03/27/2025

Electrical and Computer Engineering Fall 2025 Course Offerings

Please note this list does not include EK courses please refer to the MyBU Student schedule for Fall 2025 to see what EK courses are being offered. For information on prerequisites please refer to the ECE course bulletin.

Graduate Level Courses:

ENG EC 500 A1 Medical Image Analysis Using AI Tools **Prof Batmanghelich**
Monday/Wednesday 12:20 – 2:05pm
This course introduces the foundation for understanding, manipulating, and analyzing medical images. The topics include introducing AI concepts and tools to students, understanding and manipulating various types of medical data, data harmonization, biomedical image registration, segmentation, and disease localization. We will discuss how to develop resilient algorithms for various confounders common in the medical imaging domain, jointly analyze medical image data with other data modalities, and create an explainable AI method specifically for medical imaging applications.

ENG EC 500 A2 AI methods in optics and photonics **Prof Wang**
Monday/Wednesday 2:30 – 4:15pm
This course provides tutorial on applying artificial intelligence (AI) methods to photonics research. Topics include a practical guide to artificial neural networks and their training methods; basics of supervised, unsupervised, and reinforcement learning methods, and their application scenarios; inverse design using adjoint method in nanophotonics; end-to-end hardware-in-the-loop optimization; physics-aware training; photonic computing systems; physics-informed neural networks for differential equations, and other advanced topics at the intersection of AI and photonics.

ENG EC 500 A3 Foundations of Probabilistic Machine Learning **Prof Venkataraman**
Monday/Wednesday 2:30 – 4:15pm
This course covers the fundamentals of detection, estimation, and inference as it applies to probabilistic machine learning. Selected topics include probability spaces, random variables, derived distributions, decision theory, parameter estimation, graphical models, EM algorithm, approximate inference techniques, Markov models, random sequences, Dirichlet processes, and basic neural networks.

ENG EC 501 A1 Dynamic System Theory **Prof Baillieul**
Tuesday/Thursday 9:00 – 10:45am
Introduction to analytical concepts and examples of dynamic systems and control. Mathematical description and state space formation of dynamic systems; modeling, controllability, and observability. Eigenvector and transform analysis of linear systems including canonical forms. Performance specifications. State feedback: pole placement and the linear quadratic regulator. Introduction to MIMO design and system identification using computer tools and laboratory experiments. Same as ENG ME 501 and ENG SE 501. Students may not receive credit for both.

ENG EC 503 A1 Introduction to Learning from Data **Prof Saligrama**
Tuesday/Thursday 1:30 – 3:15pm
This is an introductory course in statistical learning covering the basic theory, algorithms, and applications. This course will focus on the following major classes of supervised and unsupervised learning problems: classification, regression, density estimation, clustering, and dimensionality reduction. Generative and discriminative data models and associated learning algorithms of parametric and non-parametric varieties will be studied within both frequentist and Bayesian settings in a unified way. A variety of contemporary applications will be explored through homework assignments and a project.

ENG EC 504 A1 Advanced Data Structures **Prof Brower**
Tuesday/Thursday 11:00 – 12:45pm
Review of basic data structures and Java syntax. Data abstraction and object-oriented design in the context of high-level languages and databases. Design implementation from the perspective of data structure efficiency and distributed control. Tailoring priority queues, balanced search trees, and graph algorithms to real-world problems, such as network routing, database management, and transaction processing.

ENG EC 516 A1 Digital Signal Processing **Prof Nawab**
Monday/Wednesday 10:10 – 11:55am
Advanced structures and techniques for digital signal processing and their properties in relation to application requirements such as real-time, low-bandwidth, and low-power operation. Optimal FIR filter design; time-dependent Fourier transform and filterbanks; Hilbert transform relations; cepstral analysis and deconvolution; parametric signal modeling; multidimensional signal processing; multirate signal processing.

ENG EC 521 A1 Cybersecurity **Prof Egele**
Tuesday/Thursday 9:00 – 10:45am
Fundamentals of security related to computers and computer networks. Laws and ethics. Social engineering and psychology-based attacks. Information gathering, network mapping, service enumeration, and vulnerability scanning. Operating system security related to access control, exploits, and disk forensics. Shellcoding. Wired and wireless network security at the physical, network, and application layers. Theoretical lessons are augmented with case studies and demonstrative experimental labs.

