TICKLE COLLEGE OF ENGINEERING (TCE) GRADUATE CURRICULUM CHANGES

Tickle College of Engineering
All Changes Effective Fall 2022.

I. COURSE CHANGES

BIOSYSTEMS ENGINEERING AND SOIL SCIENCES

Biosystems Engineering (BSE)
SLOs: Understanding of the scientific method as applied to research and to engineering design and development. Specifically, understanding the importance of developing and testing hypotheses, and of the use of scientific, mathematical, and statistical tools; Capacity to effectively locate literature relevant to a topic, and to critically evaluate such literature. In particular, familiarity with the primary scientific literature, as well as secondary and commercial sources; Capacity to write proposals; conduct experiments; design, construct, and test devices; and prepare coherent technical reports based on such work; Understanding of professional scientific ethics, including issues such as designation of authorship, and patent rights; Competence in a particular focus area of Biosystems Engineering.

ADD

BSE 511 Mechanical Systems Engineering (3) Fundamentals of power delivery systems and simple mechanisms; selection and design of mechanical, hydraulic, and tractive power transmission systems. Emphasis on off-road vehicles and bioprocessing systems.

Credit Restriction: Students cannot receive credit for both 411 and 511.
Recommended Background: Undergraduate engineering coursework in statics, dynamics, and mechanics of materials.
Registration Restriction: Minimum student level – graduate

DROP

BSE 411 Mechanical Systems Engineering (3)

Rationale: We want more flexibility to have graduate students take this without the prerequisites, and to have more graduate course possibilities. Students in 511 will be required to submit additional graduate-level literature reviews and design work. Impact on other units: None. Financial impact: None.

DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING

Chemical and Biomolecular Engineering (CBE)

No Course changes.

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Civil Engineering (CE)

No CE course changes.

Environmental Engineering (ENVE)

DROP

ENVE 530 Urban Hydrology and Stormwater Engineering (3)

Rationale: ENVE530 no longer taught. Course content replaced with ENVE 531 Hydrology and ENVE 533 Green Infrastructure Design. Impact on other units: None. Financial impact: None.

REVISE TITLE AND COURSE DESCRIPTION

ENVE 516 Watershed Management (3) Principles and practice of watershed science and engineering, including monitoring and assessment of water quality and biological data, statistical data analysis and modeling of anthropogenic impacts to watershed ecological integrity, and development of watershed restoration plans for management.

Recommended Background: Hydrology.

Formerly:
ENVE 516 Watershed Monitoring and Assessment (3) Fundamentals of experimental design, monitoring design, instrumentation, sample collection, statistical analysis, data interpretation, and data representation for studies in watershed science and engineering. Class projects and case studies focused on obtaining, analyzing, and presenting quality data sets collected during field-based research.

Recommended Background: Hydrology

Rationale: The course is of interest to students among different disciplines. The change in title and course description more closely describes the current course material. No impacts and better supports the Undergraduate and Graduate Watershed minors. Financial impact: None.

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Computer Science (COSC)

ADD

COSC 524 Natural Language Processing (3) This course presents natural language processing (NLP) theory and methods available for reasoning about text in computational systems. NLP is deeply interdisciplinary, drawing on both linguistics and computer science, and enables numerous applications of computational text analysis. The course will cover major algorithms used in NLP, common applications of NLP, and the underlying linguistic phenomena NLP systems attempt to model.
Recommended Background: Undergraduate coursework in algorithms and data structures.

Rationale: Natural language processing is an important topic for a wide range of industry and research applications. Its interdisciplinary content is relevant for many students in our graduate programs, especially computer science. This course has been taught as a special topics course in two previous semesters.
Impact on other units: None
Financial impact: Staffing costs for this course will be supported by funding from the university, college, and department that has been set aside for the online Computer Science MS offerings.

ADD

COSC 533 Cloud and Web Architectures (3) An in-depth study on the principles of designing and developing applications in the context of the Internet and the web. Includes an overview of web protocols, the client-server architecture paradigm, and software components that underlie the two of them. Related topics are also covered, including security, synchronization, interactivity, and advanced web architectures.
Recommended Background: Undergraduate coursework in computer interfaces and operating systems.

Rationale: With the emergence of computing as a service paradigms, cloud-based architectures are now fundamental to the modern computing landscape. This course will equip students with knowledge and skills that are necessary to navigate and develop software for the modern computing landscape.
Impact on other units: None.
Financial impact: Staffing costs for this course will be supported by funding from the university, college, and department that has been set aside for the online Computer Science MS offerings.

ADD

COSC 552 Computer Graphics (3) Digital image synthesis, geometric modeling and animation. Topics may include visual perception, displays and color spaces, frame buffers, affine transformations, data structures for geometrical primitives, visible surface determination, shading and texturing, anti-aliasing, computing light transport, rendering equation, shader programming, general purpose GPU programming, level of detail, curves and surfaces, and graphics hardware.
Recommended Background: 302.

DROP

COSC 556 Computer Graphics (3)

Rationale: COSC 552 is added to align with COSC 452 in the undergraduate catalog. COSC 556 is dropped. Impact on other units: none. Financial impact: none.

Course Equivalency Table	
Former Course Number	**Equivalent Course Number**
COSC 556 Computer Graphics	COSC 552 Computer Graphics

ADD

COSC 558 User Interfaces (3) Advanced coverage of the design, implementation, and study of user interfaces. Provides an overview of the user interface design/evaluation process, event abstraction within user interfaces, user interface components, specification of user interfaces, and the architectures within which user interfaces are developed.
Recommended Background: Undergraduate coursework in software engineering.

Rationale: User interfaces are foundational for how users and computers interact, and are very important for a wide range of computing applications. This course will equip students with knowledge and skills necessary to design and develop high quality user interfaces for modern computing applications.
Impact on other units: None.
Financial impact: Staffing costs for this course will be supported by funding from the university, college, and department that has been set aside for the new online Computer Science MS offerings.

ADD

COSC 559 Human-Computer Interaction (3) An in-depth study on the field of human-computer interaction with particular emphasis on understanding how human factors shape the creation and evaluation of usable and useful computational artifacts. Provides an overview of basic phenomena of human perception, cognition, memory, and problem solving, and relationship to user-centered design. Methods and techniques for interaction design and evaluation.
Recommended Background: Undergraduate coursework in software engineering.

Rationale: Human factors can have a significant impact on the effectiveness of computational artifacts. This course will give students a theoretical basis for understanding human-computer interaction as well as practical knowledge of how to design computer programs to enhance usability.
Impact on other units: None.
Financial impact: Staffing costs for this course will be supported by funding from the university, college, and department that has been set aside for the online Computer Science MS offerings.

ADD

COSC 563 Mobile and Ubiquitous Computing (3) Advanced coverage of mobile and ubiquitous computing paradigms, including Internet of Things (IoT). Provides an overview of differences to the desktop computing model: applications, interaction in augmented environments, security, mobile operating systems, sensors, and embedded systems design. Particular attention given to the design and implementation of ubiquitous computing systems.
Recommended Background: Undergraduate coursework in computer interfaces and operating systems.

Rationale: With the trends of smaller and more connected computing processors, the popularity and importance of mobile and embedded computing has grown significantly in recent years. This course will equip students with the knowledge and skills to design and develop artifacts for mobile and embedded computers.
Impact on other units: None.
Financial impact: Staffing costs for this course will be supported by funding from the university, college, and department that has been set aside for the online Computer Science MS offerings.

DROP 400 LEVEL COURSES FOR GRADUATE CREDIT

COSC 440 Formal Foundations of Software Engineering (4)

Rationale: This course is an introductory course in formal foundations of software engineering. It should not be in the graduate catalog. It will remain in the undergraduate catalog. Impact on other units: none. Financial impact: none.

