# M.Sc. in Computer Engineering

## Program Structure

**CORE COURSES:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC 711</td>
<td>Advanced Programming Languages</td>
<td>3</td>
</tr>
<tr>
<td>CC 721</td>
<td>Advanced Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>CC 731</td>
<td>Computer Networks and Security</td>
<td>3</td>
</tr>
<tr>
<td>CC 752</td>
<td>Systems Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>4 Courses * 3 Credit Hours</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

**ELECTIVE COURSES:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CC 712</td>
<td>Advanced Database Systems</td>
<td>3</td>
</tr>
<tr>
<td>CC 713</td>
<td>Software Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CC 714</td>
<td>Computer Systems Security</td>
<td>3</td>
</tr>
<tr>
<td>CC 716</td>
<td>Pattern Recognition</td>
<td>3</td>
</tr>
<tr>
<td>CC 722</td>
<td>Advanced Digital Systems</td>
<td>3</td>
</tr>
<tr>
<td>CC 723</td>
<td>Embedded Systems Design</td>
<td>3</td>
</tr>
<tr>
<td>CC 725</td>
<td>VLSI System Design</td>
<td>3</td>
</tr>
<tr>
<td>CC 727</td>
<td>Application-Specific Architectures</td>
<td>3</td>
</tr>
<tr>
<td>CC 729</td>
<td>Computer Design and Performance Evaluation</td>
<td>3</td>
</tr>
<tr>
<td>CC 732</td>
<td>CAD for Computer Communications Networks</td>
<td>3</td>
</tr>
<tr>
<td>CC 733</td>
<td>Analysis and Design of Computer Networks</td>
<td>3</td>
</tr>
<tr>
<td>CC 735</td>
<td>Sensor Networks</td>
<td>3</td>
</tr>
<tr>
<td>CC 737</td>
<td>Mobile, Wireless and Ad-Hoc Networks</td>
<td>3</td>
</tr>
<tr>
<td>CC 742</td>
<td>Real-Time Systems</td>
<td>3</td>
</tr>
<tr>
<td>CC 743</td>
<td>Data Compression and Image Processing</td>
<td>3</td>
</tr>
<tr>
<td>CC 753</td>
<td>Advanced Topics in Artificial Intelligence</td>
<td>3</td>
</tr>
<tr>
<td>CC 756</td>
<td>DSP Hardware and Software System Design</td>
<td>3</td>
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<tr>
<td>CC 757</td>
<td>Modeling and Simulation</td>
<td>3</td>
</tr>
<tr>
<td>CC 758</td>
<td>Advanced Applications of Digital Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>CC 759</td>
<td>Advanced Robotics</td>
<td>3</td>
</tr>
<tr>
<td>CC 760</td>
<td>Computer Engineering Seminars</td>
<td>3</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>4 Courses * 3 Credit Hours</strong></td>
<td><strong>12</strong></td>
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continued/…
M.Sc. in Computer Engineering
Program Structure

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**RESEARCH THESIS:**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CC 701</td>
<td>Master's Research Thesis (Part 1)</td>
<td>6</td>
</tr>
<tr>
<td>CC 702</td>
<td>Master's Research Thesis (Part 2)</td>
<td>6</td>
</tr>
<tr>
<td>Subtotal</td>
<td><strong>2 Parts * 6 Credit Hours</strong></td>
<td><strong>12</strong></td>
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</tbody>
</table>

**Total**                                                                                     36
Course Detailed Structure

Course Code : CC 711
Course Title : Advanced Programming Languages
Credit Hours : 3

Course Description
Different paradigms of programming languages. Introduction to programming languages, history of programming languages, language design principles, syntax, basic semantics, data types, control and abstract data types. Difference between object oriented, functional logic, parallel programming and visual programming.

Course Objectives
To introduce the major principles and concepts underlying all programming languages with no concentration on one particular language.

Course Topics
- History and Programming Languages
- Language design principles
- Syntax
- Basic Semantics
- Data Types
- Control
- Abstract Data Types
- Object Oriented Programming
- Functional Programming
- Logic Programming
- Parallel Programming
- Visual Programming

References
- IEEE Transactions on Software Engineering
Course Code : CC 712
Course Title : Advanced Database Systems
Credit Hours : 3

Course Description
This course introduces material related to current advancements and research topics in the area of distributed heterogeneous database.