ENG EC 522 A1 Computational Optical Imaging **Prof Tian**
Tuesday/Thursday 1:30 – 3:15pm
Recent years have seen the growth of computational optical imaging - optical imaging systems that tightly integrate hardware and computation. The results are the emergence of many new imaging capabilities, such as 3D, super resolution, and extended depth of field. Computational optical imaging systems have a wide range of applications in consumer photography, scientific and biomedical imaging, microscopy, defense, security and remote sensing. This course looks at this new design approach as it is applied to modern optical imaging, with a focus on the tools and techniques at the convergence of physical optical modeling, and signal processing.

ENG EC 523 A1 Deep Learning **Prof Kulis**
Monday/Wednesday 2:30 – 4:15pm
Feed-forward networks. Backpropagation. Training strategies for deep networks. Convolutional networks. Recurrent neural networks. Transformers. Diffusion Models. Deep unsupervised learning. Exposure to Pytorch and other modern programming tools. Other recent topics, time permitting. Same as CAS CS 523. Students may not receive credit for both.

ENG EC 524 A1 Optimization Theory and Methods **Prof Castanon**
Tuesday/Thursday 3:30 – 5:15pm
Introduction to optimization problems and algorithms emphasizing problem formulation, basic methodologies, and underlying mathematical structures. Classical optimization theory as well as recent advances in the field. Topics include modeling issues and formulations, simplex method, duality theory, sensitivity analysis, large-scale optimization, integer programming, interior-point methods, non-linear programming optimality conditions, gradient methods, and conjugate direction methods. Applications are considered; case studies included. Extensive paradigms from production planning and scheduling in manufacturing systems. Other illustrative applications include fleet management, air traffic flow management, optimal routing in communication networks, and optimal portfolio selection. Same as ENG EC 674, ENG SE 524, ENG SE 674. Students may not receive credit for both.

ENG EC 528 A1 Cloud Computing **Prof Turk**
Monday/Wednesday 6:30 – 8:15pm
Fundamentals of cloud computing covering IaaS platforms, OpenStack, key Big Data platforms, and data center scale systems. Examines influential publications in cloud computing. Culminates in a group project supervised by a mentor from industry or academia. Same as CAS CS 528. Students may not receive credits for both.

ENG EC 533 A1 Advanced Discrete Mathematics **Prof Levitin**
Monday/Wednesday 2:30 – 4:15pm
Selected topics in discrete mathematics. Formal systems. Mathematical deduction. Logical concepts. Theorem proving. Sets, relations on sets, operations on sets. Functions, graphs, mathematical structures, morphisms, algebraic structures, semigroups, quotient groups, finite-state machines, their homomorphism, and simulation. Machines as recognizers, regular sets. Kleene theorem.

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ENG EC 535 A1 Introduction to Embedded Systems **Prof Coskun**

Monday/Wednesday 10:10 – 11:55am

The growing popularity of modern embedded systems calls for a new generation of electrical and computer engineers who can easily cross the boundary between hardware and software. The course is designed to train such engineers by introducing students to an integrated view of software and hardware in designing embedded computer systems. The lectures will survey a broad array of subjects including system specification languages, embedded processors, memory architecture, communication architecture, real-time operating systems, scheduling, energy efficiency in hardware and software, hardware-software co-design techniques, debugging and verification techniques, and embedded systems security. The concepts will be reinforced with homework and project assignments that involve system design, modeling, and validation. The assignments will involve C/Linux programming, ARM/Linux-based evaluation boards, and optionally other microprocessor or FPGA-based boards.

ENG EC 555 A1 Introduction to Biomedical Optics **Prof Roblyer**

Monday/Wednesday 2:30 – 4:15pm

This course surveys the applications of optical science and engineering to a variety of biomedical problems, with emphasis on optical and photonics technologies that enable real, minimally-invasive clinical and laboratory applications. The course teaches only those aspects of the biology itself that are necessary to understand the purpose of the applications. The first weeks introduce the optical properties of tissue, and following lectures cover a range of topics in three general areas: 1) Optical spectroscopy applied to diagnosis of cancer and other tissue diseases; 2) Photon migration and diffuse optical imagine of subsurface structures in tissue; and 3) laser-tissue interactions and other applications of light for therapeutic purposes. Some classes will invoke traditional lectures, and others will be "inverted," devoted to discussing and understanding application problems, with students having read textbook sections or online material prior to class. Same as ENG BE 555. Students may not receive credit for both.