COSC 461 Compilers (3)

Rationale: This course is an introductory course in compilers and should not be in the graduate catalog. It will remain in the undergraduate catalog. Graduate students who are interested in compilers now have the option to take COSC 561. Impact on other units: none. Financial impact: none.

Electrical and Computer Engineering (ECE)

ADD

ECE 585 Electric Vehicles (3) Electric vehicle drivetrains, batteries, battery management systems, battery chargers, electric vehicle machines, motor drive systems, electric charging infrastructures, and electric vehicle modeling. Electric vehicle battery usage (charging, discharging) and management (state of charge and state of health estimation), modeling vehicle drive cycles, EV charging, and EV motor drive control.

Rationale: Vehicle electrification is rapidly accelerating all over the world in recent years, which brought in large amount of research and job opportunities. The interdisciplinary topics in electric vehicles, such as energy storage, power electronics and vehicle communication are directly related to our EECS program. This course has been taught as a special topics course twice (Fall 2018, Fall 2020).
Impact on other units: The course would be available to mechanical engineering students (thermal, vehicle dynamics) and chemical engineering students (battery aging and SOC/SOH estimation)
Financial Impact: None.

ADD

ECE 586 Wide Bandgap (WBG) Device Characterization (3) Wide bandgap device static and dynamic characterization, double pulse test (DPT) design and test, gate drive circuit, switching loop parasitics analysis, high-speed measurement techniques, solid state circuit breaker design and test. Hands-on training of curve tracer, pcb layout, high-voltage electrical circuit test and debugging.

Rationale: The rapid development of wide-bandgap devices entails the need of more in-depth understandings and experimental skills for device characterization for power electronics students. The trainings provided by this lab-based class are fundamental and will equip the students with cutting-edge knowledge in WBG devices that is beneficial to a wide range of applications. This course has been taught as a special topics course three times (Fall 2017 with 16 students, Spring 2020 with 12 students, and Fall 2021 with 9 students).
Impact on other units: None. Financial Impact: None.

ADD

ECE 684 Power Electronics Packaging (3) Power electronics packaging materials and procedures for silicon, silicon carbide, and gallium nitride devices. Packaging techniques (printed circuit board assembly and wire bonding), thermal management in power modules, and packaging related EMI. Electro-thermal and circuit simulation to model the impact of parasitics in power electronic modules.

Rationale: Wide-bandgap (WBG) devices such as silicon carbide (SiC) and gallium nitride (GaN) devices are replacing conventional silicon devices in recent years, given their superior switching and thermal performance. Semiconductor manufacturers and the companies that use power semiconductors in their products are working together to accelerate the adoption of next generation SiC and GaN power electronics. Their fast switching speed, however, requires less parasitics, which furthermore yields the demand of compact footprint and layout thereby advanced packaging technologies. This course will be included as one of the electives for the WBG Power Electronics Certificate. This course was taught as a special topics course in Spring 2021. Impact on other units: None. Financial Impact: None.

DROP

ECE 571 Pattern Recognition (3)

Rationale: The material in this course is now covered in COSC 425 and COSC 522. We have no plans to offer this course in future semesters. Impact on other units: None. Financial Impact: None.

REMOVE (RE) COREQUISITE(S)

ECE 511 Linear Systems Theory (3)

Formerly:
ECE 511 Linear Systems Theory (3)
(RE) Corequisite(s): CBE 529.

Rationale: The corequisite requirement not necessary as the required material from CBE 529 is currently taught in ECE 511. Impact on other units: None. Financial Impact: None.

REMOVE (RE) PREREQUISITE(S)

ECE 635 Advanced Semiconductor Devices (3)
Registration Restriction(s): Minimum student level – graduate.

Formerly:
ECE 635: Advanced Semiconductor Devices (3)
(RE) Prerequisite(s): 531 or consent of instructor.
Registration Restriction(s): Minimum student level – graduate.

Rationale: The prerequisite requirement is only listed for historical reasons and is not necessary. Impact on other units: None. Financial Impact: None.

REVISE COURSE TITLE, DESCRIPTION, ADD REPEATABILITY MAXIMUM HOURS

ECE 682 Power Electronics Technologies (3) Survey of practical design details in the realization of power electronic circuits followed by design-oriented, hands-on laboratory work in the realization of advanced power electronics. Topics include topology investigation, power transistor selection and characterization, modulation schemes, control realization, and EMI compliance. Topics covered through design and realization of a functioning power conversion system.
Registration Restriction(s): Minimum student level – graduate.
Registration Permission: Consent of instructor.
Repeatability: May be repeated for maximum of 6 hours.

Formerly:
ECE 682 Power Electronics Technologies II (3) Design-oriented, hands-on laboratory work in the realization of advanced power electronics. Topics include topology investigation, power transistor selection and characterization, modulation schemes, control realization, and EMI compliance. Topics covered through design and realization of a functioning power conversion system.
Registration Restriction(s): Minimum student level – graduate.
Registration Permission: Consent of instructor.

Rationale: The course was previously titled "Power Electronics Technologies II" and was part of a two-course sequence (ECE 681 & ECE 682). This change consolidates the catalog by combing the two courses into one and allowing repeatability for a two-course sequence. Impact on other units: None. Financial Impact: None.

ENGINEERING FUNDAMENTALS

No Course changes.

DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

Industrial Engineering (IE)

ADD 400 LEVEL COURSE FOR GRADUATE CREDIT

IE 452 Project Planning and Organizational Management (3) Aspects of leadership in a professional environment will be studied from current literature reading and discussions. Industry professionals will periodically lead the class to enlighten students to aspects of organizational and project management. Lectures will be based on the Project Management Body of Knowledge (PMBOK) and will qualify students to take the CAPM/PMP certification exam at the end of their Senior year. Each student will develop a project plan including Project Charter, scope management, Communication plan, with an oral project review presentation.

Rationale: This course will be a valuable addition to Tickle college graduate courses, especially for accelerated BS/MS students. It is already being taught at the undergraduate level. Impact on other units: None. Financial Impact: None, there is enough faculty to cover this course.

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Materials Science and Engineering (MSE)

ADD

MSE 575 Introduction to Corrosion (3) Aspects of corrosion science are explored through the lenses of electrochemistry, kinetics, and industry solutions; with emphasis on the impact of corrosion on microstructure, including pitting and grain boundary corrosion; hands-on lab experience in the corrosion testing facility with real-world industrial experiments. A project on corrosion science and technology will be conducted, requiring a presentation and written report.

Rationale: This course is added to reflect an important component of materials science and engineering. The knowledge from this course will help form a diverse range of topics of interests to the graduate students. Impact on other units: None. Financial impact: None.

DROP

MSE 516 Fundamentals of Plastic Deformation (3)

Rationale: This course has not been taught for a few years, and its content overlaps significantly with MSE 532 (Metallurgy of Deformation and Fracture) and MSE 612 (Computational Plasticity and Micromechanics). Impact on other units: None. Financial impact: None.

REVISE (RE) PREREQUISITE(S)

MSE 405 X-ray Diffraction (3) Crystal structures and the reciprocal lattice and how the atomic parameters relate to X-ray powder diffraction data. Production of laboratory X-rays and overview of hardware, data collection, and data analysis software and applications.
Satisfies General Education Requirement: (WC)
(RE) Prerequisite(s): MSE 360 or MSE 367; and ENGL 102*, ENGL 132*, ENGL 290*, or ENGL 298*.
Registration Permission: Consent of instructor.

