Electronics and Computer Engineering (ECE)

Course Descriptions

(3 ŞEHİR credits each, equivalent to 5 ECTS credits)

ENGR 500
Teaching the principals of research methods and ethical issues in engineering research.

ECE 501 Analog Circuit Design
Description: The course deals with the analysis and design of switched capacitor circuit, Nyquist rate and over-sampling digital-to-analog and analog-to-digital converters and continuous time filters. The emphasis will be at the opamp level and above; however, transistor level knowledge is required. A detailed summary on transistor level design will be provided as well.
Pre-requisites: A course on electronic circuits (MOS Transistors) and discrete-time signal processing is required. Knowledge on continuous time filters is desirable.
Textbook: Analog Integrated Circuit Design by Tony Chan Carusone, David A. Johns, Ken W. Martin

ECE 502 RF Radio Design
The course provides thorough introduction to the fundamental concepts of RF design, including nonlinearity, interference and noise. Modulation and detection theory; multiple access techniques, and circuits pertinent to current wireless networks. It includes case studies of transceiver architectures from leading manufacturers. The course also involves CAD activity.

ECE 503 mm Wave IC Design
The course focuses on silicon based technologies and covers device modeling, circuit building blocks, phased array systems, and antennas pertinent to mm-Wave amplifiers, mixers, VCO's, power amplifiers, and beam forming arrays.

ECE 504 Advanced Communication Circuits
The course covers a brief review of analog and digital communication concepts, contemporary receiver transmitter architectures for modern wired and wireless communication systems, delay-locked loops (DLLs), fractional-N synthesizers, phase locked loops and clock recovery circuits. The course involves design and CAD activity.

ECE 507 VLSI Design
This course provides an introduction to the design of digital ASICs and microprocessors. Students will be introduced to the various steps in design process including planning, design and verification.

ECE 508 Analog-Digital Interface Integrated Circuits
This course covers the data converter circuits in modern mixed-signal VLSI systems. The course presents switched-capacitor amplifiers/integrators, sample- and-hold circuits, Nyquist-rate converters, and oversampled converters. As the major advancement in this field was developed using CMOS technology in the past decade, the course will focus on CMOS building blocks and circuit techniques that implement these converters. Extensive computer simulations are required in the project. The course content includes Sample-and-hold amplifiers, switched-capacitor (SC) circuits, Nyquist-rate data converters, oversampled data converters, precision techniques, digital calibration, and data converter testing.

ECE 509 Statistical Signal Processing I: Estimation Theory

This course provides the students with a solid background with the theory of estimation. The course introduces the concepts of consistency and bias in estimation, criteria for the parameter estimation, performance bounds for the estimation problems, and the ability to assess the performance of the estimation techniques. The course then introduces some of the estimation techniques: linear estimators, ML, techniques based on Bayesian estimation, and Kalman estimators. This course is a must for students who wish to acquire a deep understanding of the fundamentals of parameter estimation techniques that are used extensively in communication systems.

ECE 510 Statistical Signal Processing II: Detection Theory

This course provides the students with a solid background with the theory of statistical decision theory. It aims to provide the fundamentals of the theory of detection theory. It intends to provide a thorough understanding of the modelling of the systems with noise and how to perform detection with no or a prior information of PDF being available. The course extends the problem of detection for the cases where the parameters of the noise are unknown and when the signal in present is either deterministic or random. Matched filtering in statistical decision

theory and the concept of hypothesis testings are also covered in the course. This course is a must for the communication system engineers, who plan to develop receiver algorithms.

ECE 511 Probability and Stochastic Process

This course covers the introduction to probability and random processes relevant to electrical and electronics engineering applications. Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, correlations and spectra, spectral density, effects of filtering, linear least-squares estimation, and convergence of random sequences.