Course Objectives
To be able to write survey papers covering a contemporary topic, and implement software tools to enable exchanges among heterogeneous database systems.

Course Topics
- Heterogeneous Database Systems
- Data Warehouse and Data Mining
- Database and World Wide Web
- Object Database
- Active, Temporal, and Deductive Database
- Client Server and Distributed Database Systems
- Digital Library and Multimedia Database

References
Course Detailed Structure

**Course Code**: CC 713

**Course Title**: Software Engineering

**Credit Hours**: 3

**Course Description**

This course introduces software engineering as a concept, software development and the development life cycle. It also introduces different topics of software engineering like software quality, reusability, reliability, maintenance, security, testing, and software psychology. Also requirement analysis software tools and software design topics explained.

**Course Objectives**

To introduce students to the systematic approach to development, operation, maintenance and retirement of software engineering and its different topics.

**Course Topics**

- Software Development Life Cycle.
- Systems Analysis “Requirement Analysis and Specification”
- Systems Design and Functional Oriented and Object Oriented
- Validation and Verification
- Software Maintenance
- Project Management
- Software Quality
- Software Reliability
- Software Reusability
- Computer Aided Software Engineering (CASE) Tools
- Software Engineering

**References**

- IEEE Transactions on Software Engineering
- ACM publications
Course Detailed Structure

Course Code : CC 714
Course Title : Computer Systems Security
Credit Hours : 3

Course Description
Conventional encryption (classical and modern algorithm techniques), public-key cryptography, number theory, message authentication and hash functions, hash and MAC algorithm, digital signatures and authentication protocols, mail security, IP security, web security, system security firewalls, projects for teaching cryptography and network security.

Course Objectives
To provide a practical survey of both the principles and practice of cryptography and network security including practical applications previously implemented in encryption techniques and firewalls.

Course Topics
- Network Security Practice
- Encryption Algorithms and Cryptography
- System Security
- Research Projects and Programming Projects
- Internet Security
- Cryptography and Data Security
- Cryptography and Network Security
- Maximum Security (Anonymous)
- Web Security
- Computer Security Policies
- Disappearing Cryptography

References
- Bruce Schneier, Applied Cryptography, John Wiley, 1996
Course Detailed Structure

Course Code : CC 716
Course Title : Pattern Recognition
Credit Hours : 3

Course Description
This course provides in-depth review of various methodologies and techniques used in pattern recognition. This includes: feature extraction, reduction and representation to building complex algorithms for handling problems of data analysis. Concepts used in structural and statistical pattern recognition are also explored.

Course Objectives
To introduce the student to the analysis of difficult data structures, for which no prior models is available in order to be able to grasp basic techniques and learn where to learn more about advanced application-specific techniques.

Course Topics
- General approaches: learning from examples, measurements and features
- Classification Problem
- Clustering techniques
- Structural Pattern Recognition
- Statistical Pattern Recognition
- Image Analysis
- Advanced Applications

References
- IEEE. *Transactions on Pattern Analysis and Technique Intelligence*.
Course Code : CC 721
Course Title : Advanced Computer Architecture
Credit Hours : 3

Course Description
Overview of parallel architectures and programming techniques, parallel processes, models and semantics, parallel, concurrent and distributed programming. Task scheduling, shared memory parallel programming, complexity aspects, parallel processor design considerations, and pipelined processor design consideration, special-purpose parallel architecture design.

Course Objectives
To introduce first-year graduate students in computer science and computer professionals to the theory and applications of advanced parallel architectures and programming.

Course Topics
- Parallel Computational Models
- Parallel Processors Design Considerations
- Instruction-Level Parallel Processor (ILP)
- Thread and Process-Level Parallel Architecture

References
- Krishnamurthy, “Parallel Programming, Principles and Practice”, 1989
- W. Petersen, P. Arbenz, “Introduction to Parallel Computing”, Oxford University Press, 2004
- Deszso Sima et al., Advanced Computer Architectures, Addison Wesley, 1997
Course Code : CC 722
Course Title : Advanced Digital Systems
Credit Hours : 3

Course Description
This course introduces a range of aspects of advanced digital design. It starts with an introduction to the VHDL, Verilog and ABEL hardware description languages. The course provides techniques for designing and implementing synchronous and asynchronous digital circuits. It explains briefly the various design parameters and tradeoffs such as area, timing and cost of die. Advanced processor design paradigms and architectures such as dataflow, reconfigurable, asynchronous and processor-in-memory are also discussed.