Formerly:
(RE) Prerequisite(s): 360, Physics 232; and English 102, 132, 290, or 298.
Registration Permission: Consent of instructor.

Rationale: This entry in the graduate catalog was not updated in accordance with its listing in the undergraduate catalog. Changes are thus made to ensure consistency. Impact on other units: None. Financial impact: None.

REVISE DESCRIPTION AND ADD CREDIT RESTRICTION

MSE 515 Diffusion, Phase Transformations, and Microstructure of Materials (3) Applications of diffusion to material processing. Diffusion in dilute and concentrated alloys. Thermo- and electro-transport in solids. Grain boundaries and interfaces. Grain boundary diffusion. Recovery, recrystallization, and grain growth. Thermally activated phase transformations. Diffusionless transformations. Students will complete a project applying the concepts learned to a phase transformations-related phenomenon of their choice, requiring a presentation and written report.
Credit Restriction: Students cannot receive credit for both MSE 415 and MSE 515.
Recommended Background: 513.

Formerly:
MSE 515 Diffusion, Phase Transformations, and Microstructure of Materials (3) Applications of diffusion to material processing. Diffusion in dilute and concentrated alloys. Thermo- and electro-transport in solids. Grain boundaries and interfaces. Grain boundary diffusion. Recovery, recrystallization, and grain growth. Thermally activated phase transformations. Diffusionless transformations.
Recommended Background: 513.

Rationale: This course is co-taught with MSE 415 of the same tile. Additional course requirements and credit restriction are added for the graduate students. Impact on other units: None. Financial impact: None.

REVISE CREDIT RESTRICTION

MSE 522 Defects in Crystals (3) Analytical and experimental analysis of defect interactions in solids. Two papers are required that describe industrial or research applications that rely on the properties of defects in non-metal crystals for successful operation.
Credit Restriction: Students cannot receive credit for both MSE 432 and MSE 522.
Recommended Background: 421.

Formerly:
Credit Restriction: None.
Recommended Background: 421.

Rationale: A credit restriction is added for this course is co-taught with MSE 432 of the same tile. Impact on other units: None. Financial impact: None.

REVISE DESCRIPTION

MSE 543 Quantum Mechanics for Engineers (3) Covers fundamentals of quantum mechanics using an approach suitable for engineering undergraduates and beginning graduate students. Topics will include mathematical preliminaries, Dirac notation, two-state systems, the Bloch sphere, the Schrödinger wave equation, operators and time evolution, the square well, the harmonic oscillator, the hydrogen atom, angular momentum, and approximation methods. Students will be expected to complete several short writing projects in which they will link current developments in quantum computing and other quantum technologies to what they are learning in class.
Credit Restriction: Students cannot receive credit for both MSE 443 and MSE 543.
Recommended Background: Calculus, linear algebra, and physics taught at the level of Engineering Fundamentals.

Formerly:
MSE 543 Quantum Mechanics for Engineers (3) Covers fundamentals of quantum mechanics using an approach suitable for engineering undergraduates and beginning graduate students. Topics will include mathematical preliminaries, Dirac notation, two-state systems, the Bloch sphere, the Schrödinger wave equation, operators and time evolution, the square well, the harmonic oscillator, the hydrogen atom, angular momentum, and approximation methods.
Credit Restriction: Students cannot receive credit for both MSE 443 and MSE 543.
Recommended Background: Calculus, linear algebra, and physics taught at the level of Engineering Fundamentals.

Rationale: This course is co-taught with MSE 443 of the same title. Additional course requirements are added for the graduate students. Impact on other units: None. Financial impact: None.

REVISE DESCRIPTION AND ADD CREDIT RESTRICTION

MSE 556 Materials for Energy (3) Investigate the role that materials scientists play in the broader issue of renewable energy, climate change and sustainable development; topics include the evaluation of impacts of climate change, national renewable energy plans, materials solutions for renewable energy storage or conversion technologies and case studies of sustainable development. Class will conclude with a student report and presentation based on current research on one of the topics covered in class.
Credit Restriction: Students cannot receive credit for both MSE 455 and MSE 556.
Recommended Background: 201.
Comment(s): Prior knowledge may satisfy Recommended Background with consent of instructor.

Formerly:
MSE 556 Materials for Energy (3) Underlying physics and operating principles of functional materials used in energy applications such as photovoltaics and photocatalysts, fuel cells, batteries, thermoelectrics, and superconductors. Class will conclude with a student report and presentation based on current research on one of the topics covered in class.
Credit Restriction: None.
Recommended Background: 201.
Comment(s): Prior knowledge may satisfy Recommended Background with consent of instructor.

Rationale: This course is co-taught with MSE 455 of the same title. Course description is updated to ensure the consistency. Credit restriction is added. Impact on other units: None. Financial impact: None.

REVISE CREDIT RESTRICTION

MSE 572 X-Ray Diffraction (3) Symmetry of crystals, space group theory, reciprocal lattice and application to definition of structures; powder and single crystal X-ray techniques; introduction to crystal structure determination; characterization of orientation; application to inorganic, metallic and polymer structures.
Credit Restriction: Students cannot receive credit for both MSE 405 and MSE 572.

Formerly:
Credit Restriction: None.

Rationale: A credit restriction is added for this course is co-taught with MSE 405. Impact on other units: None. Financial impact: None.

REVISE CREDIT HOURS

MSE 576 Special Topics in Materials Science and Engineering (1-3) Topics of current significance and interest. Repeatability: May be repeated. Maximum 6 hours.
Registration Permission: Consent of instructor.

Formerly:
MSE 576 Special Topics in Materials Science and Engineering (3)

Rationale: This course can be taken with a range of 1~3 credit hours, thus providing flexibility for the instructors to arrange special topics with variable scopes and intensities. It also follows the suits of other engineering departments (e.g., ME 599). Impact on other units: None. Financial impact: None.

REVISE TITLE AND DESCRIPTION

MSE 674 Quantum and Energy Materials (3) Focuses on the behavior of electrons in advanced materials for quantum and energy applications, starting with basics of quantum mechanics. Solar cells, light emitting diode, atomic dynamics in liquid electrolyte for energy storage, superconductivity and quantum computing, topological materials, and materials for spintronics are discussed.
Recommended Background: 511 and 514.
Comment(s): Prior knowledge may satisfy prerequisites, with consent of instructor.
Registration Restriction(s): Minimum student level – graduate.

Formerly:
MSE 674 Materials Physics (3) Starts with the description of the electronic states in regular crystals, and extends it to surfaces, interfaces, defects, amorphous and liquid state and strongly correlated electron systems including magnetism. Also, advanced experimental methods to study the electronic states and atomic structure are discussed. Recommended Background: 511 and 514. Comment(s): Prior knowledge may satisfy prerequisites, with consent of instructor. Registration Restriction(s): Minimum student level – graduate.

Rationale: The title and description of this course are updated to appropriately highlight the course objectives in quantum and energy materials. Impact on other units: None. Financial impact: None.

DEPARTMENT OF MECHANICAL, AEROSPACE, AND BIOMEDICAL ENGINEERING

No Course Changes.

DEPARTMENT OF NUCLEAR ENGINEERING

Nuclear Engineering (NE)

ADD

NE 564 Physics of Plasmas (3) This course covers the principles of the physics of plasmas pertaining to the operations of magnetically confined fusion systems. The topics to be covered include: Single particle motion/orbits, fluid description of plasmas, magnetohydrodynamics (MHD), MHD equilibrium and stability, collisions and transport, confinement.

(RE) Co-Requisite(s): NE 560 or NE 460 or Permission of Instructor.

Recommended Background: It is highly desirable for students to have advanced understanding in electricity
and magnetism as well as advanced classical mechanics (Lagrangian and Hamiltonian formalism).