ECE 512 Information Theory

Our course will explore the basic concepts of Information theory for students planning to delve into the fields of communications, data compression, and statistical signal processing. It will cover the concepts of source, channel, rate of transmission of information. Entropy and mutual information. The noiseless coding theorem. Noisy channels; the coding theorem for finite state zero memory channels. Channel capacity. Error bounds. Parity check codes. Source encoding.

ECE 513 Digital Communications I

This is an advanced course that covers digital transmission of information across discrete and analog channels. It covers up to date subjects such as sampling; quantization; noiseless source codes for data compression: Huffman's algorithm and entropy; block and convolutional channel codes for error correction; channel capacity; digital modulation methods: PSK, MSK, FSK, QAM; matched filter receivers. Performance analysis: power, bandwidth, data rate, and error probability.

ECE 514 Data Compression and Modeling

This course covers the introduction to a variety of source coding techniques such as quantization, block quantization; and differential, predictive, transform and tree coding. Introduction to rate-distortion theory. Applications include speech and image coding.

ECE 515 Linear Dynamical Systems

Course offers an introduction to applied linear algebra and linear dynamical systems with applications to circuits, signal processing, communications, control systems and autonomous dynamical systems.

ECE 516 Convex Optimizations

This course covers different optimization tools and algorithms such as: Genetic algorithms, ant colony optimization, tabu search, integer programming, and evolutionary algorithms. It also covers optimal control and dynamic programming; linear quadratic regulator, Lyapunov theory and methods, time-varying and periodic systems, realization theory, linear estimation and the Kalman filter. Examples and applications from digital filters, circuits, signal processing, bioinformatics and control systems.

ECE 517 Numerical Methods in Engineering

Basic methods for obtaining numerical solutions with a digital computer will be discussed. Included are methods for the solution of algebraic and transcendental equations, simultaneous linear equations, ordinary and partial differential equations, and curve fitting techniques. The methods are compared with respect to computational efficiency and accuracy.

ECE 518 Advanced Digital Communications

This advanced course aims to provide topics of digital communication systems by focusing on characteristics of the wireless channels and their impact on the signals. Moreover, the course aims to provide an understanding of mathematical modeling of digital communication systems when the fading channels are in present. Other topics include Adaptive Equalization, Linear Equalization, Decision Feedback Equalization, Multichannel and Multicarrier Systems, Fading Channels characterization and signaling, and the capacity of the fading channels. At the end fo the course the students will be able to design practical communication systems in Matlab.

ECE519 Robotics

This is a course on modeling, design, planning and control of robot systems. It surveys results from geometry, kinematics, statics, dynamics and control theory.

ECE520 Software Based Startups

This course will cover modern software engineering principles with a focus on mobile HTML5 development. You will learn the philosophy of startups, some software tools used in contemporary startups, and do a class project that promotes your idea in a web application using responsible web design

ECE521 Motion Planning

This course provide coherent framework of motion planning for robots and autonomous vehicles and it covers subjects pertinent to automatic motion planning such as path planning, space configuration, sampling strategies, target detection and tracking and collision detection.

ECE522 Antenna Theory and Design

Description: The objective of the course is to provide an overview of antennas and wave propagation for wireless communications. The course will cover fundamentals of radiation and propagation, antenna parameters, simple radiating systems, linear wire, loop, and broadband antennas, antenna arrays, and antenna synthesis.

ECE 523 Machine Learning

In this course, students learn advanced programming techniques for representing and reasoning about complex objects and various applications of such techniques, including expert systems, natural language processors, image understanding systems and machine learning.

ECE524 Computer Vision

The goal of computer vision is to compute properties of the three-dimensional world from digital images. Problems in this field include identifying the 3D shape of an environment, determining how things are moving, and recognizing familiar people and objects, all through analysis of images and video. This course provides an introduction to computer vision, including such topics as feature detection, image segmentation, motion estimation, image mosaics, 3D shape reconstruction, and object recognition.