Course Objectives
To become familiar with the major principles and concepts including all aspects of synchronous and asynchronous digital circuit design with emphasis on new processor design paradigms.

Course Topics
- The VHDL, Verilog, and ABEL language constructs and applications
- Design tradeoffs such as area, time, and cost
- Asynchronous circuit design fundamentals
- Static dataflow structures
- Handshake implementations
- Processor design and implementation

References
Course Detailed Structure

Course Code : CC 723
Course Title : Embedded Systems Design
Credit Hours : 3

Course Description
Processors, chipsets, busses, and I/O devices for high-end embedded systems. Embedded operating systems; device drivers and applications for embedded systems.

Course Objectives
To present the theory and tools of Embedded systems and invoke students in different aspects of Embedded system design through projects.

Course Topics
- Introduction to Embedded Systems
- Embedded Products (PDAs, Transaction Terminals, Industrial PC Controllers)
- Hardware for Embedded Systems Design
  - Processors and Chipsets
  - X86 ISA - I/O devices and interfaces
  - Common Bus Standards and Interfaces (ISA, PCI, AGP)
  - Programmed I/O - Interrupts
  - DMA - Example Design (i.e. Celeron motherboard)
- Software for Embedded Systems Design
  - Role of an Embedded Operating System
  - Multitasking and Threads
  - Example Operating Systems (Windows CE, NT embedded, Linux, BOS, Wind River)
  - Overview of Windows CE
- Proposed Project Design Review
- Design Project Implementation
- Project Demo and Presentation

References
- J. Henkel and S. Parameswaran, Designing Embedded Processors: A Low Power Perspective. 2007
Course Detailed Structure

Course Code : CC 725
Course Title : VLSI System Design
Credit Hours : 3

Course Description
This course focuses on a range of current VLSI design methods, testing and design-for-test techniques. The course presents designs for datapath subsystems including adders, shifters, multipliers, counters and others. Moreover, the course describes memory subsystems and special-purpose subsystems including clocking, I/O, mixed-signal blocks and routing techniques.

Course Objectives
To become versed in VLSI design to face the encountered growing challenges of power consumption and productivity of CAD tools.

Course Topics
- Logic Verification Principles
- Manufacturing Test Principles
- Datapath Subsystems
- Memory Subsystems
- Special-purpose Subsystems
- Analog Circuits
- Power Dissipation
- Clock Generation and Distribution

References
Course Detailed Structure

Course Code : CC 727
Course Title : Application-Specific Architectures
Credit Hours : 3

Course Description
This course tackles the micro-architectures that are non Von Neumann architectures. These architectures are dataflow, processor-in-memory, reconfigurable computing and asynchronous processor approaches. The course also discusses special-purpose architectures.

Course Objectives
To become familiar with the design principles associated with non von Neumann architectures, and special-purpose machine design.

Course Topics
- Basic Pipeline and Simple RISC Processors
- Dataflow Processors
- Processor in Memory (PIM)
- Asynchronous Processors
- Artificial Neural Net (ANN)
- Reconfigurable Processors
- Finite Element and Finite Difference Processors
- Steganographic Processor
- Encryption Processors
- Genetic Optimization Processors
- Design Project

References
Course Code : CC 729
Course Title : Computer Design and Performance Evaluation
Credit Hours : 3

Course Description
This course compares between the two major design methodologies based on ISA (Instruction Specific Architecture) and Special-purpose Architecture. The course covers the topics of queuing theory and Markov processes as a tool for computer system performance evaluation. Moreover, the students are introduced to operational analysis techniques regarding performance of computer systems. The course introduces the student to the principles of design, build and test of special-purpose processors. Moreover, the students are introduced to the concepts of evaluating the performance of such processors. It is intended for first year graduates specializing in computer engineering. These include Markov continuous and discrete processes. Benchmarking processor and computer system architectures have become extremely difficult due to the complexity of the processors and the complexity of the applications that run on the computers. This course will focus on quantitative and analytical characterization of processors and applications from general purpose and scientific computing. Several papers from recent computer architecture, performance evaluation, and workload characterization related conferences will be used as supplemental material.

