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Graduate Course Descriptions in Engineering Education #### Introduction to Engineering Education (ESE 500) This non-regular graduate course provides an in-depth analysis of engineering knowledge and practices within secondary science content and instruction. It focuses on applying design principles from biology, chemistry, and physics disciplines. Key concepts include design-based approaches, optimization, STEM integration, assessment, and transferring science principles to technology solutions. #### System Specification and Modeling (ESE 501) This comprehensive introduction covers the field of System-on-Chip design, including digital system modeling and simulation methodologies. It delves into hardware description languages such as Verilog, VHDL, and System C, as well as top-down and bottom-up design methodology, specification language syntax and semantics, and RTL. #### Linear Systems (ESE 502) This core course develops transfer matrices and state-space equations based on linearity, time-invariance, causality, and lumpedness. It covers op-amp circuit implementations, solutions, equivalent state equations, stability and Lyapunov equations, controllability, observability, and applications in minimal realization, state feedback, and state estimators. #### Stochastic Systems (ESE 503) This core course introduces basic probability concepts and their applications, including probabilistic bounds, characteristic functions, multivariate distributions, stochastic processes, stationarity, ergodicity, correlation functions, spectral densities, and transmission properties. It also covers optimum linear filtering, estimation, and prediction. #### Performance Evaluation of Communication and Computer Systems (ESE 504) This course focuses on advanced queueing models and algorithms for communication and computer systems, including mean value analysis, convolution algorithm, transient analysis, M/G/1 queue, buffer sizing calculations, bursty and self-similar traffic. Prerequisite: ESE 503 or instructor permission. #### Wireless Communications (ESE 505) This course covers first-year graduate-level material in wireless communications, including wireless channels, digital communications, signal processing, voice and data applications, design basics for wireless modems, analysis of system issues like resource management and handoff, cellular and wireless LAN systems. #### Wireless Network (ESE 506) This course examines the unique network protocol challenges and opportunities presented by wireless and mobile computing. Given text: paraphrase this text here The course catalog for engineering systems presents a range of courses focused on emerging technologies like quantum computing, photovoltaics, and advanced electronics. Students can expect a comprehensive introduction to quantum principles, including encryption, algorithms, and technology. ESE513 introduces students to the basics of photovoltaic solar energy conversion, discussing the operating principles, theoretical limits, device fabrication, and primary challenges of major photovoltaic technologies. ESE514 covers MOS transistor modeling, providing an overview of the metal-oxide semiconductor transistor and its models for circuit analysis. The course is modular in structure, allowing students to focus on their preferred subtopic: device physics, digital circuits, or analog circuits. ESE515 explores the physics of microwave and optical lasers, including laser concepts, quantum theory, classical radiation theory, and resonance phenomena. ESE516 and 517 delve into integrated electronic devices and circuits, covering topics such as semiconductor electronics, methods of fabrication, bipolar junction transistors, FETs, MOS transistors, diodes, capacitors, and resistors. Design techniques for linear digital integrated electronic components and circuits are also discussed, including computer-aided design. ESE518 focuses on advanced design of low-noise and low-power analog circuit, providing fundamental knowledge on low-noise electronics for sensors with particular attention to radiation detectors. Students learn about signal and noise sources in electronic circuits, low-noise charge amplification, optimal and sub-optimal filters, frequency-domain and time-domain noise analysis, signal discrimination, amplitude and timing measurement circuits, analog and digital signal processing. These courses offer students a solid foundation in emerging technologies, preparing them for careers in research and development. The acquired knowledge is applicable to various fields, including engineering, physics, and computer science. Commercial instrumentation encompasses a wide range of applications including defense, industrial, medical, physics, safety, security, and space fields. Electrical Engineering Courses: A Comprehensive Overview This semester's course offerings in electrical engineering are diverse and exciting. Students can explore various topics, from sensing technologies to communication systems. ESE 525: Modern Sensors in AI Applications ---------- This course delves into the physics principles, design, and practical applications of sensors and transducers, including piezoelectric, acoustic, inertial, pressure, position, flow, capacitive, magnetic, optical, radiation, chemical, and bioelectric sensors. Students will learn about interfacing various sensors with