MATERIALS AND ENERGY SCIENCE AND ENGINEERING

Subject-area course lists indicate courses currently active for offering at the University of Louisville. Not all courses are scheduled in any given academic term. For class offerings in a specific semester, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm).

500-level courses generally are included in both the undergraduate- and graduate-level course listings; however, specific course/section offerings may vary between semesters. Students are responsible for ensuring that they enroll in courses that are applicable to their particular academic programs.

Course Fees

Some courses may carry fees beyond the standard tuition costs to cover additional support or materials. Program-, subject- and course-specific fee information can be found on the Office of the Bursar website (http://louisville.edu/bursar/tuitionfee/).

MESE 600. Energy Science and Engineering **3 Units**
Term Typically Offered: Fall, Spring
Description: This course presents an overview of global challenges associated with energy/environment nexus, energy demand, generation and storage. In particular, the course will cover fundamentals of thermodynamics, physics, chemistry and kinetics as applied to various energy technologies. The topics will include thermodynamic efficiency, state of the art, challenges associated with size and for each of the energy systems and their impact on environment and sustainability. Topics on energy conversion will include all renewable forms of electricity and fuel generation, their storage and transportation. Topics will also include advanced fossil fuel R&D, carbon dioxide capture and utilization and renewable fuels.
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MESE 601. Materials Science and Engineering **3 Units**
Term Typically Offered: Fall, Spring
Description: Provides a background in materials for students coming from various majors in engineering and science. The course will review fundamental crystal structures, structure, bonding relations and defects in crystals. Thermodynamics of solids, phase diagrams, structure-property relationships, microstructure control, lattice dynamics and fundamental electrical, magnetic and optical properties.
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MESE 603. Fundamentals of electrical, optical and thermal properties of solid materials **3 Units**
Term Typically Offered: Fall, Spring
Prerequisite(s): MESE 601 or Permission by Instructor Prerequisites or corequisites: MESE 600 This course is intended to introduce the fundamentals of electrical, optical and thermal properties of materials along with relevant characterization methods.
Description: Students will gain a comprehensive understanding of key concepts, including semiconductor fundamentals (band structure, work function, Fermi energy, effective mass, etc.), semiconductor statistics, doping (carrier concentrations, Fermi-Dirac distribution, and equilibrium properties), transport phenomena (drift, diffusion, ambipolar effects, and hot electron phenomena), carrier dynamics (recombination and generation processes, lifetime, and mobility), thermal properties (heat capacity, thermal conductivity), and optical properties (absorption and emission, reflection, refraction). The course also includes selected other important topics such as magnetic properties, superconductivity, ion-conductivity, and semiconductor devices. Additionally, students will be introduced to computational techniques and predictions in materials scie
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MESE 610. Materials Characterization: Microscopy & Diffraction **3 Units**
Term Typically Offered: Summer Only
Prerequisite(s): MESE 601.
Description: This course provides graduate students fundamental understanding of some of the most important material's characterization techniques. Special focus is placed on fundamental aspects and practical applications of electron microscopy and diffraction methods to phase identification and structure determination for crystalline material. Following this course, students will (1) learn and understand fundamental concepts of materials structure, with the emphasis on crystals structure, (2) understand fundamentals of electron microscopy and diffraction techniques, and (3) apply theoretical methods and software tools to analyze and interpret various types of microscopic and diffraction data.
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MESE 612. Photovoltaics and Solar Fuels **3 Units**
Term Typically Offered: Spring Only
Prerequisite(s): MESE 600, MESE 601.
Description: This course develops the fundamentals of semiconductor physics specific to solar energy and uses these key concepts to understand solar cell behavior. The various photovoltaic technologies, including both commercial and research-stage approaches, are described in detail. In addition, electrochemical and catalysis concepts are introduced and integrated with semiconductor behavior to understand the myriad criteria necessary to leverage solar energy in electrochemical fuel production processes such as water-splitting via artificial photosynthesis.
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MESE 614. Biomass Processing and Biofuels **3 Units**
Prerequisite(s): MESE 600 or permission of instructor.
Description: Manufacturing of bio-based products (materials, chemicals and energy produced using sustainable resources such as agricultural biomass) offers socio-economic and environmental benefits. In order to be a part of this emerging bioeconomy, it is essential to learn the fundamental skills of managing biorenewable resources for the effective development of the rapidly evolving bioenergy and biofuels industries. This multi-disciplinary course for senior level undergraduates and all graduate students integrates the biorenewable knowledge base of academic disciplines that include agriculture, chemistry, engineering, environmental sciences, and economics to provide a student with a broader perspective on biomass conversion to bioproducts.
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MESE 616. Energy Storage Systems **3 Units**
Term Typically Offered: Fall, Spring
Prerequisite(s): ME 440.
Description: This course will cover functional knowledge of various energy storage modes with emphasis on electrochemical energy storage. It will introduce the fundamental principles of different energy storage systems such as mechanical energy storage, thermal energy storage, chemical energy storage, and electrochemical energy storage. The practical applications for each energy storage system will be discussed. This course will also focus on the chemistry and materials science behind these energy storage systems. In addition, the basis performance analysis of different types of batteries will be introduced and compared.
Note: Cross-listed with ME 572.