Course Objectives
To become familiar with the principles of design, build and test of special-purpose processors, and to be able to evaluate the performance of such processors.

Course Topics
- Introduction to ISA-based Computer Design, Sequencing and Control
- Hardwired and Micro-Programmed Control
- Pipelined Control and Performance Evaluation
- Instruction Set Architecture and Addressing Architecture
- Central Processing Unit Design
- High Performance CPU Concepts
- Design Parameters; Area, Time, and Cost
- Operational Analysis
- M/G/1 Queuing Model
- Discrete-Time Markov Chains
- Benchmark System Evaluation
- Design Project

References
- A Collection of papers from conferences and journals. See reading list on course web page.
Course Detailed Structure

Course Code : CC 731
Course Title : Computer Networks and Security
Credit Hours : 3

Course Description
Fundamental concepts of computer network architectures and protocols and security issues.

Course Objectives
To provide the student with the required background in the field of computer networks by studying the fundamental concepts of network architectures, protocols and network security.

Course Topics
- Network architecture and protocols
- Network applications
- Network Layer and Transport Layer
  - Routing and IP
  - Transport Protocol Mechanisms
  - Examples of Transport Protocols (UDP, TCP)
- Physical Layer and Data Link Layer
- Network Reconnaissance Techniques
  - Network Mapping and Vulnerability Assessment
- Network Security Problems and Schemes
- Identifying Threats to Network Devices
- Network Intrusion Detection Systems, Firewalls and VPN
- Network Security services and Tools
- Wireless Network Security
- Risk Analysis and Management

References
Course Code: CC 732
Course Title: CAD for Computer Communications Networks
Credit Hours: 3

Course Description
Investigation of the methodologies and algorithms used for designing and optimizing computer/communications networks with a focus on the algorithmic aspects of network design.

Course Objectives
- To investigate the methodologies and algorithms used for designing and optimizing computer/communications networks.
- To focus on the algorithmic aspects of network design.

Course Topics
- Modeling Networks as Graphs
  - Representations of Networks
  - Computational Complexity
- Fundamental Graph Algorithms
  - Finding Trees
  - Shortest Paths
  - Single Commodity Network Flow
- Topological Design
  - Selecting Terminal-Concentrator Locations
  - Heuristic Algorithms
  - Network Topology Optimization
- Algorithms
  - Flow Deviation Algorithm
  - Bertsekas-Gallager Algorithm
  - Generalized Cut-Saturation Algorithm for Distributed Computer
- Communications Network Optimization
  - Cut Saturation Algorithm for Topological Design of Packet Switched
- Communication Networks
  - Algorithm for the Access Facility Location Problem
  - Dimensioning Schemes
- Mesh Topology Optimization
  - Capacity Assignment
  - Branch Exchange
- MENTOR Algorithm (Mesh Network Topology Optimization and Routing)

References
- No specific references
Course Code : CC 733
Course Title : Analysis and Design of Computer Networks
Credit Hours : 3

Course Description
To provide the advancements in research and technology of the field of computer networking to emphasize the hot research topics of the analysis, design, architecture and methodology of computer networking and their standards.

Course Objectives
To build solid knowledge of network protocols, HDLC, X.25, Frame relay, ISDN, ATM implementation and performance evaluation and to highlight the research topics in these areas.

Course Topics
- Computer Networks Taxonomy
- WAN Protocol and Standards
- LAN Protocol and Standards
- MAN Protocol and Standards
- HDLC
- Routing Protocol and Congestion Control
- X.25
- Frame Relay
- ISDN
- ATM
- Student Seminars of Selected Topics

References
- Andrew S. Tanenbaum, “Computer Networks”,
- IEEE/ACM Transactions on Networking
Course Detailed Structure

Course Code : CC 735
Course Title : Sensor Networks
Credit Hours : 3

Course Description
Basics of sensor network communications. Applications, architectures, and communication protocols for sensor networks are treated in depth.

Course Objectives
- To become familiar with the basics of sensor network communications.
- To become versed in applications, architectures, and communication protocols for sensor networks in depth.