ECE 525 Advanced Topics in Computer Vision

This class will focus on advanced topics in computer vision: image sequence analysis, spatio-temporal filtering, camera calibration and hand-eye coordination, robot navigation, shape representation, physically-based modeling, regularization theory, multi-sensory fusion, biological models, expert vision systems, and other topics selected from recent research papers.

ECE526 Computational Biology

This course focuses on algorithms derived from computer science such as robotics, computational geometry to study structure and motion of molecules.

ECE527 Bioinformatics

This course is an algorithmic principles driving in bioinformatics. It emphasizes the relatively few design techniques used in diverse range of practical problems in biology such as DNA mapping, genome rearrangements, statistical methods for gene prediction and molecular evolution.

ECE 528 Probabilistic Graphical Models

This class covers both the theoretical underpinnings of the PGM framework and practical skills needed to apply these techniques to new problems. In particular this class will teach the basics of the Probabilistic Graphical Models (PGM) representation and how to construct them, using both human knowledge and machine learning techniques; algorithms for using a PGM to reach conclusions about the world from limited and noisy evidence, and for making good decisions under uncertainty. This class is based on a class offered at Stanford University.

ECE 529 Multimedia Systems

The course topics include multimedia systems, applications, and standards for video, image, audio, haptics, and other media. Specifically, multimedia networking, transport, and adaptation, (ii) multimedia compression, coding, and processing, (iii) multimedia synchronization, quality of service, and resource management are included. Furthermore, case studies in multimedia conferencing, gaming, and mobile multimedia are covered.

ECE531 Advanced Electromagnetics

Detailed discussion of electromagnetic theory and wave analysis in various media. It also includes the theory of transmission lines and basics of microwave circuits

ECE 532 Mobile Programming

Description: This course will introduce programming modern android apps for smartphones and tablets. A complete and useful app will be developed that uses programming tools that Android software developers use.

ECE536 Fiber Optic Communications

Overview of optical communication networks and building blocks of optical communication systems.

ECE537 Optoelectronic Devices and Lasers

Course covers the fundamental theory of semiconductor optoelectronic materials and lasers.

ECE538 Optical Waves and Optical Imaging

Course covers the wave theory in optics and its application to imaging and spectroscopy.

ECE541 Advanced Nano and Micro Electro Mechanical Systems

The objective of this course is to provide the design and operational principles of micro/nanoelectromechanical devices and systems (M/NEMS). The course will cover scaling laws, overview of micro and nanofabrication methods including top-down and bottom-up approaches, M/NEMS sensors and actuators, micro/nanofluidics, and applications of M/NEMS in electronics, photonics, sensing, and biomedical fields.

ECE542 Advanced MOSFET Theory

This course offers through understanding of MOSFET operation and physical limits of future technology.

ECE 555 Advanced Embedded System Design

This course will cover the design of advanced embedded systems on programmable logic devices. Students will learn how to build a complex system-on-chip around a processor. The features and capabilities of synthesizable soft processor system will be explored in the lectures along with general embedded system concepts, tools and techniques. The hands-on lab assignments provide students with experience designing, expanding, and modifying an embedded system, including adding and simulating vendor provided or custom designed peripherals. Students will also learn about hardware-software co-design, development and debugging using vendor provided tools.

ECE551 Design and Manufacturing in Electrical Engineering

This course teaches contemporary issues in circuit design, optical systems, microwave systems, communications and biotechnology.

ECE552 Energy and Energy Efficiency

This course introduces the methods and issues related to energy production, distribution and its efficient use.

Prerequisite: knowledge of at least one OO programming language. i.e. Java or C++.

Textbooks:

An Introduction to Object-Oriented Programming, by Timothy Budd, Addison-Wesley Pub. 3rd edition, 2002

Design Patterns, Elements of Reusable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides, Addison-Wesley Professional Computing Series, 1996.