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MESE 619. Industrial Catalysis **3 Units**
Term Typically Offered: Fall, Spring
Description: This course will teach scientific and technological concepts involved with industrial catalysis in many chemical processing applications. In addition to catalytic reaction mechanisms, the course will also teach industrial catalyst production methods and testing.
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MESE 622. Roll to Roll Processing **3 Units**
Term Typically Offered: Fall Only
Description: Continuous manufacturing through roll-to-roll processes has been a staple within several industries over the past century including film, newspaper and other traditional low cost high volume products. As the renewable industry begins to scale, roll-to-roll processes can play an extremely important role in reducing costs at high volumes. This course will explore the roll-to-roll manufacturing processes through fundamental engineering principals including economics, heat and mass transfer, thermodynamics and materials. The course will consider the manufacturing of solar modules, batteries and fuel cell membranes.
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MESE 640. Entrepreneurship in Renewable Energy **3 Units**
Term Typically Offered: Fall Only
Prerequisite(s): MESE 600; MESE 618; or ECE 531.
Description: The renewables market will continue to grow as the world seeks and finds cleaner and more sustainable techniques to produce energy. This product-based course guides student teams through the ideation to prototype development to test the commercial relevance of renewable energy products. At the end of the course each student team will have developed a prototype design supported by a business plan.
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MESE 642. Techno-Economic Analysis and Energy Policy **3 Units**
Term Typically Offered: Fall Only
Prerequisite(s): MESE 600 or instructor approval.
Description: While many novel scientific ideas are being explored for renewable energy generation and energy storage, a successful technology will require more than a proof-of-concept and an efficient prototype. This course will introduce methods for conducting a techno-economic analysis on an energy technology, determining the levelized cost of product over the facility lifetime, and modeling a sensitivity analysis to determine key performance metrics required to reach possible profitability. The development and current status of energy policies will be addressed as well and incorporated to inform ideal markets for a prospective energy technology. Student teams will conduct their own project analysis as the core component of their grade for the course.
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MESE 644. Smart Manufacturing **3 Units**
Term Typically Offered: Fall, Spring
Prerequisite(s): MESE 600, MESE 601.
Description: Smart Manufacturing are systems that are "fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs" (NIST). This directed reading and project-based course will address the key principles of Smart manufacturing with an emphasis on Energy efficiency, sustainability, and advanced sensors and control systems.
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MESE 690. Master's Project **3 Units**
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): MESE 600, MESE 601.
Description: Students enrolled in this course will engage in an engineering project or research activity and produce a report that demonstrates both mastery of the subject matter and a high level of communication skills. Oral presentaiton of the report is required.
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