**MSc PROGRAM IN COMPUTER ENGINEERING**

**COURSE DESCRIPTIONS**

**ENS501-Research Methods and Scientific Ethics**

Thesis necessities, Scientific Research, Scientific Reserach Methods, Ethics of Science are some of the basic topics of the lectures, details are given at the weekly flow.

**COME502 Seminar**

A series of lectures in Computer Engineering is given by faculty or outside speakers.

**COME504- Discrete Structures**

This subject offers an interactive introduction to discrete mathematics oriented toward computer science and engineering. The subject covers topics which are fundamental concepts of mathematics: Definitions, proofs, sets, functions, relations, Discrete structures: graphs, state machines, modular arithmetic, counting and discrete probability theory.

**COME505- Data Structures and Algorithms**

Basic concepts of Algorithms, analysis of algorithms, linked lists, stack, Queue, Trees, Graphs and its basic concepts, Searching and sorting algorithms.

**COME506- Programming Language Concepts**

This is a course in comparative programming languages. We learn the fundamental concepts important to the field. We will study the major programming language paradigms: imperative, logic and functional. Among the other topics discussed are syntax, semantics, types and objects, exception handling, and modules. More broadly, it is the study of human to computer communication.

**COME507- Computer Communications**

Local and wide area network architectures, protocols, services and applications; Physical data transmission, the elements of reliable and unreliable communications protocols; Transfer of information between machines with similar and different characteristics; How communications services fit in with the hardware and operation system.

**COME508- Operating System Design**

Introduction to operating systems concepts, process management, memory management, virtual memory, input-output and device management, file management and file systems, job scheduling, deadlocks, interrupt structures, case studies of operating systems.

**COME509- Computer Structures**

Binary numbers, Digital signals, Logic Gates, Flip Flops, Basic Arithmetic Circuits, Basic Structure of Computers, Hierarchical Layers of Hardware and Software, Machine Instructions and Programs, ARM instructions, Input/Output Organization, The Memory System, Arithmetic Logic Units, Pipelining

**COME511- Advanced Algorithms**

Algorithm design methods, greedy algorithms, divide and conquer method, dynamic programming, graph algorithms, NP-Completeness, parallel algorithms, distributed algorithms

**COME512- Advanced Database Design**

Database systems concepts and architecture, Concepts used in UML, EER, and XML, Transformation of conceptual models to a relation. Properties of normalisation up to 4NF, Views, implementation of integrity constraints, Centralised, decentralised and distributed databases, Transaction handling. Concurrency and recovery. Query optimization. Advanced and embedded SQL. Triggers and stored procedures, The problem of using different architectures in client and server side applications, Techniques for efficient storing, accessing, securing, and recovering of data, Implementation of advanced structures in relational, hybrid, and object oriented databases.

**COME513- Advanced Computer Networks**

Computer network protocols, data link layer, network layer, transport layer, socket programming, UNIX network programming, network programming with Python, wireless networks, network security

**COME514- Artificial Intelligence and applications**

Artificial intelligence (AI) is a research field that studies how to realize the intelligent human behaviors on a computer. The ultimate goal of AI is to make a computer that can learn, plan, and solve problems autonomously. The main research topics in AI include: problem solving, reasoning, planning, natural language understanding, expert systems, vision and robotics will be explored.

**COME515- Advanced Topics in Data Mining**

This course emphasizes advanced data mining algorithms and techniques. Topics
include: feature selection, high dimensional indexing, and pattern discovery,
interdisciplinary applications of data mining; web and text data mining, e-commerce,
security analysis, and data mining of economic data.

**COME516- Advanced Software Engineering**

This course is aimed at helping students build up an understanding of how to develop a software system from scratch by guiding them thru the development process and giving them the fundamental principles of system development with object oriented technology using UML. The course will initiate students to the different software process models, project management, software requirements engineering process, systems analysis and design as a problem-solving activity, key elements of analysis and design, and the place of the analysis and design phases within the system development life cycle.

**COME517-System Science and Engineering**

The System Science and Engineering prepares students to address those issues of system design that assure effective operation of the system as a whole. Most systems have mechanical, electrical, and other aspects to them. These systems usually include one or more computers as well. For detailed design and analysis of these aspects of a system, we usually turn to a specialist in mechanical, electrical, or computer engineering. The specialty of the system engineer is in integrating the pieces of the system into an effective whole. These pieces are typically not mechanical, electrical, or computer in nature, but rather, functional in nature; hence, they often belong more nearly to the systems engineering specialty than to any other

**COME518-Statistical Analysis Methods and Applications**

The course provides insight on how to formulate a problem into statistical language, how to build a statistical model, how to analyse data and how to validate results. Regression methods, analysis of variance, design of experiments, logistic regression, survival analysis and simple time-series analysis are covered.