Rationale: This course is needed to support the training of students engaged in plasma physics and nuclear fusion research. MHD is one of the basic building blocks of fusion science and it plays a primary role in the design and physics goals of major fusion devices such as ITER. This course is also envisioned for students in the physics department that want to learn the fundamentals of plasma physics and its application to magnetically confined fusion systems. Impact on other units: none. Financial Impact: none.

ADD

NE 650 Advanced Topics in Semiconductor Detectors (3) This course covers the physical foundation and application of semiconductor detectors. Topics include the historical development and fabrication of semiconductor detectors, how to characterize their electronic properties and performance, current state-of-the-art, and their applications.

(RE) Pre-Requisite(s): NE 550 or NE 401 or Permission of Instructor.
Registration Restriction(s): Minimum student level – graduate.

Rationale: This course has been taught as special topics and was very well received. There is possible interest in it eventually being cross-listed with EECS, MSE, Physics, and Chemistry. Impact on other units: none. Financial Impact: none.

REVISE TITLE AND DESCRIPTION, ADD RECOMMENDED BACKGROUND

NE 582 Transport Theory: Monte Carlo (3) Modeling and simulation of neutral particle transport in nuclear systems. Transport theory through the Boltzmann transport equation. Source driven and criticality calculations. Energy discretization and multi-group transport equations. Relevant nuclear data. The adjoint transport equation. Probability distribution functions. Monte Carlo solutions of the transport equation. Error estimates. Non-analog Monte Carlo and variance reduction methods. Modern Monte Carlo transport codes.

Recommended Background: Prior programming experience (in any programming language) is required.
Registration Permission: Consent of instructor.

Formerly:
NE 582 Monte Carlo Analysis (3) General overview of the Monte Carlo Method for solving problems in physics and engineering. Random sampling, evaluation of integrals, analog particle transport, techniques of variance reduction, forward and adjoint modes of analysis, importance function biasing, splitting/weight window survival biasing and contribution theory. Particular emphasis on solving neutral particle radiation transport problems using the MCNP code system.
Registration Permission: Consent of instructor.

Rationale: Our radiation transport courses are being updated to reflect the latest material being taught by our new faculty member teaching the course. Impact on other units: None. Financial impact: None.

REVISE TITLE AND DESCRIPTION, ADD RECOMMENDED BACKGROUND and REGISTRATION PERMISSION

NE 583 Transport Theory: Deterministic Methods (3) Modeling and simulation of neutral particle transport in nuclear systems. Transport theory through the Boltzmann transport equation. Source driven and criticality calculations. Energy discretization and multi-group transport equations. Relevant nuclear data. The adjoint transport equation. Time-dependent problems and the neutron kinetics equations. Deterministic solution methods of the transport equation: discrete ordinates and integral transport methods. Modern deterministic transport codes.

Recommended Background: Prior programming experience (in any programming language) is required.
Registration Permission: Consent of instructor.

Formerly:
NE 583 Radiation Transport Methods (3) Application of analytic/deterministic solutions of the Boltzmann transport equation to problems in neutral particle transport. Special emphasis is placed on application of the discrete ordinates method (in forward and adjoint) to deep penetration shielding analysis.

Comment(s): Prior knowledge may satisfy prerequisites, with consent of instructor.

Rationale: Our radiation transport courses are being updated to reflect the latest material being taught by our new faculty member teaching the course. Impact on other units: None. Financial impact: None.

II. PROGRAM CHANGES

DEPARTMENT OF BIOSYSTEMS ENGINEERING AND SOIL SCIENCES

Biosystems Engineering (BSE)
SLOs: Understanding of the scientific method as applied to research and to engineering design and development. Specifically, understanding the importance of developing and testing hypotheses, and of the use of scientific, mathematical, and statistical tools; Capacity to effectively locate literature relevant to a topic, and to critically evaluate such literature. In particular, familiarity with the primary scientific literature, as well as secondary and commercial sources; Capacity to write proposals; conduct experiments; design, construct, and test devices; and prepare coherent technical reports based on such work; Understanding of professional scientific ethics, including issues such as designation of authorship, and patent rights; Competence in a particular focus area of Biosystems Engineering.

REVISE ADMISSIONS STANDARDS / PROCEDURES for Biosystems Engineering Major; MS

To the Office of Graduate Admissions submit online application, application fee, and official transcripts. The Graduate Record Examination (GRE) is recommended but not required for admission to the program. Scores from the general GRE test are given different weights by various faculty advisors, so applicants are encouraged to directly contact their desired faculty advisor to determine the importance of this indicator to the success of their application. The online application procedure will also direct the applicant to submit an updated resume, three letters of reference (or three Graduate Rating Forms) from persons capable of assessing the applicant's suitability for graduate work, and a statement of professional goals, research interests, and reasons for applying (less than one page). Each applicant will be advised about any prerequisite courses before entering a program. The student's program of study must be approved by his/her advisory committee and must comply with the requirements of the Graduate Council. Prerequisite courses are selected based on the standards described in the BESS Graduate Student Handbook (https://bess.tennessee.edu/wp-content/uploads/sites/20/2019/11/grad_handbook.pdf) .

Formerly:
To the Office of Graduate Admissions submit online application, application fee, official transcripts, and scores from the general portion of the Graduate Record Examination (GRE). The online application procedure will also direct the applicant to submit an updated resume, three letters of reference (or three Graduate Rating Forms) from persons capable of assessing the applicant's suitability for graduate work, and a statement of professional goals, research interests, and reasons for applying (less than one page). Each applicant will be advised about any prerequisite courses before entering a program. The student's program of study must be approved by his/her advisory committee and must comply with the requirements of the Graduate Council.

REVISE ADMISSIONS STANDARDS / PROCEDURES for Biosystems Engineering Major; PhD

To the Office of Graduate Admissions submit online application, application fee, and official transcripts. The Graduate Record Examination (GRE) is recommended but not required for admission to the program. Scores from the general GRE test are given different weights by various faculty advisors, so applicants are encouraged to directly contact their desired faculty advisor to determine the importance of this indicator to the success of their application. The online application procedure will also direct the applicant to submit an updated resume, three letters of reference (or three Graduate Rating Forms) from persons capable of assessing the applicant's suitability for graduate work, and a statement of professional goals, research interests, and reasons for applying (less than one page). Each applicant will be advised about any prerequisite courses before entering a program. The student's program of study must be approved by his/her advisory committee and must comply with the requirements of the Graduate Council. Prerequisite courses are selected based on the standards described in the BESS Graduate Student Handbook (https://bess.tennessee.edu/wp-content/uploads/sites/20/2019/11/grad_handbook.pdf) .

Students applying for admission into the doctoral program must submit evidence of ability to perform and report independent research to the satisfaction of the faculty of the department. An approved master's thesis will usually be acceptable for this purpose.

Formerly:
To the Office of Graduate Admissions submit online application, application fee, official transcripts, and scores from the general portion of the Graduate Record Examination (GRE). The online application procedure will also direct the applicant to submit an updated resume, three letters of reference (or three Graduate Rating Forms) from persons capable of assessing the applicant's suitability for graduate work, and a statement of professional goals, research interests, and reasons for applying (less than one page).

Students applying for admission into the doctoral program must submit evidence of ability to perform and report independent research to the satisfaction of the faculty of the department. An approved master's thesis will usually be acceptable for this purpose.

Rationale: Moving towards test-optional admission, as desired by the BESS Faculty. Impact on other units: None.
Financial impact: None.

DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING

Chemical and Biomolecular Engineering (CBE)

No Program Changes.

