software project management and management tools. It also provides a practical overview of project management with the help of case studies.

**Course Objectives**

- To build increased capability in students to manage projects successfully.
- To broaden the knowledge of project management principles.
- To be able to estimate, plan, and monitor the progress, and perform a project risk assessment for a software development project.

**Course Contents**


**Recommended readings**

1. Applied Software Project Management, Andrew Stellman, Jennifer Greene, O'Reilly Media November 2005
3. Agile Project Management with Scrum, Ken Schwaber, Microsoft Press, 2004
4. Agile Project Management: Creating Innovative Products, Jim Highsmith, Addison-Wesley Professional, 2004
5. Current research publications and literature.

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**CS773 Emerging Technologies in Software Engineering (3 cr.hrs)**

**Course Description**

This course takes an overview of the latest developments and research in the field of software engineering. New ideas being presented in flagship software engineering conferences and journals are discussed. The entire course will be based upon the literature review of topics from the research
papers presented in Software Engineering conferences and published in journals in the recent years.

Course Objectives
- To keep the students up to date with the latest advancements in the field of software engineering.
- To be able to discuss current issues in software engineering research.

Course Contents
Following are some of the proposed topics, the instructor may add any other topic(s) of interest from the latest technologies and may cover two or more of the following topics in detail: Advances in Security Engineering, Knowledge management issues in software engineering, Agile Knowledge Management, Software testing, End user software engineering, Patterns and frameworks, Knowledge Based Software Engineering, Semantic Web Enabled Software Engineering, Literature review and support tools (if apply)

Recommended readings:
1. Current research publications and literature.

CS774   Usability Engineering
(3 cr.hrs)

Course Description
Usability engineering is integral to the design process of an individual software product or service in terms of how the end-users perceive and use that product or design. The objective of this course is to provide students an advanced understanding of the role of usability engineering in the software design process. The students will also have practical experience with tools and methods that are used as part of the usability engineering process.

Course Objectives
- To understand the concept of usability engineering and its importance in software development.
- To learn the techniques of usability engineering.

Course Contents
Usability Definitions, Justification for Usability, User Centered Design, Interaction Design, Users, Tasks, Usability Engineering, Interface Evaluation, Usability Methods, Usability Testing, Usability Data Analysis and Reporting

Recommended readings
4. Latest research publications and literature.

CS775 Agile Software Development
(3 cr.hrs)

Course Description
This course describes agile software methodologies and discusses how to select the appropriate methodology for a project. The course covers Extreme Programming methodology in detail. The students will work in teams to implement and understand the process of agile software development and to simulate the real work environment.

Course Objectives
- To understand the principals behind agile methodologies
- To gain knowledge of new vocabulary for describing methodologies,
- To understand the concept of adjusting a methodology for a project

Course Contents

Recommended readings
1. Agile Estimating and Planning Mike Cohn 1 edition Prentice Hall, 2005
6. Current research publications and literature.
CS766  Software System Quality
(3 cr.hrs)

Course Description
The objective of this course is to study in detail the issues involved in software quality engineering. The course focuses on current practice, research and trends in Quality including how to assure it and verify it, and the need for a culture of quality. Avoidance of errors and other quality problems, Inspections and reviews, Testing, verification and validation techniques. Process assurance vs. Product assurance. Quality process standards. Product and process assurance. Problem analysis and reporting. Statistical approaches to quality control. Economics of testing, verification and validation activities, and software quality improvement through systematic test planning, design and executions, problem reporting and resolutions, and test documentation. Establishing software quality goals and improvement measurement.

Course Objectives
• To study the concepts of software quality.
• To make a thorough study of different testing techniques which ensure software system quality
• To learn different statistical approaches to quality control.

Course Contents

Recommended readings
3. Latest research publications and literature
CS777 Software Configuration Management
(3 cr.hrs)

Course Description
Software configuration management is one of the crucial functions in software project management; hence it has become an important area of research in software engineering. This course is designed to familiarize the students with configuration management requirements, and to equip them with basic skills of configuration management. Also, it will help them understand how to develop configuration management plans and procedures, and to establish and maintain a successful Configuration control board. The course also gives an insight into agile configuration management environments.

Course Objectives
- To understand the concepts of configuration management.
- To discuss different phases of configuration management w.r.t the software development lifecycle.
- To study different tools which are used to aid the software configuration management process.

Course Outline

Recommended readings
CS778  Software Engineering Laboratory
(3 cr.hrs)

Course Description
The course is basically designed for developing software design and development skills while gaining knowledge about advanced research methodologies. The students will work on a software development project relating to an application area of their choice, incorporating object oriented concepts, database programming, web and multimedia application development using data validation and error handling techniques, and interface design techniques, Shell programming for Windows/Linux, etc. The project and project documentation will be evaluated for grades at the end of the semester.

Course Objectives
• To make the students improve their software design and development skills.
• To make the students have hands on experience of latest software development tools and techniques.
• To make them understand the software development process as a whole to give them an understanding of the practices used in software development industry.

Course Contents
Specifying, designing, and implementing real-life software applications following software development methodologies. Each student/team is expected to select an area of greatest interest and implement a related general interest non trivial software application. Software application areas covered include. Multimedia, Client server, Internet/network computing, database systems, objects oriented modeling, software quality documentation, and testing and project management. The students are supposed to understand the concepts and have a practical implementation of best programming practices such as a) design patterns, b) coding techniques, c)coding standards, d)incremental programming, e)peer reviews. Use of Repositories and version control is also a requirement.