electronics and implementing intelligence at the sensor level. ESE 526: Silicon Technology for VLSI ---------- This course introduces students to the fundamental technologies used in fabricating advanced integrated circuits, including epitaxy, diffusion, oxidation, chemical vapor deposition, ion implantation lithography, and etching. The significance of these steps on device performance is discussed, along with electrical and geometric design rules. ESE 528: Communication Systems – CORE COURSE ---------- This core course provides an overview of communication theory and fundamental concepts in the field. Topics include signals and systems representations, continuous and digital modulation schemes, spread spectrum systems, and advanced communication systems. General concepts of wide and local area networks are also introduced. ESE 530: Computer-Aided Design ---------- Students learn techniques for analyzing linear and nonlinear dynamic electronic circuits using computers. Topics covered include network graph theory, generalized tableau, hybrid analysis, companion modeling, numerical integration, sensitivity analysis, and optimization. ESE 531: Statistical Learning and Inference ---------- This course covers minimum variance unbiased estimation, Cramer-Rao lower bounds, learning and inference with linear models, maximum likelihood estimation, least squares estimation, Bayesian inference, statistical decision theory, hypothesis testing with deterministic and random signals, composite hypothesis testing, and model selection. ESE 532: Theory of Digital Communication ---------- Optimum receivers, efficient signaling, channel capacity theorem, bounds on optimum system performance, encoding for error reduction, fading channels, source coding, and some coding algorithms are discussed in this course. ESE 533: Convex Optimization and Engineering Applications ---------- Students learn about convex optimization and its applications, including convex sets, functions, and basics of convex analysis. Topics covered include linear and quadratic programs, second-order cone programming, semidefinite programming, geometric programming, duality theory, optimality conditions, unconstrained minimization methods, interior-point methods, non-differentiable problems, and decomposition methods. Note: Prerequisites for each course are mentioned in the original text. Given article text here Looking for engineering courses in cyber-physical systems, parallel distributed systems, mobile sensing, nanoelectronics, reliability theory, digital system design and more. Three credits, Spring, ESE 534 focuses on cyber physical systems including medical devices healthcare smart transportation systems smart buildings. Several principles are covered such as formal modeling embedded systems real time systems feedback control sensor networks. Prerequisite needed for background in embedded systems and computer networking. In Fall, ESE 536/CSE 626 Switching and Routing covers parallel distributed systems message switching design of interconnection networks permutation multicast routing performance modeling. Required pre-requisites include ESE 503 or CSE 502. ESE 537 Mobile Sensing Systems & Applications focuses on recent advances in mobile sensing especially those leveraging modern devices embedded sensors. Topics include sensor networks participatory sensing intelligent hardware Internet-of-Things location sensing information centric networking applications in smart homes buildings transportation environment health fitness. ESE 538 Nanoelectronics aims to provide graduate students with knowledge on physical background and applications of nanoelectronics. Topics covered include electrical optical properties of materials nanostructures fabrication of nanostructures nanoelectronic devices resonant-tunneling devices transistors single-electron transfer devices. Given course descriptions: ESE 542/MEC 525 Product Design Concept Development and Optimization focuses on the product development cycle, from creative solution development to preliminary concept evaluation and selection. The course covers methods for mathematical modeling, computer simulation, and optimization, including intellectual property and patent issues. ESE 543 Mobile Cloud Computing introduces the basic concepts of mobile cloud computing, covering technology used in smartphones and existing data centers. Students gain knowledge on fundamental principles, major technologies, challenges, and research areas within the field. ESE 544 Network Security Engineering emphasizes building security into hardware and software, covering encryption, public key cryptography, authentication, intrusion detection, digital rights management, firewalls, trusted computing, and encrypted computing. ESE 545 Computer Architecture – CORE COURSE covers uniprocessor and pipelined vector processors. The course involves a system design project using VHDL. ESE 546 Networking Algorithms and Analysis introduces algorithms and analysis for computer and telecommunication networks, covering continuous time and discrete time single Advanced courses in electrical engineering and computer science include: algorithms for public key cryptography, digital signal processing, computer networks, advanced VLSI system testing, network management and planning, and electronics and radiation effects. Topics cover analysis, routing, protocol verification, multiple