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

No Program Changes.

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

COMPUTER SCIENCE (COSC)

ADD CONCENTRATIONS – COMPUTER SCIENCE MAJOR, MS

Applied Cybersecurity
Data Mining and Intelligent Systems
Software Engineering

In the 2022-23 Graduate catalog, Computer Science Major, MS, add (3) new concentrations. Campus Code for the 3 new concentrations is: Distance Education Option only:

Applied Cybersecurity — Coursework Only without Comprehensive Exams
Data Mining and Intelligent Systems — Coursework Only without Comprehensive Exams
Software Engineering — Coursework Only without Comprehensive Exams

REVISE COMPUTER SCIENCE MAJOR, MS TO ADD CATALOG TEXT AND REQUIREMENTS FOR THE 3 NEW CONCENTRATIONS.

In the 2022-23 Graduate catalog, insert catalog text and requirements for the 3 new concentrations.

Applied Cybersecurity – Coursework only without Comprehensive Exams Option

Campus Code: Distance Education

The description and requirements are as follows:

The Tickle College of Engineering offers a Master of Science in Computer Science to qualified applicants. Candidates for the MS program are expected to possess a Bachelor of Science degree in Computer Science or related field. The concentration focuses on the theory and practice of cybersecurity, with an emphasis on its application in modern technological business, government, and society.

Credit Hours Required
- 30 graduate credit hours

Required Courses
- Applied Cybersecurity students take a total of 30 credit hours as shown below. All courses are 3 credit hours each.
  - Core courses - Students must take both of these core courses.
    - COSC 530: Computer Systems Organization
    - COSC 566: Software Security
  - Focus area courses – Students much take four of these focus area courses.
    - COSC 534: Network Security
    - COSC 569: Human Factors in Cybersecurity
    - COSC 583: Cryptography
    - ECE 559: Secure and Trustworthy Hardware Design
    - ECE 569: Mobile and Embedded Systems Security
  - Elective courses - Students must take four of these elective courses (or from the focus area courses above).
    - COSC 522: Machine Learning
    - COSC 523: Artificial Intelligence
    - COSC 525: Deep Learning
    - COSC 526: Data Mining
    - COSC 528: Natural Language Processing
    - COSC 533: Cloud and Web Architectures
    - COSC 540: Software Engineering
    - COSC 545: Digital Archeology
    - COSC 557: Visualization
    - COSC 558: User Interfaces
    - COSC 559: Human-Computer Interaction
    - COSC 561: Compilers and Runtime Systems
    - COSC 562: Operating Systems: Design and Implementation
    - COSC 563: Mobile and Ubiquitous Computing
    - COSC 565: Databases and Scripting Languages
    - COSC 581: Algorithms
    - ECE 517: Reinforcement Learning
    - ECE 553: Networking
    - ECE 574: Computer Vision

- Students can take coursework in a manner that best fits their schedule. This concentration does not strictly use a cohort system, so students can complete the concentration as their schedule and finances allow. This flexibility would allow students to complete the concentration in as little as 18 months or more slowly based upon individual situations

Rationale: The department is adding online-only Computer Science MS concentrations in the areas of applied cybersecurity, data mining and intelligent systems, and software engineering. These changes specify the distance education campus code for each relevant concentration. The other concentrations are for on-campus students only.
Impact on other units: None.
Financial impact: Costs for the online Computer Science MS concentrations will be supported by funding from the university, college, and department that has been set aside for these programs.

Data Mining and Intelligent Systems – Coursework only without Comprehensive Exams Option

Campus Code: Distance Education

The description and requirements are as follows:

The Tickle College of Engineering offers a Master of Science in Computer Science to qualified applicants. Candidates for the MS program are expected to possess a Bachelor of Science degree in Computer Science or related field. The concentration focuses on the theory, practice, and application of data mining and intelligent systems.

Credit Hours Required
- 30 graduate credit hours

Required Courses
- Data Mining and Intelligent Systems students take a total of 30 credit hours as shown below. All courses are 3 credit hours each.
  - Core courses - Students must take both of these core courses.
    - COSC 522: Machine Learning
    - COSC 523: Artificial Intelligence
  - Focus area courses – Students much take four of these focus area courses.
    - COSC 525: Deep Learning
    - COSC 526: Data Mining
    - COSC 528: Natural Language Processing
    - COSC 545: Digital Archeology
    - COSC 557: Visualization
    - ECE 517: Reinforcement Learning
    - ECE 574: Computer Vision
  - Elective courses - Students must take four of these elective courses (or from the focus area courses above).
    - COSC 530: Computer Systems Organization
    - COSC 533: Cloud and Web Architectures
    - COSC 534: Network Security
    - COSC 540: Software Engineering
    - COSC 558: User Interfaces
    - COSC 559: Human-Computer Interaction
    - COSC 561: Compilers and Runtime Systems
    - COSC 562: Operating Systems: Design and Implementation
    - COSC 563: Mobile and Ubiquitous Computing
    - COSC 565: Databases and Scripting Languages
    - COSC 566: Software Security
    - COSC 569: Human Factors in Cybersecurity
    - COSC 581: Algorithms
    - COSC 583: Cryptography
    - ECE 553: Networking
    - ECE 559: Secure and Trustworthy Hardware Design
    - ECE 569: Mobile and Embedded Systems Security
  - Students can take coursework in a manner that best fits their schedule. This concentration does not strictly use a cohort system, so students can complete the concentration as their schedule and finances allow. This flexibility would allow students to complete the concentration in as little as 18 months or more slowly based upon individual situations.

Rationale: The department is adding online-only Computer Science MS concentrations in the areas of applied cybersecurity, data mining and intelligent systems, and software engineering. These changes specify the distance education campus code for each relevant concentration. The other concentrations are for on-campus students only.
Impact on other units: None.
Financial impact: Costs for the online Computer Science MS concentrations will be supported by funding from the university, college, and department that has been set aside for these programs.

Software Engineering – Coursework only without Comprehensive Exams Option

Campus Code: Distance Education

The description and requirements are as follows:

The Tickle College of Engineering offers a Master of Science in Computer Science to qualified applicants. Candidates for the MS program are expected to possess a Bachelor of Science degree in Computer Science or related field. The concentration focuses on the theory and practice of software engineering, including the design and implementation of modern software systems.

Credit Hours Required
- 30 graduate credit hours

Required Courses
- Software Engineering students take a total of 30 credit hours as shown below. All courses are 3 credit hours each.
  - Core courses - Students must take both of these core courses.
    - COSC 540: Software Engineering
    - COSC 581: Algorithms
  - Focus area courses – Students much take four of these focus area courses.
    - COSC 530: Computer Systems Organization
    - COSC 533: Cloud and Web Architectures
    - COSC 545: Digital Archeology
    - COSC 558: User Interfaces
    - COSC 559: Human-Computer Interaction
    - COSC 561: Compilers and Runtime Systems
    - COSC 562: Operating Systems: Design and Implementation
    - COSC 563: Mobile and Ubiquitous Computing
    - COSC 565: Databases and Scripting Languages
  - Elective courses - Students must take four of these elective courses (or from the focus area courses above).
    - COSC 522: Machine Learning
    - COSC 523: Artificial Intelligence
    - COSC 525: Deep Learning
    - COSC 526: Data Mining
    - COSC 528: Natural Language Processing
    - COSC 557: Visualization
    - COSC 534: Network Security
    - COSC 566: Software Security
    - COSC 569: Human Factors in Cybersecurity
    - COSC 583: Cryptography
    - ECE 517: Reinforcement Learning
    - ECE 553: Networking
    - ECE 559: Secure and Trustworthy Hardware Design
    - ECE 569: Mobile and Embedded Systems Security
    - ECE 574: Computer Vision
  - Students can take coursework in a manner that best fits their schedule. This concentration does not strictly use a cohort system, so students can complete the concentration as their schedule and finances allow. This flexibility would allow students to complete the concentration in as little as 18 months or more slowly based upon individual situations.