Recommended readings

2. UML distilled, M. Fowler, 2nd Ed., Addison-Wesley 2000
4. Reference for software development tools will be taken from internet.
CS779    Information Security
(3 cr.hrs)

Course Description
The protection of information assets underpins the commercial viability and profitability of all enterprises and the effectiveness of public sector organizations. It should not be left to chance. If you work in an organization concerned (directly or indirectly) with valuable information assets, this practical course will enable you to understand and manage strategic and operational aspects of information security, including IT governance and risk analysis and management. It will also provide the knowledge and skills needed to plan the implementation of an information security management system that provides efficient, effective safeguards and responds to your organization’s needs.

Course Objectives
- Understand contemporary issues in information security management
- Analyze and prioritize information security risks
- Identify countermeasures and review techniques appropriate to the management of information security risks
- Understand the policy and technology trade-offs involved in developing information security systems of adequate quality
- Locate, read, comprehend and evaluate developments in the field as they appear in contemporary professional and research publications.

Course Contents

Security management: need, aims and objectives of security management, various approaches to solve security problems

Cryptography and security mechanisms: main types of cryptographic mechanism, security services, key management, cryptographic algorithms.

Network security: Networking security technologies, user identification techniques, authentication protocols and key distribution mechanisms, security solutions for a variety of types of practical networks, include LANs, WANs, proprietary computer networks, mobile networks and electronic mail.

Computer security: security requirements/policy, security models, security features and mechanisms in operating systems, security-related issues of computer architecture, security of middleware, software protection and web security.

Secure electronic commerce and other applications

Standards and evaluation criteria
**Database security:** concurrency control in distributed databases, methods for concurrency control and failure recovery in distributed databases and the interaction between those methods and security requirements, adapting access control policies to relational and object-oriented databases.

**Information crime:** history, causes, development and repression through studies of surveys, types of crime, legal measures, and system and human vulnerabilities, effects of computer crime, motives and attitudes of hackers and other computer criminals.

**Recommended Readings**


**CS780 Real-Time Systems**

(3 cr.hrs)

**Course Description**

Real-time systems play a crucial role in many applications, such as avionic control systems, automotive electronics, telecommunications, industrial automation, and robotics. Such safety-critical applications require high reliability in timing assurance to prevent from serious damage to the environment and significant human loss.

**Course Objectives**

The objective of this course is to bring students into the position to understand the broad concept of real-time systems. The course aims to provide a practical understanding for industry and tries to stimulate research interest. At the end of the course the students should be able to:

- Understand and apply the fundamental concepts of real-time systems
- Explain and address the fundamental problems of real-time systems
- Analyze and partially design real-time systems

Pre-Requisites: Operating Systems

**Course Contents**
The following topics will be covered in the course:

- Introduction to Real Time Systems: basics
- Task scheduling
- Periodic task management
- Schedulability Analysis
- Aperiodic server mechanisms
- Accessing shared resources
- Predictable communication mechanisms
- Limits of hard real time systems
- Flexible real time systems
- Programming real time applications

Recommended Readings


CS781 Parallel Programming for Multicores
(3 cr.hrs)

Course Description

The introduction of multicore chips into the computing market has created a revolution in the software industry. To benefit from increases in hardware performance, software must be parallel. The purpose of this course is to teach the next generation of programmers to develop exciting new applications that can take advantage of on-chip parallelism.

Course Objectives

This course will provide an introduction to parallel programming with a focus on the techniques that are most appropriate for multicore architectures and the use of parallelism to improve program performance.

Prerequisites

Computer architecture, Operating Systems, C programming language or equivalent.

Course Contents
The following topics will be covered in the course:

- Introduction to Parallel Architecture
- Parallel programming paradigms and issues
- The multicore revolution
- Parallel programming using shared memory
- Parallel programming using distributed memory
- Multi-Threading: OS threads, Posix threads and Java threads
- OpenMP for shared memory multiprocessors
- Message passing interface (MPI)
- Multicore Communication API

**Recommended Readings**


**CS782 Concurrent and Real Time Programming**

*(3 cr.hrs)*

**Course Description**

Many real-time systems are inherently concurrent. In the past, software controlling these systems have used sequential frameworks. The result has been systems which are inflexible, difficult to design and costly to maintain. Having concurrency supported explicitly by a programming language makes an enormous difference to the expressive power of that language. The Java programming language is one of the few standard concurrent object-oriented programming languages. Furthermore, the Real-Time Specification for Java has facilities designed to cope with the special demands of real-time systems.

**Course Objectives**

This course provides an in-depth study on both the concurrency and the real-time facilities of Java (including the Real-Time Specification for Java). After the course students should be able to:

- Analyze requirements for programming concurrent and real-time systems.
- Evaluate strengths and weaknesses of the Java concurrency model and how it can be used to facilitate the programming of concurrent systems.
- Understand how Java can be restricted for Real-Time Systems.
- Develop real-time software in Java.
Prerequisites
Operating systems, Java programming language or equivalent.

Course Contents
The following topics will be covered in the course:

- The requirements for real-time programming and changes made to Java for real-time programming.
- Multi-threaded programming in Java
- Schedulable Objects in RTSJ: Real-time threads, No Heap Real-time threads, Asynchronous event handlers.
- Memory management in RTSJ: Scoped memory areas, Immortal memory and the Java Heap
- Clocks and high resolution timers in RTSJ
- Asynchronous transfer of control (ATC)
- Raw and physical memory access

Recommended Readings