ECE 561 Approximation Algorithms

This is a core theory course. We will discuss a wide array of fundamental topics that include Epsilon approximations, PTAS and FPTAS; techniques for the design of approximation algrorithms; P, NP, NP-complete problems, polynomial transformations, Turing reductions, strong NP-completeness, NP-hardness and inapproximability results; topics in algorithms include: amortized analysis, advanced graph algorithms and data structures.

ECE 562 Network Modeling

Prerequisites: No strict prerequisite. Some statistical and stochastic processes background may be useful. Necessary fundamentals will be reviewed in the class.

A course on network modeling and analysis of complex systems from natural ones such as biological networks, food webs etc. to man-made networks such as the Internet, communication networks, peer-to-peer networks, sensor networks, networks-on-a chip, power grid, etc. and social networks such as acquaintance networks, organizational networks, online communities etc. In this course the main topic is using the graph-theoretical approaches.

ECE 563 Combinatorial Algorithms

Many large-scale scientific discoveries are enabled by combinatorial algorithms. The course focuses on the recent trends on the boundary of combinatorial algorithms and scientific computing. Methods for solving sparse linear systems (direct and iterative), graph models for matrix factorizations, linear algebraic formulations of graph algorithms, graph/hypergraph partitioning, matching, and graph coloring for finite differences.

ECE 564 Computational Geometry

The purpose of this course is to present and discuss algorithms and lower bound techniques in computational geometry; decision tree models of computation; geometric searching; point location and range search; convex hull and maxima of a point set; proximity algorithms; geometric intersections.

ECE 565 Theory of Computation and Complexity

Advanced subjects in computation theory.

ECE 566 Object Oriented Design

Review OO concepts: classes, inheritance, delegation, polymorphism; use of UML in OO Design; Design patterns: i.) Creational Patterns: Abstract Factory, Builder,Factory Method, Prototype, Singleton; ii.) Structural Patterns: Adapter, Bridge, Composite, Decorator, Facade, Flyweight, Proxy; iii.) Behavioral Patterns: Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template Method, Visitor. Design patterns in enterprise and telecommunication software development.

ECE 567 Advanced Internet Services

Protocol standardization (IETF), regulation in telecommunications,   the economics of networks, network neutrality and the Open Internet, network-layer transition (Ipv6), delay- and disruption-tolerant networks   audio and video coding,   audio and video transmission (RTP),   quality of service   peer-to-peer networks , media on demand , Internet telephony architecture andprotocols (SIP, enum),   presence, instant messaging , location-based services , VoIP and network service creation

ECE 570 Software Engineering

In this course, students learn the principles of software engineering disciplines emphasizing requirements analysis, specification design, coding, testing and correctness proofs, maintenance, and management. Students use a number of software engineering tools.

ECE 571 Data Engineering

This course covers state-of-the-art and state-of-the-practice activities in the knowledge and data engineering area. We are interested in well-defined theoretical results and empirical studies that have potential impact on the acquisition, management, storage, and graceful degeneration of knowledge and data, as well as in provision of knowledge and data services. Specific topics include, but are not limited to: a) artificial intelligence techniques, including speech, voice, graphics, images, and documents; b) knowledge and data engineering tools and techniques; c) parallel and distributed processing; d) real-time distributed; e) system architectures, integration, and modeling; f) database design, modeling and management; g) query design and implementation languages; h) distributed database control; j) algorithms for data and knowledge management; k) performance evaluation of algorithms and systems; l) data communications aspects; m) system applications and experience; n) knowledge-based and expert systems.

ECE 572 Advanced Topics in Database Systems

In this course, we cover data models, semantics, data integrity, database design, serializability theory, concurrency control, recovery, distributed databases.

ECE 573 Advanced Topics in Distributed Systems

In this course, we cover the fundamental problems in distributed systems and the various tools used to solve them. Of primary interest is the issue of fault-tolerance. Topics include event ordering, clocks, global states, agreement, fault-tolerance, and peer-to-peer systems.