Rationale: The department is adding online-only Computer Science MS concentrations in the areas of applied cybersecurity, data mining and intelligent systems, and software engineering. These changes specify the distance education campus code for each relevant concentration. The other concentrations are for on-campus students only.
Impact on other units: None.
Financial impact: Costs for the online Computer Science MS concentrations will be supported by funding from the university, college, and department that has been set aside for these programs.

ELECTRICAL AND COMPUTER ENGINEERING (ECE)

REVISE COMPUTER ENGINEERING MAJOR, MS, REQUIRED COURSES

In the 2022-23 Graduate catalog, under the Required Courses heading, remove current list and replace with the following:

Required Courses
- Option Specific Courses:
  - Thesis Option: ECE 500 (6 credit hours)
  - Project Option: ECE 501 (3 credit hours), with a minimum grade of B.
- 24 (thesis option) or 27 (project option) or 30 (Coursework only without comprehensive exams) credit hours of graduate coursework
  - At least two-thirds of the total credit hours must be at the 500-level or above
  - At least 6 credit hours selected from the following courses: ECE 504, ECE 505, ECE 533, ECE 551, ECE 553, ECE 555, ECE 572, COSC 522, and COSC 530.
  - A maximum of 6 credit hours of courses outside the department chosen in consultation with major advisor may be applied toward the degree.

Formerly:
Required Courses
- 24 (thesis option) or 27 (project option) or 30 (Coursework only without comprehensive exams) credit hours of graduate coursework
  - At least two-thirds of the total credit hours must be at the 500-level or above
  - At least 6 credit hours selected from the following courses: ECE 504, ECE 505, ECE 533, ECE 551, ECE 553, ECE 555, ECE 572, COSC 522, and COSC 530.
- Option Specific Courses:
  - Thesis Option: ECE 500 (6 credit hours)
  - Project Option: ECE 501 (3 credit hours), with a minimum grade of B.

Rationale: New text and reordering the bullets, make the text in this program consistent with the Computer Science and Electrical Engineering MS programs. Impact on other units: None. Financial impact: None.

REVISE ELECTRICAL ENGINEERING MAJOR, MS, REQUIRED COURSES

In the 2022-23 Graduate catalog, under the Required Courses heading, revise the last bullet as follows:

Required Courses
  - A maximum of 6 credit hours of courses outside the department chosen in consultation with major advisor may be applied toward the degree.

Formerly:
  - A maximum of 6 graduate credit hours of courses outside ECE or COSC may be applied toward the degree

Rationale: The edits make the requirements for courses taken outside the department consistent with the Computer Science and Computer Engineering MS programs. Impact on other units: None. Financial impact: None.

ENGINEERING FUNDAMENTALS

No Program changes.

DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

Industrial Engineering (IE)

ADD NEW MAJOR AND DEGREE

Major: Engineering Management
Degree: Master of Science

In the 2022 Graduate Catalog, add program and program requirements (pending THEC approval)

This program is pending approval from the Tennessee Higher Education Commission and the Southern Association of Colleges and Schools Commission on Colleges. Students will be admitted to the major should the program be approved.

The MS in Engineering Management program is designed for graduates of accredited undergraduate programs in engineering or similar discipline with industrial experience in an appropriate engineering or applied science position. The program is mainly for working engineers who can complete the program in two years while working fulltime. The program is 100% online with both synchronous and asynchronous options.

Campus Code
Knoxville Campus
UTSI Campus
Distance Education

Option Available
  Coursework only without Comprehensive Exam

Admission Standards/Procedures
- Applicants must submit a formal Graduate Application for Admission. In addition to the minimum requirements of the Graduate School, the Department of Industrial and Systems Engineering requires three rating forms or letters of reference.
- The Departmental Graduate Committee sets any prerequisite courses or other measures that apply to the particular situation of the applicant. The department and the Office of Graduate Admissions must be notified of any change in the entering date after admission has been granted.

Credit Hours Required
The credit hours required for the MS in Engineering Management are 30 graduate credit hours.

Required Courses

Course	Title	Hours
IE 533	Theory and Practice of Engineering Management	3
IE 516	Statistical Methods in Industrial Engineering	3
IE 518	Advanced Engineering Economic Analysis	3
IE 534	Financial Management for Engineering Managers	3
IE 536	Project Management	3
IE 537	Analytical Methods for Engineering Managers	3
IE 544	Manufacturing Systems Modeling and Analysis	3
IE 539	Strategic Management in Technical Organizations	3
IE 542	Design of Experiments for Engineering Managers	3
IE 550	Graduate Seminars	1 × 3

Non-Course Requirements
  None.

Rationale:
The department of Industrial and Systems Engineering and UT Space Institute started the Engineering Management (EM) MS program in 1984 as one of the first online programs in the nation. The program offers MS degree in Industrial Engineering (IE) with Engineering Management (EM) concentration. The program has been supported by the faculties on both Knoxville and UTSI campuses. It has graduated many students in the formats of online, in-person, and cohort over the years. The demography of students includes the on-campus full-time and off-campus part-time students from government agencies, industry, military, community colleges, etc. With the 30 plus years of experience of EM graduate program, it is the time now to convert our "experimental" EM program under the IE master degree with EM concentration to a true EM master degree program. This change will strength our program in competition with the similar programs offered by other university. All courses have been regularly offered and there are currently 36 students pursuing the EM concentration. After adding the EM MS program, the EM graduate Certificate will stay but the EM concentration under the Industrial Engineering MS program. Impact on other units: none. Financial Impact: none.

Additional Documentation: The program proposal is to be submitted for approval from the Tennessee Higher Education Commission, which needs the final disposition resulting from the UTK curricular approval process. Students will be admitted to the degree only after the university and THEC approve the program. The Letter of Intent and proposal submission (including ISE faculty and CVs) will be submitted to THEC.

DROP CONCENTRATION – INDUSTRIAL ENGINEERING MAJOR, MS

  Engineering Management – Thesis, Project, Course Only without Comprehensive Exam

In the 2022 Graduate Catalog, drop the Engineering Management concentration for the Industrial Engineering major, MS. Also, under the Additional Course Requirements heading, remove reference to the Engineering Management concentration.

Formerly:
Concentrations (Optional) and Options Available
  Engineering Management — Thesis, Project, Course Only without Comprehensive Exam

Formerly:
Additional Course Requirements
- Selection of a concentration is optional. They represent areas of research within the program. Courses are selected in consultation with the major professor and guidance committee
    - o Engineering Management

Rationale: With the added program, Engineering Management Major, MS, the Engineering Management concentration under the Industrial Engineering Major, MS is removed. Impact on other units: none. Financial Impact: none.

REVISE REQUIREMENTS

RELIABILITY AND MAINTAINABILITY ENGINEERING MAJOR, MS

Add IE 536 Project Management and IE 565 Applied Data Science into the list of the "Reliability and Maintainability Engineering Electives" in the "Required Courses" section.