access, error correction, data compression, search, and more. Prerequisites vary by course. ESE 545 Equivalent Coursework Fall, 3 Credits, Grading ACF ESE 553 Integrated Data Converters - Continuous & Discrete-Time Signals, Sampling Theorem, Ideal Converters, Testing Specifications Prerequisite: ESE 545 or Equivalent ESE 554 Computational Models For Computer Engineers Core Course Fall, 3 Credits, Grading ACF Set Theory, Relations, Functions, Graph Algorithms, Complexity, Lattices Prerequisite: BS Electrical Engineering Or Computer Science ESE 555 VLSI Circuit Design Advanced Spring, 3 Credits, Grading ACF MOS Transistor Theory, CMOS Processing Technology Prerequisite: BS In Electrical Engineering Or Computer Science ESE 556 Physical and Logic Design Automation Tools Develop State-Of-The-Art CAD Spring, 3 Credits, Grading ACF Floor Planning Module Placement Signal Routing Optimization Electromagnetic Interference Issues in Power Electronics Converters ========== This course covers basic concepts of electromagnetic interference (EMI) measurement, modeling, and mitigation, focusing on conducted EMI in power electronics converters. The curriculum is divided into lectures and a lab session, catering to both senior undergraduate and graduate students. The ESE 561 Theory of Artificial Intelligence course focuses on problem-solving techniques using search methods, game trees, constraint satisfaction problems, uncertain knowledge, and reasoning. It also covers probabilistic reasoning, Markov decision processes, reinforcement learning, and partially observable Markov decision processes. Another fall course, ESE 562 AI Driven Smart Grids, explores the application of artificial intelligence to power system analysis, planning, and operation. Topics include basics of AI and smart grids, predictive analytics, data preprocessing, and advanced analytics for static and dynamical modeling. For spring, the ESE 563 Fundamentals of Robotics course covers homogenous transformations, kinematic and dynamic equations, control, and programming of robots. It requires permission from the instructor due to its technical nature. The ESE 564 Artificial Intelligence for Robotics course introduces students to basic techniques in AI, including probabilistic inference, planning and search, localization, tracking, and control. This course also demands prior knowledge in probability and random processes, linear algebra, feedback control, and programming experience. Lastly, the ESE 565 Parallel Processing Architectures course provides a comprehensive introduction to parallel processing, covering topics such as types of parallelism, classification of parallel computers, functional organizations, memory organizations, and performance enhancement techniques. Embedded Systems Course Descriptions Deep learning is driving AI advancements in tasks like Siri's speech recognition and self-driving cars. Topics covered include neural networks, convolutional and recurrent structures, unsupervised and reinforcement learning, with applications to problem domains such as speech recognition and computer vision. Classes will combine lectures, hands-on problem-solving, and group project work. Fall semester, 3 credits, grading ABCF. ESE 579 Advanced Topics in Translational Bioinformatics introduces machine learning and data mining techniques in biomedical data science, discusses current translational research areas and progresses, and provides team projects for graduate students to design and practice data-driven solutions for cutting-edge biomedical research topics. Fall semester, 3 credits, grading ABCF. ESE 580, 581 Microprocessor-Based Systems I and II focus on engineering methodologies and techniques for designing reliable microprocessor-based systems with diagnostic features. The course covers steps in the design cycle, including requirement definitions, implementation, testing, debugging, documentation, and maintenance. Laboratory experience is included in this course. Fall and Spring semesters, 4 credits each semester, grading ABCF. ESE 585 Nanoscale Integrated Circuit Design describes high-performance and low-power IC design issues for advanced nanoscale technologies. The course emphasizes the shift from logic-centric to interconnect-centric design and covers four phases of an interconnect-centric design flow. Prerequisites include ESE 555 or ESE 330, and ESE 355. Spring semester, 3 credits, grading ABCF. ESE 586 Microgrids explores advanced modeling, control, resilience, and security technologies for microgrid design, analysis, and operation from a unique angle. Topics include smart inverters, microgrid architectures, distributed energy resources modeling, hierarchical control, stability, fault management, resilient microgrids through programmable networks, reliable networked microgrids, and cyber security. ESE 587 Hardware Architectures for Deep Learning focuses on the design of specialized hardware architectures for deep learning applications. The course covers topics such as neural processing units (NPUs), graphics processing unit (GPU) accelerators, field-programmable gate array (FPGA) based systems, and tensor processing units (TPUs). Prerequisites include ESE 579 or equivalent. The course curriculum centers around crafting specialized digital hardware systems for executing deep learning algorithms. It's split into three parts: first, students delve into field-programmable gate