ECE 574 Advanced Topics in Computer Architecture

In this graduate course, students learn the advanced instruction set architectures, pipelining, dynamic scheduling, branch prediction, superscalar issue, out-of-order execution, memory-hierarchy design, advanced cache architectures and prefetching. As part of the class, several real designs are dissected and simulators are developed for performing quantitative evaluations of design decisions

ECE 575 Big Data Analysis
The course will discuss algorithms for analyzing very large amounts of data. The emphasis will be on Map/Reduce (M/R) as a tool for creating parallel algorithms that can process very large amounts of data. Newly emerging massive data analysis and processing tool stack including Spark, Shark, Storm, Tachyon, and MLBase will be used extensively to work with big data rapidly.

ECE 576 Scalable Internet Services

In this course, students learn about all the technologies that go into a scalable internet service, specifically into dynamic web sites. A very hands-on, learn-by-doing course with a significant project component. Building a transactional dynamic web site in Ruby on Rails and running on Amazon's Elastic Compute Cloud (EC2). Deployment on multiple servers on EC2 and using httperf to demonstrate that the site scales by running a front-end load balancer server, a database server, a memcached server, and up to 10 application servers.

ECE 577 Cloud Computing

Students gain practical knowledge in growing technology industry. Cloud computing refers to a network that distributes processing power, applications and large systems among many computers. The "Cloud Computing" course will provide students with current industry techniques and practices, outline future challenges and survey applications deployed by Amazon, Google and Microsoft. Through the exploration of these services, participants will build an understanding of cloud computing models, techniques and architectures, and its application by providers in delivering common business functions such as data storage, computing resources and messaging online.

ECE 578 Data Visualization
The increasing scale and accessibility of digital data – including government records, corporate databases, and logs of online activity – provides an under-exploited resource for improving governance, business, academic research, and our personal lives. For such data to prove broadly useful, people from a variety of backgrounds must be able make sense of it. Facilitating the analysis of large and diverse data sets is a fundamental challenge in both computer systems and human-computer interaction research, and requires the design of new tools for exploring, analyzing and communicating data.

This course will explore how a broad class of data analysts might more effectively work with data through novel interactive tools. The class will be interdisciplinary in nature, therefore we will touch on diverse topics such as data management (analytic databases, text analysis), user interface techniques (programming-by-demonstration, visualization), and human-centered issues (perceptual, cognitive and social factors).

ECE 580 Networks

Over the past decade there has been a growing public fascination with the complex "connectedness" of modern society. This connectedness is found in many incarnations: in the rapid growth of the Internet and the Web, in the ease with which global communication now takes place, and in the ability of news and information as well as epidemics and financial crises to spread around the world with surprising speed and intensity. These are phenomena that involve networks, incentives, and the aggregate behavior of groups of people; they are based on the links that connect us and the ways in which each of our decisions can have subtle consequences for the outcomes of everyone else.

This course combines different scientific perspectives in its approach to understanding networks and behavior. Drawing on ideas from economics, sociology, computing and information science, and applied mathematics, it describes the emerging field of study that is growing at the interface of all these areas, addressing fundamental questions about how the social, economic, and technological worlds are connected.

ECE 581 Network Security

In this course, we study the theoretical and practical aspects of network security. We start with a threat model, and describe vulnerabilities of computer networks to attacks by adversaries and hackers using a variety of techniques. We then study methods and techniques to circumvent or defend against these attacks and to minimize their damage. In this context, we study cryptographic techniques and protocols, network security protocols, digital signatures and authentication protocols, network security practice, and wireless network security.

Security attacks, mechanisms, and services; network security and access security models; overview of secret-key and public-key cryptography; authentication protocols and key management; network security practice; email security; IP security and web security; intrusion detection and prevention systems; firewalls and virtual private networks; wireless network security.