- Six credit hours of reliability and maintainability engineering elective courses or statistics elective courses chosen from these lists.
    - o Reliability and Maintainability Engineering Electives:
        - ▪ CBE 529, BME 529, CE 529, ECE 529, ENVE 529, ME 529, MSE 529, or NE 529
        - ▪ ECE 504
        - ▪ IE 522*
        - ▪ IE536*
        - ▪ IE 565*
        - ▪ ME 534*
        - ▪ NE 441
        - ▪ NE 575*
        - ▪ NE 579*
    - o Statistics Electives:
        - ▪ STAT 537*
        - ▪ STAT 538*
        - ▪ STAT 575
        - ▪ STAT 579*

Formerly:
- Six credit hours of reliability and maintainability engineering elective courses or statistics elective courses chosen from these lists.
    - o Reliability and Maintainability Engineering Electives:
        - ▪ CBE 529, BME 529, CE 529, ECE 529, ENVE 529, ME 529, MSE 529, or NE 529
        - ▪ ECE 504
        - ▪ IE 522
        - ▪ ME 534*
        - ▪ NE 441
        - ▪ NE 575*
        - ▪ NE 579*
    - o Statistics Electives:
        - ▪ STAT 537*
        - ▪ STAT 538*
        - ▪ STAT 575
        - ▪ STAT 579*

Rationale: The reliability and maintainability engineers need more skills in project management and data sciences now and in the future. Impact on other units: none. Financial Impact: none.

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Materials Science and Engineering (MSE)

No Program changes.

DEPARTMENT OF MECHANICAL, AEROSPACE, AND BIOMEDICAL ENGINEERING

ADD CERTIFICATE

HYPERSONICS

In the 2022-23 Graduate Catalog, add heading, text and requirements for new certificate: Hypersonics.

Hypersonics Graduate Certificate

The graduate certificate in Hypersonics is intended for currently admitted graduate students.

The Mechanical, Aerospace & Biomedical Engineering Department offers this graduate certificate in hypersonics. The (12 credit hour) certificate will enable our graduate students to accomplish the following:

- Students will be able to utilize a knowledge of the foundational scientific disciplines relevant to hypersonic flight to contribute to the development of emerging aerospace systems.
- Students will apply knowledge of interactions between foundational scientific disciplines to understand the significant technical challenges associated with the highly integrated nature of hypersonic systems and to contribute to the multidisciplinary development of such systems.
- Certificate holders will have accomplished coursework in electives focused on particular segments of the broader field of hypersonics.

Campus Code:
Knoxville Campus
Distance Education

Graduate Certificate Type:
Stand-Alone
Add-On

Admissions Standards/Procedures:
Certificate candidates must currently be admitted to a graduate program at the university or hold a terminal degree and be admitted to the graduate school.

Credit Hours Required:
12 graduate credit hours

Required Courses:
- AE 525 (3 credit hours)
- Select at least three (9 credit hours) of the following*:
  - AE 521 Aerodynamics of Compressible Fluids I
  - AE 522 Aerodynamics of Compressible Fluids II
  - AE 532 Introduction to Turbulence
  - AE 569 Plasma Dynamics
  - AE 581 Rocket Propulsion I
  - AE 593 Independent Study

*Students may request substitution for one of the required courses listed in this bullet; requires approval from the certificate coordinator

Non-Course Requirements
To receive the certificate, students must:
1) complete the Graduate Certificate Course Verification Form (located on the Graduate School webpage under the Forms Central tab) and
2) through MyUTK, apply to graduate from the certificate program.

Rationale: There is a growing need for this graduate certificate due to the recent national prioritization of the development of hypersonic capabilities and the associated explosive growth of demand for engineers with hypersonics knowledge and experience. Industry partners and government routinely request we offer such a certificate to enhance their companies' labor force capabilities. Impact on other units: none. Financial impact: none.
CIP Code: (14.0201)

AEROSPACE ENGINEERING (AE)

ADD CONCENTRATION – AEROSPACE ENGINEERING MAJOR, MS

Nuclear Space Science and Engineering

In the 2022-23 Graduate Catalog, revise the Aerospace Engineering Major, MS, to include/add the new Nuclear Space Science and Engineering concentration,

Nuclear Space Science and Engineering – Thesis, Project, Course Only with Comprehensive Exams

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

ADD CONCENTRATION – AEROSPACE ENGINEERING MAJOR, PhD

Nuclear Space Science and Engineering

In the 2022-23 Graduate Catalog, revise the Aerospace Engineering Major, PhD, to include/add the new Nuclear Space Science and Engineering concentration,

Nuclear Space Science and Engineering – Thesis, Project, Course Only with Comprehensive Exams

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

REVISE REQUIREMENTS - AEROSPACE ENGINEERING MAJOR, PHD

In the 2022-23 Graduate Catalog, under the Required Courses heading, revise the next to last bullet as shown below:

- o The total number of approved course work and dissertation credit hours must meet the university's requirement of a minimum of 72 credit hours, inclusive of AE 595 and AE 601.

Formerly:
Required Courses
- o The total number of approved course work and dissertation credit hours must meet the university's requirement of a minimum of 72 credit hours.

REVISE REQUIREMENTS - AEROSPACE ENGINEERING MAJOR, PHD,

In the 2022-23 Graduate Catalog, under the Additional Course Requirements heading, revise as shown below:

1) first paragraph, first sentence: delete the word (three) and replace with (four);
2) in second-level open-circle bulleted list: add new concentration (Nuclear Space Science and Engineering) alphabetically to the other concentrations listed. Text should read:

Additional Course Requirements
- Concentration Specific Courses for the following four concentrations are selected in consultation with the major professor and guidance committee:
  - o Applied Mechanics
  - o Nuclear Space Science and Engineering
  - o Systems and Controls
  - o Thermal-Fluid Mechanics

Formerly:

Additional Course Requirements
- Concentration Specific Courses for the following three concentrations are selected in consultation with the major professor and guidance committee:
  - o Applied Mechanics
  - o Systems and Controls
  - o Thermal-Fluid Mechanics

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

BIOMEDICAL ENGINEERING (BME)

DROP CONCENTRATION – BIOMEDICAL ENGINEERING MAJOR, MS
Biomedical Systems

ADD CONCENTRATIONS – BIOMEDICAL ENGINEERING MAJOR, MS
Biomechanics
Materials
Nuclear Space Science and Engineering
Robotics
Theranostics

In the 2022-23 Graduate Catalog, remove dropped concentration and replace with new concentrations. There are no changes to the Admissions, Required Courses, or Non-Course Requirements sections.

Concentrations (Optional) and Options Available
Biomechanics – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Materials – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Nuclear Space Science and Engineering – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Robotics – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Theranostics – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

DROP CONCENTRATION – BIOMEDICAL ENGINEERING MAJOR, PHD
Biomedical Systems

ADD CONCENTRATIONS – BIOMEDICAL ENGINEERING MAJOR, PHD
Biomechanics
Energy Science and Engineering
Materials
Nuclear Space Science and Engineering
Robotics
Theranostics

In the 2022-23 Graduate Catalog, remove dropped concentrations and replace with new concentrations. There are no changes to the Admissions, Required Courses, or Non-Course Requirements sections.

Biomechanics – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Energy Science and Engineering - Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Materials – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Nuclear Space Science and Engineering – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Robotics – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option
Theranostics – Thesis Option, Project Option, Coursework Only with Comprehensive Exams Option

Rationale: The department faculty have determined that concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

REVISE ADDITIONAL COURSE REQUIREMENTS – BIOMEDICAL ENGINEERING MAJOR, PHD

In the 2022-23 Graduate Catalog, under the Additional Course Requirements heading, remove first paragraph and replace with the following:

Additional Course Requirements
- Concentration Specific Courses for the following six concentrations are selected in consultation with the major professor and guidance committee:
    o Biomechanics
    o Energy Science and Engineering
    o Materials
    o Nuclear Space Science and Engineering
    o Robotics
    o Theranostics

Formerly:
Additional Course Requirements
  Concentration Specific Courses for the following the Biomechanics and Biomedical Systems and Controls concentrations are selected in consultation with the major professor and guidance committee.