arrays (FPGAs) and the tools associated with them; second, an overview of modern deep learning methods and their applications are presented (such as object recognition or speech identification); third, students put this knowledge to use by completing a significant project that involves implementing and optimizing a deep learning algorithm on an FPGA. ESE 588 Fundamentals of Machine Learning provides the foundational understanding of machine learning concepts including parametric models, online learning, classification techniques like logistic regression and nearest neighbor rule, as well as neural networks and their applications in deep learning. Prerequisites include stochastic processes and data structures. ESE 589 is about applying these methods for engineering purposes through representation models, pattern extraction, and classification techniques suitable for various fields such as IoT, electronic design automation, and healthcare. Students will learn to devise software for discussed topics as part of a project that's assessed based on standard benchmarks. Meanwhile, ESE 590 focuses on practical use of machine learning with an emphasis on state-of-the-art methods through lectures and labs where students work in teams to develop specific AI applications using modern tools. Lastly, the course ESE 591 requires students to carry out an industrial design project in Optoelectromechanical Systems engineering, presenting it both technically and orally. Computation and control techniques, including consensus, distributed averaging, and optimization, as well as formation control and rendezvous problems, are discussed in this course. Additionally, recent advancements in distributed machine learning over networks are explored. Pre-requisites include linear algebra and applied calculus, with 3 credits awarded upon completion. Grading is ABCF. The ESE 597 Practicum in Engineering course provides part-time and full-time students with the opportunity to participate in Curricular Practical Training (CPT) through private corporations, public agencies, or non-profit institutions. Students must have a faculty coordinator and an outside organization contact for regular consultations and final report submission. Prior approval from the Graduate Program Director is required for registration. The ESE 599 Research course is designed for Master's program students, offering variable and repetitive credit with S/U grading. In the ESE 610 Seminar in Solid-State Electronics, current research topics in solid-state devices, circuits, and computer-aided network design are explored. This course offers 3 credits with ABCF grading. The ESE 670 Topics in Electrical Sciences course provides students with flexibility to learn new material before it becomes part of the regular curriculum. Topics include biomedical engineering, circuit theory, controls, electronics circuits, digital systems, and more. The course offers variable and repetitive credit with no specific grading. The ESE 691 Seminar in Electrical Engineering course exposes students to a broad range of current electrical engineering topics through on- and off-campus speakers. This seminar is offered for 1 credit with S/U grading. Lastly, the PHY 693 High Power RF Engineering course provides an essential review of low and medium power RF properties and components, as well as high power RF limitations and effects. The course discusses methods for mitigating or avoiding these issues and involves a project component. Prerequisites include a basic microwave course, with 3 credits awarded upon completion and ABCF grading. Graduate students in Electrical and Computer Engineering (ECE) at Stony Brook University are required to complete a teaching-related course as part of their degree requirements. The courses include ESE 697 Practicum in Teaching, where students gain experience in teaching and interacting with students enrolled in electrical and computer engineering courses. Students enrolled in ESE 698 Practicum in Teaching Non-Regular Course must perform various teaching duties, such as attending lectures, providing office hours, holding review/recitation sessions, assisting in lab sections, and grading. The course is offered in Fall, Spring, and Summer semesters with variable and repetitive credits. ESE 699 Dissertation (Research On Campus) is a non-regular course that students should register for if the major portion of their research will take place on Stony Brook University campus or at Cold Spring Harbor. This course has variable and repetitive credit with an "S" or "U" grading scale. ESE 700 Dissertation Research (Off Campus – Domestic) is another non-regular course where students can register if their research takes place off-campus in the United States and/or U.S. provinces. However, international students must enroll in one of the graduate student employee insurance plans and receive clearance from an International Advisor. ESE 701 Dissertation Research (Off Campus – INTERNATIONAL) is a course for students whose research takes place outside the United States and/or U.S. provinces. Domestic students can opt for the MEDEX health plan, while international students must adhere to specific requirements regarding health insurance. Students are advised to inform the department two weeks prior to each semester if they plan to take ESE 697 or ESE 698. The graduate program director will then assign them to a course.