ECE 582 Data Science for Business
Data Science for Business introduces the fundamental principles of data science, and walks you through the "data-analytic thinking" necessary for extracting useful knowledge and business value from the data you collect. The class provides examples of real-world business problems to illustrate these principles. You'll not only learn how to improve communication between business stakeholders and data scientists, but also how to participate intelligently in your company's data science projects. You'll also discover how to think data-analytically, and fully appreciate how data science methods can support business decision-making.

ECE 583 Cryptography and Coding

The first part of the course concentrates on methods, algorithms, techniques, and tools of cryptography. We study in detail algorithmic and mathematical aspects of cryptographic methods and protocols, such as secret-key cryptography, public-key cryptography, hash functions, and digital signatures. We also show how these techniques are used to solve particular data and communication security problems. The second part of the course deals with subjects related to algebraic codes, their constructions, mathematical properties, and encoding and decoding algorithms.

ECE 584 Advanced Cryptography and Coding

This graduate course is designed for computer science, mathematics, electrical engineering students interested in understanding, designing, developing, testing, and validating cryptographic software and hardware. We will study algorithms, methods, and techniques in order to create state-of-art cryptographic embedded software and hardware using common platforms and technologies.

ECE 585 Cognitive Computing

This graduate course studies the possibilities for collaboration between humans and machines such that the cultivated intelligence is something that cannot be produced by either machines or human beings alone. Specific topics to discuss include neural networks and its applications, deep learning and its horizons, using state-of-the-art analytics platforms, e.g., IBM Watson Analytics.

ECE 586 Computational Genomics

This course covers the molecular basis of inherited disease. We will discuss both simple Mendelian diseases and complex, multifactorial diseases in which both genetics and environmental factors are involved. We will discuss genomics, functional genomics, epigenetics, gene expression, SNPs, copy number and other structural genomic variations involved in disease. In addition to these diagnostic approaches, we will discuss novel therapeutic methods such as stem cell therapy, gene therapy and drug developments that depend on the knowledge of genomics. We will discuss personal genomics, pharmacogenomics and clinical genomics and their role in the future of preventive medicine.

ECE 588 Agile Methods

The course aims to make students familiar with the agile methods, fundamental principles and practices associated with each agile method. Several agile methods will be described, but the emphasis is on Scrum and XP.

ECE 590 Advanced Topics in Electrical Engineering

Advanced subjects and problems in electrical and computer engineering will be studied.

ECE 589 Natural Language Processing

This course introduces the theory and methods of natural language processing (NLP). NLP systems understand and produce human language for applications such as information extraction, machine translation, automatic summarization, question-answering, and interactive dialog systems. The course covers knowledge-based and statistical approaches to language processing for syntax, semantics, and pragmatics/discourse. This course presents an opportunity for students to gain experience with models and algorithms used in computational linguistics that underlie practical applications while gaining an appreciation for the theoretical questions of the field.

ISE 534 Data Mining

Definitions, introduction, examples, and the process data preparation and reduction, brief review of regression, decision trees, neural networks, k-nearest neighbor, cluster analysis, association rule mining, Principal components, pruning, boosting, bagging, cross-validation, bootstrapping.

Textbook: *Introduction to Data Mining: Tan, Steinbach, and Kumar; Addison Wesley, 2006.*

ECE 592 (ECE 592A Independent Study I)

ECE 593 (ECE 592B - Independent study II)

ECE 596 Advanced Topics in Computer Engineering

This course covers advanced research and development topics related to computer engineering and computer science. The specific course topic might vary depending on the area of research of the instructor teaching the course. This course is intended to be a placeholder course for impromptu course offerings by visiting professors, adjunct faculty, faculty on sabbatical, and others.

ECE 597 Software Processes

This course provides a study of the process of developing software systems

Using Software processes in software development,

traditional software processes, Agile processes, Requirements engineering, refactoring, testing, techniques used to ensure quality of the software products

ECE 595 Graduate Project

ECE 599 Master Thesis