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

REVISE REQUIRED COURSES HEADING - BIOMEDICAL ENGINEERING MAJOR, PHD

In the 2022-23 Graduate Catalog, under the Required Courses heading, revise the 3rd bullet as shown below

- A minimum of 6 semester credit hours of graduate course work is required at the 600-level, exclusive of BME 600 and BME 601.

Formerly:
Required Courses
A minimum of 6 semester credit hours of graduate course work is required at the 600-level. These are exclusive of <u>BME 500</u>, <u>BME 600</u>, and <u>BME 601</u>.

REVISE REQUIRED COURSES HEADING - BIOMEDICAL ENGINEERING MAJOR, PHD

In the 2022-23 Graduate Catalog, under the Required Courses heading, revise the 4th bullet as shown below

- o The total number of approved course work and dissertation credit hours must meet the university's requirement of a minimum of 72 credit hours, inclusive of BME 595 and BME 601.

Formerly:
Required Courses
The total number of approved course work and dissertation credit hours must meet the university's requirement of a minimum of 72 credit hours.

MECHANICAL ENGINEERING (ME)

ADD CONCENTRATION – MECHANICAL ENGINEERING MAJOR, MS

Nuclear Space Science and Engineering

In the 2022-23 Graduate Catalog, revise the Mechanical Engineering Major, MS, to include/add the new Nuclear Space Science and Engineering concentration,

Nuclear Space Science and Engineering – Thesis Option, Project Option, Course Only with Comprehensive Exams

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

ADD CONCENTRATION – MECHANICAL ENGINEERING MAJOR, PHD

Nuclear Space Science and Engineering

In the 2022-23 Graduate Catalog, revise the Mechanical Engineering Major, PhD, to include/add the new Nuclear Space Science and Engineering concentration,

Nuclear Space Science and Engineering – Thesis Option, Project Option, Course Only with Comprehensive Exams
Concentrations (Optional)
Applied Mechanics
Automotive Manufacturing Simulation and Design
Energy Science and Engineering
Nuclear Space Science and Engineering
Systems and Controls
Thermal-Fluid Mechanics

Formerly:
Concentrations (Optional)
Applied Mechanics
Automotive Manufacturing Simulation and Design
Energy Science and Engineering
Systems and Controls
Thermal-Fluid Mechanics

REVISE ADDITIONAL COURSE REQUIREMENTS HEADING TO INCLUDE NEW CONCENTRATION – MECHANICAL ENGINEERING MAJOR, PHD

In the 2022-23 Graduate Catalog, Additional Course Requirements section, first paragraph, first sentence: delete the seventh word (four) and replace with (six); moreover, in second-level open-circle bulleted list: add new optional concentration (Nuclear Space Science and Engineering) alphabetically between the existing (Automotive Manufacturing Simulation and Design) and (Systems and Controls) concentrations. Text should read:

In the 2022-23 Graduate Catalog, under the Additional Course Requirements heading, in the first paragraph delete the word "four" and replace with "six". Also, add the new concentration to the list of concentrations. Text should read:

- Concentration Specific Courses for the following five concentrations are selected in consultation with the major professor and guidance committee:
    - Applied Mechanics
    - Automotive Manufacturing Simulation and Design
    - Nuclear Space Science and Engineering
    - Systems and Controls
    - Thermal-Fluid Mechanics
    - Energy Science and Engineering

Formerly:
Additional Course Requirements
Concentration Specific Courses for the following four concentrations are selected in consultation with the major professor and guidance committee:
  Applied Mechanics
  Automotive Manufacturing Simulation and Design
  Systems and Controls
  Thermal-Fluid Mechanics
  Energy Science and Engineering

Rationale: The department faculty have determined that optional concentration changes are necessary to reflect the needs of potential and current students as well as reflecting additional resources and new faculty. Impact on other units: None. Financial impact: None.

REVISE REQUIRED COURSES HEADING - MECHANICAL ENGINEERING MAJOR, PHD

In the 2022-23 Graduate Catalog, under the Required Courses section, revise the last bullet as follows:

- The total number of approved course work and dissertation credit hours must meet the university's requirement of a minimum of 72 credit hours, inclusive of ME 595 and ME 601.

Formerly:
Required Courses
The total number of approved course work and dissertation credit hours must meet the university's requirement of a minimum of 72 credit hours.

DEPARTMENT OF NUCLEAR ENGINEERING

Nuclear Engineering (NE)

ADD CONCENTRATION – Nuclear Engineering Major, PhD:

Nuclear Space Science and Engineering

In the 2022-2023 Graduate Catalog, add new concentration to the Nuclear Engineering Major, PhD. Campus Code, Admissions Standards, Credit Hours Required, are same as other concentrations.

Rationale: NE graduate courses related to space exploration (NE 512 – Space Radiation, NE 518 – Radioisotope Power Systems, and NE 618 – Nuclear Reactors for Space Exploration) have been drawing 12-15 students per class, including students from other departments. Jobs related to space exploration jobs have increased in the past decade in both the government and private industry. UTSI and MABE are planning concentrations in space sciences as well, providing students a large range of classes related to space exploration. Impact on other units: None. Financial impact: None.

REVISE THE NUCLEAR ENGINEERING MAJOR, PHD, TO ADD HEADING AND REQUIRED COURSES FOR THE NEW NUCLEAR SPACE SCIENCE AND ENGINEERING CONCENTRATION

In the 2022-23 Graduate Catalog, add heading and requirements for the Nuclear Space Science and Engineering concentration.

Required Courses:
- NE 600 (minimum of 24 credit hours)
- A minimum of 39 credit hours in nuclear engineering (NE) courses numbered 500 and above (or the equivalent).
    - A minimum of 27 credit hours of graduate courses in nuclear engineering at or above the 500-level
    - Students must take NE 512, NE 518, and NE 618
    - Two electives from the list below:
        - NE 517 (Isotope Production)
        - NE 520 (Introduction to Nuclear Fuels and Materials)
        - NE 540 (Fundamentals of Irradiation Effects in Nuclear Materials)
        - AE/ME 599 (Nuclear Space Propulsion)
        - AE 581 (Rocket Propulsion I)
        - AE 566 (Electric Propulsion)
        - AE 599 (Orbital Mechanics)
        - AE 599 (Spacecraft Systems Engineering)
        - AE 682 (Rocket Propulsion II)
    - To include 3 credit hours (1+1+1) of NE 501
    - Excludes thesis, practice project, or dissertation credit
    - A minimum of 12 additional course work credit hours is required, subject to approval by the student's faculty committee
    - At least 6 credit hours of the above coursework must be at the 600-level, with at least 3 of these credit hours in nuclear engineering
    - At the discretion of the student's dissertation committee and depending on the student's background, more than 39 credit hours of courses may be required
    - A maximum of 24 credit hours from a master's degree may be used to satisfy the course work requirements for the PhD
    - A minimum of 39 credit hours of graduate course work beyond the bachelor's degree and 24-33 credit hours of dissertation (NE 600)

Additional Course Requirements: None.

Non-Course Requirements: None.

Rationale: NE graduate courses related to space exploration (NE 512 – Space Radiation, NE 518 – Radioisotope Power Systems, and NE 618 – Nuclear Reactors for Space Exploration) have been drawing 12-15 students per class, including students from other departments. Jobs related to space exploration jobs have increased in the past decade in both the government and private industry. UTSI and MABE are planning concentrations in space sciences as well, providing students a large range of classes related to space exploration.
Impact on other units: None. Financial impact: None.