Course Topics
- Introduction
- Sensor Networks Architecture and Protocol Stack
- Factors influencing the design of sensor networks
- Sensor Network Applications
- Application Layer
- Transport Layer Protocols
- Routing Algorithms
- Medium Access Control Protocols
- Error Control Algorithms
- Physical Layer Solutions
- Localization and Target Detection Algorithms
- Time Synchronization Algorithms
- Sensor and Actor (Actuator) Networks
- Coordination and Communication Problems

References
Course Detailed Structure

Course Code : CC 737
Course Title : Mobile, Wireless and Ad-Hoc Networks
Credit Hours : 3

Course Description
Mobile and wireless networking. Architectures and communication protocols for wireless local area networks, ad-hoc networks, cellular systems, WiMAX, and Wireless Mesh Networks.

Course Objectives
The student will be familiar with the fundamental concepts of mobile wireless networking and gain technical details of emerging wireless network standards.

Course Topics
- Wireless Sensor Networks
  - Network Architecture, Applications, Factors Influencing Network Design
  - Application Layer Framework, Transport Layer Solutions
  - Routing Algorithms, Medium Access Control Schemes, Error Control
- Ad Hoc Networks
  - Topologies and Characteristics, Routing Algorithms
  - Proactive and Reactive Routing Protocols
- Wireless Local Area Networks (WLANs)
  - Reference Architecture, Protocol Architecture
  - Family of Wireless LAN Standards and Details (IEEE 802.11a; b; d; e; f; g; h; i; n)
  - Physical Layer Functions, CSMA and its Problems for WiLANs, MAC Layer Solutions
- Wireless Personal Area Networks (Bluetooth)
- Mobile IP
  - Agent Discovery/Advertising Care-of Addresses
  - Registration, Tunneling (Encapsulation), Triangle Routing, Optimized Routing
  - Mobility Management, Handovers
- 2.5 Generation Wireless Systems (GPRS)
  - Reference Architecture, Devices and Terminal Types
  - Location Management and Handoffs in GPRS
  - Short Messages Services (SMS)
- Third Generation Wireless Systems
  - IMT-2000 (International Mobile Telephone)
  - UMTS (Universal Mobile Telephone Systems)
  - Evolution from 2G to 3G; Differences
- WiMAX
  - Motivation, Architecture and IEEE 802.16 Standards
- Wireless Mesh Networks
  - Architecture (Mesh Clients, Mesh Routers), WMNs vs Ad Hoc Networks (Differences)
  - Application Scenarios, Critical Factors Influencing Network Design
  - Physical Layer Solutions, Existing MAC Solutions, Routing Protocols, Research Challenges
IEEE Standard Activities and their Status

References

Course Code : CC 742
Course Title : Real-Time Systems
Credit Hours : 3

Course Description
Real-time systems are characterized by the fact that it is not only the result of the calculation that is of importance but also the time when the result is available. A computer used for controlling a process is a good example of a real-time system. It must operate in a time-scale that is determined by the time scale of the process. At the same time it should be reactive to external events, often with time constraints on the reaction time.

Course Objectives
To study methods for design and implementation of computer control systems with focus on the application classes mentioned and to implement some systems in a project.

Course Topics
- Real-time programming
- Synchronization and mutual exclusion
- Real-time kernels and operating systems
- Periodic controller tasks
- Computer implementation of control algorithms
- Scheduling theory
- Formal methods
- Sequence control
- Set-point handling
- Industrial control systems
- Real-time communication

References
Course Detailed Structure

Course Code : CC 743
Course Title : Data Compression and Image Processing
Credit Hours : 3

Course Description
Theory and algorithms of signal encoding and decoding for data compression. Applications in information systems, digital telephony, digital television, and multimedia Internet.

Course Objectives
- To cover the theory and algorithms of signal encoding and decoding for data compression.
- To study applications in information systems, digital telephony, digital television, and multimedia Internet.

