Master of Science (M.S.)
in
Software Systems
(four semesters)

Course descriptions

BITS ZC463 Cryptography 3
Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BITS ZG553 Real Time Systems 5
Real time software, Real time operating systems–scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

CS ZG524 Real Time Operating Systems 5
Real time software, Real time operating systems–scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

CS ZG551 Advanced Compilation Techniques 5

CS ZG623 Advanced Operating Systems 5
Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.
EA ZC473 Multimedia Computing
Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

EEE ZG512 Embedded System Design
Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

IS ZC422 Parallel Computing
Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

IS ZC423 Software Development for Portable Devices
Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC424 Software for Embedded Systems

IS ZC444 Artificial Intelligence
The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

IS ZC446 Data Storage Technologies & Networks
IS ZC462 Network Programming 3
Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS ZC464 Machine Learning 3
Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical/probabilistic methods, genetic algorithms; inductive/analytic/reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

IS ZC472 Computer Graphics 3
Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

IS ZC481 Computer Networks 3
Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SS ZG513 Network Security 4
This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SS ZG514 Object Oriented Analysis and Design 4
Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SS ZG515 Data Warehousing 5
Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.
SS ZG518 Database Design and Applications  5
DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS ZG519 Data Structures & Algorithm Design  5

SS ZG520 Wireless & Mobile Communication 5
Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SS ZG525 Advanced Computer Networks  5
Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

SS ZG526 Embedded System Design 4
Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

SS ZG527 Cloud Computing 5
Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance
models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

**SS ZG531 Pervasive Computing**

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

**SS ZG537 Information Retrieval**

Course description to be developed.

**SS ZG538 Infrastructure Management**

Course description to be developed.

**SS ZG547 Usability Engineering**

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization; Benefits of implementing UCID; key features of UCID; UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture; designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues; Application of Usability Engineering in typical live projects to validate improved software usability.

**SS ZG548 Advanced Data Mining**

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

**SS ZG552 Software Testing Methodologies**

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.
**SS ZG554 Distributed Data Systems**  

**SS ZG562 Software Engineering & Management**  
Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

**SS ZG566 Secure Software Engineering**  
Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

**SS ZG582 Telecom Network Management**  
Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

**SS ZG622 Software Project Management**  
Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

**SS ZG626 Hardware Software Co-Design**  
SS ZG652 Software Maintenance Management

Issues in software maintenance, conceptual issues, scale of effort issues, organizational issues, productivity techniques issues, problem area issues; application systems; maintenance effort; impact of development tools and organizational controls; problems of maintenance; software evolution and maintenance; change management; impact analysis; system release planning; corrective maintenance; adaptive maintenance; perfective maintenance; reengineering source code, restructuring code, maintainability, flexibility, reusability, reliability, efficiency, reengineering tools; software testing & maintenance testing; system release and configuration management; managing the software maintenance process.

SS ZG653 Software Architectures

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SS ZG656 Networked Embedded Applications

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

SS ZG661 Software Quality Management

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.