ENG EC 556 A1 Optical Spectroscopic Imaging **Prof Cheng**

Tuesday/Thursday 3:30 – 5:15pm

This introductory graduate-level course aims to teach students how electromagnetic waves and various forms of molecular spectroscopy can be used to study a complex biological system by pushing the physical limits on engineering system design.The course will cover fundamental concepts of optical spectroscopy and microscopy, followed by specific topics covering fluorescence-based , absorption-based, and scattering-based spectroscopic imaging. In addition, this course will provide in-depth discussions of linear and nonlinear spectroscopic imaging in the aspects of theory, instrumentation, image data analysis and enabling applications. Students will learn how to give a concise and informative presentation of a recent literature to the class. Students will be able to challenge their creativity in designing advanced imaging instrument of data analysis methods as part of their course assignments. The students will learn how to write and present a convincing proposal for the required final project to be designed by interdisciplinary teams formed among the students. Same as ENG BE 556. Students may not receive credit for both.

ENG EC 562 A1 Fourier Optics in Engineering **Prof Dal Negro**

Monday/Wednesday 4:30 – 6:15pm

The goal of this course is to present a coherent formulation of wave propagation, radiation and diffraction phenomena in arbitrary linear systems for the engineering design of optical devices in strong partnership with computer simulations and engineering-led design projects. The course will introduce students to the fundamental techniques that are necessary for the quantitative analysis of optics- based engineering systems and devices.

ENG EC 572 A1 Computational Methods in Material Science **Prof Chapman**

Tuesday/Thursday 3:30 – 5:15pm

Introduction to computational materials science. Multi-scale simulation methods; electronic structure, atomistic, micro-structure, continuum, and mathematical analysis methods; rate processes and rare events. Materials defect theory; modeling of crystal defects, solid micro-structures, fluids, polymers, and bio-polymers. Materials scaling theory: phase transition, dimensionality, and localization. Perspectives on predictive materials design. Topics covered include tight binding theory, density functional theory, and many-body perturbation theory. Lectures provide the theoretical framework for computation. Same as CAS CH 455, GRS CH 572, ENG MS 508. Students may not receive credit for both.

ENG EC 574 A1 **Physics of Semiconductor Materials** **Prof Bellotti**
Tuesday/Thursday 1:30 – 3:15pm
This course teaches the relevant notions of quantum mechanics and solid state physics necessary to understand the operation and the design of modern semiconductor devices. Specifically, this course focuses on the engineering aspects of solid state physics that are important to study the electrical and optical properties of semiconductor materials and devices. Particular emphasis is placed on the analysis of the electronic structure of semiconductor bulk systems and low-dimensional structures, the study of the carrier transport properties and the calculation of the optical response that are relevant to the design and optimization of electronics and photonics semiconductor devices. The students will learn to apply the quantum mechanical formalism to the solution of basic engineering device problems (quantum wells, wires, and dots, 2D electron gas) and to perform numerical calculation on more complex systems (band structure calculation of bulk and low dimensional systems). Same as ENG MS 574. Students may not receive credits for both.

ENG EC 577 A1 **Electronic Optical and Magnetic Properties of Materials** **Prof Swan**
Monday/Wednesday 12:20 – 2:05pm
This course provides an in-depth analysis of solid-state physics as it pertains to materials science and electrical engineering applications. Students will develop an understanding of the theory of crystal structures and their determination via diffraction, as well as the thermal, electrical, and optical properties of materials that arise from these structures. Same as ENG MS 577. Students may not receive credit for both.

ENG EC 580 A1 **Analog VLSI Circuit Design** **Prof Yazicigil**
Monday/Wednesday 4:30 – 6:15pm
Anatomy of an operational amplifier using chip design techniques. Applications of op amps in wave-shaping circuits, active filters including capacitive switching. Analog multiplexing and data acquisition circuits, A/D, D/A, S/H are examined. Frequency selective circuits and interface circuits such as optocouplers are analyzed.