Course Topics
- Introduction: signal compression, lossless and lossy compression
- Quantization theory
  - Uniform quantization, distortion and bit rates
  - Amplitude distribution and high-rate quantization theory
  - Bennett approximations and optimal performance, Lloyd's code optimality and algorithm
  - Elementary distortion-rate theory
- Architecture for data compression and introduction to data modeling
  - Signal models and spectral analysis
  - Quantization with memory
  - Fixed-rate vs. variable-rate code
  - Entropy, estimated entropy, complexity and typical sequence of an ergodic source
  - Variable rate quantization: lossless codes, prefix code
- Lossless Coding Techniques
  - Huffman coding, arithmetic coding
  - Universal lossless codes, adaptive and predictive lossless coding
- Distortion and Similarity Measures
  - Sample difference, sum of squared deviations and Euclidean distance
  - Lp-norm, city-block distance, Mahalanobis distance
  - Transformation and transformation invariant similarity measures
  - Spectral distortion measures
  - Mutual-information, divergence, and Kullback-Liebler number
  - Perceptual issues
- Coding algorithms scalar quantization
  - Clustering algorithms for quantizer design
  - The Lloyd algorithm and its generalization
  - Entropy-constrained quantizers
- Coding algorithms - vector quantization (VQ)
  - Sphere packing and optimal uniform lattice quantizers
  - Progressive vector quantization
  - Variations of vector quantization
  - Finite-state VQ and Markov models
  - Tree and Trellis encoding
Course Detailed Structure

Computer Engineering

- Applications
  - Speech and audio coding
  - Image and video coding
- Compression standards and formats
  - Historical and evolitional aspects behind development of standards
  - Application areas

References

Course Code : CC 752
Course Title : Systems Science and Engineering
Credit Hours : 3

Course Description
This course introduces a range of techniques for analyzing continuous and discrete linear time invariant systems. It starts with a review to techniques of solving differential and difference equations using Fourier and the Z-transforms. Subsequently, the course veers to applications involving digital filter design. Afterward, it provides an introduction to the Discrete Fourier Transform (DFT), and Fast Fourier Transform (FFT) with various applications. In addition, the course introduces students to the theory and applications of wavelets such as the Haar wavelet, Daubechies wavelets, and Coiflet and Gabor wavelets. Applications include signal compression, audio denoising, finger print compression, and image and speech recognition.

Course Objectives
To become familiar with the major principles and concepts behind discrete and continuous linear time-invariant system analysis with emphasis on wavelet theory and applications.

Course Topics
- Linear Systems and Signal Analysis
- Difference Equations
- The Z-transform
- Solution of D.E
- A/D Conversion
- Digital Filters
- Fourier Transform
- DFT, FFT
- Discrete Cosine Transform, Hartely Transform
- Haar Wavelet
- Daub wavelet
- Coiflet wavelet
- Gabor wavelet

References
Course Detailed Structure

Course Code : CC 753
Course Title : Advanced Topics in Artificial Intelligence
Credit Hours : 3

Course Description
This course allows the introduction of material relating to current artificial intelligence research topics, and current advances in artificial intelligence technology.

Course Objectives
To write-up survey papers about a narrow topic, and implement software tools to practice the different advanced topics.

Course Topics
- Learning Systems
- Fuzzy Logic
- Genetic Algorithm
- Hybrid Intelligent Systems
- Case Based Reasoning
- Knowledge Discovery in Database Systems
- Intelligent Agents

References
Course Code: CC 756
Course Title: DSP Hardware and Software System Design
Credit Hours: 3

Course Description
A study of theory and practice in the design and implementation of DSP algorithms on programmable processors, multiprocessors, and ASICs. Specification, evaluation, and implementation of real time DSP applications on embedded DSP-based environments.

Course Objectives
- To study the theory and practice in the design and implementation of DSP algorithms on programmable processors, multiprocessors, and ASICs.
- To present the specification, evaluation, and implementation of real time DSP applications on embedded DSP-based environments.