**COME519-Data and Network Security**

The course contents include: data security and network security concepts, such as confidentiality, integrity, authenticity, availability, security threats and network-based attacks, applications of cryptography, authentication, access control, intrusion detection and response, security protocols .

**COME520- Advanced Machine Learning**

This course covers the theory and practical algorithms for machine learning from a variety of perspectives. Topics include: supervised learning (Bayesian networks, decision tree learning, Support Vector Machines), statistical learning methods, unsupervised learning and reinforcement learning.

**COME521– Natural Language Processing**

Lecture will introduce core NLP techniques for language modeling, tagging, parsing, and word-sense disambiguation. We will also discuss applications such as machine translation, question-answering, summarization, and image caption generation. We will study machine learning methods currently used in NLP, including Neural Networks, Bayesian networks, and Hidden Markov Models.

**COME522– Digital Image Processing**

This course introduces the basic concepts and methodologies of digital image processing. The covered topics include image enhancement, high-dimensional spectral analysis, spatial and frequency domain linear image filtering, nonlinear image filtering, binary image processing, edge detection, image segmentation, feature extraction, and the basics of digital video processing.

**COME523- Special Topics in Computer Engineering**

A subject related to Computer Science and Engineering is selected and scientific research is carried out on this subject. Within the content of this course; The aim of this course is to teach review the literature, data collection, data evaluation and report writing techniques.

**COME524- Human Computer Interaction**

This course gives an overview of next-generation user interfaces and underlying methodologies. Main topics include a review of HCI concepts and history, input devices and interaction techniques, information appliances, user interface design paradigms, 3D user interfaces, adaptive interfaces, user modeling, speech recognition and conversational interfaces, wearable computers, multimodal interfaces, and perceptual interfaces.

**COME525- Artificial Neural Networks**

Artificial neural networks use learning algorithms that are inspired by brain learning abilities. Various methods in neural networks have been developed for practical applications such as object recognition, image retrieval, pattern classification, function approximation and control. The course will explain both the classical and the new techniques of neural networks in supervised, unsupervised and reinforcement learning schemes. Particularly, a single perceptron and neurons, feed-forward neural networks, Kohonen's maps, associative memories, Hopfield's and many other recurrent networks will be considered.

**COME526- Digital Signal Processing Applications**

Physical Transformations of Signals: Sampling, concept of periodicity and overlap in frequency domain, conditions on sampling frequency, A / D and D / A converters \* Mathematical Transformations of Signals: Z-transform, properties, transfer function and applications, Fourier transform, discrete-time Fourier transform, discrete Fourier series, opening of periodic signals to Fourier series, discrete Fourier transform, reconstruction of signal from Fourier components \* Mathematical Transformations of Systems: Transition from differential equations to difference equations, various approximation methods and their interpretation from different angles, digital filters, realization of analog filters using digital filters, FIR and IIR low, high and band pass filters, median filters \* Digital Filter Design: Design of FIR and IIR filters, FIR and IIR filter applications

**COME527- Wireless Network Protocols**

This course provides an introduction to various current and next generation wireless networking technologies, and undertakes a detailed exploration of fundamental architectural and design principles used at all layers. Related protocols and their performance are studied using formal analytical tools and realistic simulations.

**COME528- Advanced Parallel Processing**

This course includes fundamentals of explicitly parallel programming. This includes the types of explicit parallelism, the general models used in parallelization, as well as practical usage. The course will provide at least a basic working knowledge of the three main parallel programming paradigms: Shared memory programming with OpenMP, Shared memory programming with pthreads, and Distributed memory programming with MPI.

**COME529- Embedded Systems in Real Time Applications**

The course gives an overview of key issues for the construction and verification of programmable logic and Real-Time / Embedded systems. The course provides an integrated approach to developing low-power systems with hardware, software, sensors, actuators, controllers and networking. Students will learn to develop a programmable embedded platform from scratch, interface a variety of sensors and actuators for interactive systems, build a gaming system, program an emulator to play retro games, control an autonomous robot and write an RTOS kernel from scratch.

**COME530- Bioinformatics**

The concept of bioinformatics and its application areas, information theory, gathering, processing and sharing of information, data bank creation and usage, investigation of protein and nucleotide databases, primary design, evaluation of nucleotide and protein sequence analysis results.

**COME531- Advanced Robotics**

This course provides an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, rigid-body dynamics, 3D graphic simulation; control design, actuators, and sensors; wireless networking, task modeling, human-machine interface, and embedded software.