ENG EC 591 A1 **Photonics Lab 1** **Prof Paiella**
Tuesday 9:00 – 10:45am
Introduction to optical measurements. Laser safety issues. Laboratory experiments: introduction to lasers and optical alignment; interference; diffraction and Fourier optics; polarization components; fiber optics; optical communications; beam optics; longitudinal laser modes. Optical simulation software tools.

ENG EC 601 A1 & A2 **Product Design in Electrical and Computer Engineering** **Prof Alshaykh**
Monday/Wednesday 4:30 – 6:15pm
Monday/Wednesday 12:20 – 2:05pm
Engineers influence their community, society and the world. Engineers build products and services that can enhance people's lives. The product starts with an idea and is delivered through research (technical and societal), design, implementation, testing and support. During this class, students will experience all of this. The course provides design and practical insights into building products that involve WEB and mobile app development, data simulation, analysis and modeling, cloud computing, signal processing and/or computer vision. In the class, we work on how to take an idea and concept and translate it into product requirements. Afterwards, we translate the product requirements into system and engineering requirements. We also discuss solution selection techniques. We then work on implementing our ideas into systems and verify that they address the product requirements and fulfill the concept we started with. During the class, we go over how to choose solutions to build our products. We also discuss real product realization, implementations and tradeoffs. The class is taught via an example product and the class sessions are interactive. Students are divided into groups where they work in parallel on their projects during class sessions and hackathons. Teams define their target audience, product mission, requirements and features. The class adopts agile software development based on a two-week sprint. Students present their sprint results to the class.

ENG EC 605 A1 **Computer Engineering Fundamentals** **Prof Moreshet**
Monday/Wednesday 10:10 – 11:55am
This is an introductory course to computer engineering, focusing on the hardware/software interface, and presenting a bottom-up view of a computer system. Topics include logic design: binary arithmetic, combinational and sequential logic. Computer organization: assembly language programming, CPU design, and memory systems. Introduction to compilers, operating systems, and computer networks. Open to graduate students only.

ENG EC 674 A1 Optimization Theory and Methods (PhD Students Only) Prof Castanon
Tuesday/Thursday 3:30 – 5:15pm
Introduction to optimization problems and algorithms emphasizing problem formulation, basic methodologies, and underlying mathematical structures. Classical optimization theory as well as recent advances in the field. Topics include modeling issues and formulations, simplex method, duality theory, sensitivity analysis, large-scale optimization, integer programming, interior-point methods, non-linear programming optimality conditions, gradient methods, and conjugate direction methods. Applications are considered; case studies included. Extensive paradigms from production planning and scheduling in manufacturing systems. Other illustrative applications include fleet management, air traffic flow management, optimal routing in communication networks, and optimal portfolio selection. Same as ENG EC 674, ENG SE 524, ENG SE 674. Students may not receive credit for both. 4cr

ENG EC 720 A1 Digital Video Processing Prof Konrad
Tuesday/Thursday 3:30 – 5:15pm
Review of sampling/filtering in multiple dimensions, human visual system, fundamentals of information theory. Motion analysis: detection, estimation, segmentation, tracking. Image sequence segmentation. Spectral analysis of image sequences. Video enhancement: noise reduction, super-resolution. Video compression: transformation, quantization, entropy coding, error resilience. Video compression standards (H.26X and MPEG families). Future trends in image sequence compression and analysis. Homework and project will require MATLAB programming.

ENG EC 721 A1 Advances in Cyber and IoT Security Prof Trachtenberg
Monday/Wednesday 12:20 – 2:05pm
This course covers new developments in cybersecurity, with an emphasis on networking and communications aspects and the Internet of Things (IoT). Selected topics may include threat modeling, game theory for cybersecurity, blockchains, side-channel analysis, network infrastructure security, and security for connected vehicles. The course blends theory and practice and culminates with a research project, building on recent results from the literature.

ENG EC 762 A1 Quantum Optics Prof Sergienko
Monday/Wednesday 10:10 – 11:55am
Review of the postulates of quantum mechanics. Quantization of the electromagnetic field. Coherent, thermal, squeezed, and entangled states, and their associated photon statistics. Interaction of light with matter. Spontaneous and stimulated transitions. Theory of optical detection. Quantum theory of the laser. Interaction of light with two-level atoms, including photon echo and self-induced transparency. Quantum theory of parametric interactions.