Course Topics
- Introduction to Programmable DSPs
  - Skillikorn's taxonomy and classification
  - Architectures of DSP; Examples of DSPs
  - Memory architectures; External interface units
- Data Path Design for DSP
  - SISC architectures; Reservation tables and optimization
  - Pipeline control; Synchronous data path design and retiming
  - Arithmetic circuits for DSP; Multiprocessor scheduling theory
- DSP ASIC design and VHDL
  - Introduction to VHDL and Language Fundamentals
  - Modeling DSP data and control path in VHDL
- DSP Chip Synthesis
  - Design recommendations; Compilation and coding issues
  - Joint simulation and synthesis issues
  - Synthesis Examples
  - DSP processor design
- Specification of DSP algorithms and processors
  - Programming models and virtual machines
  - Graphical specification and requirements capture
  - Textual specification and requirements capture
  - Compilation and execution environments
  - Fixed point and floating point issues
- Software architecture for DSP boards and systems
  - Host interfaces
  - I/O interfaces
  - Real-time operating systems
- DSP program framework and API
  - Real-time program architecture
  - Operating system dependencies
  - Application modules and libraries
  - Implementation of virtual machines
- Virtual prototyping of DSP applications: Examples
  - Single processor implementations
Course Detailed Structure

- Multiprocessor implementations
- Code development and debugging

- DSP Application Demonstrations
  - Sample implementations: equalizers, coders.
  - Performance measurement and optimization

References

Course Detailed Structure

Course Code : CC 757
Course Title : Modeling and Simulation
Credit Hours : 3

Course Description
To emphasize the topics of fundamental importance concerning the broad field of modeling and simulation to demonstrate the different stages included in conducting a simulation study, suing the discrete event simulation model.

Course Objectives
- To highlight system models and corresponding simulation methodology.
- To demonstrate the discrete event simulation model and its implementation.
- To discuss random number generators, generating random distributions, selecting input distributions, output analysis and comparing alternative system configurations.

Course Topics
- Systems Models and Simulation
- Discrete Event Simulation
- Single Server System
- M/M/1 Simulation
- Stage of Conducting a Simulation Study
- Random Number Generators
- Generating Random Distribution
- Selecting Input Probability Distribution
- Data Analysis of Simulation Outputs
- Building Valid and Credible Simulation Models

References
- IEEE Modeling and Simulation Transactions
Course Code : CC 758
Course Title : Advanced Applications of Digital Signal Processing
Credit Hours : 3

Course Description
Discrete time transfer function, realization topology, IIR filter design, FIR filter design, DFT, FFT, Floating Point, sub-band transform and sub-band coding, sinusoidal signal generation, compression techniques, Multi-rate signal processing, Filter Banks, Wavelets and Applications to mp3 and JPEG 2000.

Course Objectives
To be versed in advanced techniques of filter and hardware design.

Course Topics
- Overview of DSP: LTI systems, Z-transform and DTFT.
- Multi-rate signal processing.
- Filter Banks, Wavelets and Applications to mp3 and JPEG 2000.
- Overview of FIR and IIR filter design techniques.
- DFT, FFT, and role of DCT in MPEG and JPEG.
- Spectral Analysis.

References
Course Detailed Structure

Course Code : CC 759
Course Title : Advanced Robotics
Credit Hours : 3

Course Description
Robot algorithms are abstractions for controlling motion and perception in the physical world. In this course the student will study advanced topics related to current research in robotics. Planning and control issues for realistic robot systems, taking into account: dynamic constraints, control and sensing uncertainty and non-holonomic motion constraints. Analysis of friction for assembly and grasping tasks. Sensing systems for hands including tactile and force sensing. Environmental perception from sparse sensors for dexterous hands. Grasp planning and manipulation.

Course Objectives
To explore the kinematics, dynamics, and control of robotic manipulators, and to briefly discuss other areas including machine vision, CAD and AI in recent research topics.

Course Topics
- Rigid Motion and Homogeneous transformations
- The Denavit-Hartenberg representation
- Inverse and velocity kinematics
- Dynamics
- Independent joint control
- Multivariate control
- Force control
- The feedback linearization
- Variable and adaptive control
- Optimal control
- Stochastic control
- Advanced research topics

References
Course Detailed Structure

Course Code :  CC 760  
Course Title :  Computer Engineering Seminars  
Credit Hours :  3

Course Description
A series of seminars with topics related to different fields of computer engineering such as networking and computing fields: mobile ad hoc networks, voice and video over IP, state of the art in computer architecture design, etc…

Course Objectives
The student will gain knowledge about new trends in the field of computer engineering and be aware of the current research topics. The student will prepare a seminar on one of the selected topic(s), presents the seminar and gets feedback from the academic

Course Topics
- Voice and Video over IP
- MANET
- Cognitive Radio
- Computer vision
- System on a Chip

References
- According to the seminar subject