**COME532-** **Advanced Scientific Computing**

Topics to be covered include: governing equations of science and engineering (Schrodinger equation, Navier-Stokes equation, etc.), finite element method, finite volume method, Monte Carlo methods, approximation techniques used in scientific computing, molecular dynamics and other particle simulation methods.

**COME533- Mobile Application Development**

The topics to be covered in the course include: Client Hardware (Desktop vs. Mobile), Android Development with Java, iOS Development with Swift, RESTful and Non-RESTful apps, Creating and Incorporating Web/Cloud Services, Mobile Sensors, Security and Trust Management, Privacy and Ethics, Usability and Accessibility.

**COME534- Graph Algorithms**

Storage and representation of graphs on a computer, Breadth first search algorithm, Dijkstra's algorithm, Shortest/longest path on a acyclic graph, Floyd-Warshall all pairs shortest path algorithm, Finding strongly connected components (Tarjan's), Common graph theory problems, Depth first search algorithm, Topological sort algorithm, Bellman Ford's algorithm, Finding bridges/articulation points, Travelling salesman problem (TSP).

**COME535- Modeling and Simulation**

Models and the model concept. Differential equations, difference equations. Description of statistical dynamical properties. Physically based equations for model building: energy balance, mass flow balance, Newtons laws of movement, etc. General principles for model building. Bond graphs. Model reduction. Differential algebraic equations. Identification of dynamic systems: methods to build models based on measurement data from processes. Blackbox models. Parametric estimation in linear dynamic models. System identification as model building tool. Model validation. Simulation: numeric accuracy and stability.

**COME536- Microcontroller and Applications**

Microprocessor definition, components, properties and working principles, Microcontroller definition, components, properties and working principles, Microcontroller based circuit design, Well-known microcontrollers, A high level programming language and properties, Editor, Compiler and Debugger, Microcontroller based simple control and applications

**COME537-** **Web Technologies and Programming**

The course introduces the basic concepts of the World Wide Web, and the principles and tools that are used to develop Web applications. The course will provide an overview of Internet technology and will introduce current Web protocols, client side and server side programming, communication and design.

**COME538- Cyber Security**

What is Cyber Security and what targets it? Cyber War, Cyber Terrorism, Cyber Espionage Concepts, Personal Data, Enterprise Data. What are security violations and how to intervene? Types of Hackers, Internal and External Threats, Cyber Attack Analysis, Vulnerabilities. Types of Malware and Methods of Prevention of Malware, Penetration Methods, PC, Wireless Network and Online Accounts Security, Firewall Botnet, Kill Chain and Honeypot Concepts.

**COME539- Computer Vision**

This course provides an introduction to computer vision, including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification, scene understanding, and deep learning with neural networks. We will develop basic methods for applications that include finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition.

**COME540- Brain Computer Interfaces**

The course includes invasive and non-invasive brain-computer interfaces (BCIs) for controlling prosthetic arms, wheelchairs, and robotic avatars. Students will learn how such BCIs are enabling communication in locked-in patients and helping restore movement and mobility in paralyzed and disabled persons. The course will also introduce other applications of BCI technology such as security, lie detection, alertness monitoring, entertainment, gaming, education, and human augmentation.  Lectures will include primers on neuroscience, signal processing, and machine learning.

**COME541- Cryptography**

Cryptography provides important tools for ensuring the privacy, authenticity, and integrity of the increasingly sensitive information involved in modern digital systems. The course consists of encryption methods, Message integrity, Public key cryptography and Digital signatures.

**COME591- Graduation Thesis - I**

**COME592- Graduation Thesis – II**

**CYS507- Computer Forensics**

Introduces computer security administrators to computer forensics. Includes setup and use of an investigator's laboratory, computer investigations using digital evidence controls, processing crime and incident scenes, performing data acquisition, computer forensic analysis, e-mail investigations, image file recovery, investigative report writing, and expert witness testimony.

**CYS517- Penetration Testing and Vulnerability Analysis**

Introduction to penetration testing. Penetration testing planning; determining scope and rules of engagement documentation. Penetration testing tools: setting up virtual up and toolset. Reconnaissance phase: open source intelligence, information gathering, correlation, verification, and priorization. Scanning phase: enumeration, port scanning, and vulnerability analysis. Exploitation phase: manual exploitation, password cracking and Metasploit framework. Post-exploitation phase: Data gathering, network analysis, maintaining access, pivoting. Reporting phase: penetration test report structure and components. Bypassing security controls and avoiding detection.