COURSE DESCRIPTIONS

REQUIRED CORE ENERGY COURSES

- **Advanced Thermodynamics Requirement**

- WSU/ ME744 – Advanced Thermodynamics (4 quarter credits)
  Thermodynamics is studied from both the classical (macroscopic) and statistical (microscopic) viewpoints with emphasis on statistical thermodynamics. Property relationships, Maxwell relations, partition functions, distribution functions, kinetic theory and the Boltzmann transport equation are discussed. **Prerequisites:** ME316 or ME516.
- WSU/ME760 – Thermodynamics of Solids (4 quarter credits)
  Thermodynamics of solutions, reactions, phase transformations, surfaces and interfaces, and point defects. Quasi-chemical model for solutions. Heterogeneous phase equilibria. Phase diagrams and thermodynamic quantities. **Prerequisites:** ME375 or ME575.
- UD/MEE511 – Advanced Thermodynamics (3 semester credits)
  Equilibrium, first law, second law, state principle and zeroth law; development of entropy and temperature from availability concepts; chemical potential, chemical equilibrium and phase equilibrium. Thermodynamics of irreversible processes; Onsager reciprocal relations; application of these concepts to direct energy conversion. **Prerequisites:** ME316 or ME516.
- UD/CME507 – Advanced Thermodynamics (3 semester credits)
  Entropy balance, thermodynamics of energy conversion, mixtures, equilibria and current applications. **Prerequisites:** ME316 or ME516.
- AFIT/PHYS635 – Thermal Physics (4 quarter credits)
  Treats statistical mechanics and thermodynamics. Topics include statistical methods, statistical thermodynamics with applications, ensemble theory, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics with applications. **Prerequisites:** PHYS556 (PHY460 - quantum mechanics).

- **Energy Materials Requirement**

- WSU/ME780 – Advanced Energy Materials (4.5 quarter credits)
  This course will focus on principles and materials in the advanced energy conversion and storage systems from advanced batteries, fuel cells, hydrogen storage to solar cells. Through the journey in this course, students are anticipated to understand why and how these systems are advantageous in renewable energy applications. Students will have general knowledge on materials as well as materials selection/development in these systems. **Prerequisites**: ME 370 or ME 570, ME 375 or ME 575 or ME316 or ME516, ME 427 or ME 627 or ME428 or ME 628.
- UD/MAT590 – Energy Materials (3 semester credits)
  In this course various advanced energy technologies (AMTEC, Fuel Cells, RTG's, Thermoelectrics, Nuclear/Irradiation effects, etc.) are discussed with an emphasis on the role that materials serve in their development. Critical issues in materials development delaying the introduction of new advanced energy systems are identified along with how material selections are made based on operational system environments. **Prerequisites**: ME 370 or ME 570, ME 375 or ME 575 or ME316 or ME516, ME 427 or ME 627 or ME428 or ME 628.

REQUIRED RENEWABLE AND CLEAN ENERGY COURSES

- **Renewable Energy**

- WSU/ ME623 – Energy Conversion (4.5 quarter credits)
  This course will study the fundamentals of energy and energy conversion, our energy resources, direct energy conversion, heat to work energy conversion, fossil fuel energy conversion, and alternative energy conversion. **Prerequisites:** ME316 or ME516.
- WSU/ ME624 – Solar Engineering (4 quarter credits)

Fundamentals of solar radiation and how it can be utilized as an energy source. Flat plate collectors, concentrating collectors, solar hot water heating, photovoltaics and thermal energy storage will be discussed. **Prerequisites:** ME318 or ME 518.

- WSU/ME626 – Wind Power (4.5 quarter credits)
  Power in the wind, the wind turbine and its parts, performance of wind turbines, and economics of wind turbines are studied. **Prerequisites:** ME 317 or 517.
- WSU/EE699 – Electrical Power Processing (4.5 quarter credits). To be developed.
  A modern electrical engineering course that studies the processing of electrical power from alternative energy devices such as wind energy, solar energy, fuel cells, etc. to electrical power that can be placed on the electrical grid or used by modern appliances. **Prerequisites:** EE 301 or EE501.
- CSU/ WSU/ME699 – Hydropower Development (4.0 quarter credits).
  Hydraulics of turbo machines for power generation; hydrologic analysis for hydropower development for run-of the river systems and reservoir systems; dams and environmental impacts; environmental impact assessment; operations of reservoir systems; economics of hydropower generation. **Prerequisites:** ME 317 or ME517.
- WSU/ME750 – Photovoltaics (4.5 quarter credits)
  Basic principles of solar cells will be covered including semiconductors, electrons and holes, and p-n junctions. Different types of solar cell materials including crystalline and amorphous cells as well as techniques for increasing their efficiency will be presented. **Prerequisites:** ME 744 or ME760 or equivalent.
- WSU/ME752 – Hydrogen Energy (4.5 quarter credits)
  This course focuses on hydrogen as a renewable and clean means of energy storage, and discusses hydrogen production and storage, as well as an overview of hydrogen energy conversion. **Prerequisites:** ME 316 or ME 516 or ME 375 or ME 575
- UD/MEE573 – Renewable Energy Systems (3 semester credits)
  Introduction to the impact of energy on the economy and environment. Engineering models of solar thermal and photovoltaic systems. Introduction to wind power. Fuel cells and renewable sources of hydrogen. **Prerequisites:** ME 318 or ME 518.

- **Clean Energy**

- WSU/ ME628 – Fuel Cell Science and Technology (4.5 quarter credits)
  Fundamentals, technologies, applications of various types of fuel cells, Thermodynamics prediction, electrolyte conduction, electrode kinetics. Polymer electrolyte fuel cells, solid oxide fuel cell, fuel cell stack. **Prerequisites:** ME 315 or ME 515 and ME 370 or ME 570
- WSU/ ME627 – Electrochemical Storage Systems and Principles (4.5 quarter credits)
  Electrochemical principles and technologies of energy storage systems including lithium-ion batteries, fuel cells, and supercapacitors will be studied. Electrode potential, electrode kinetics, and interface double layer structure will be included in the course. **Prerequisites:** ME 315 or ME 515.
- CSU/ WSU/ME699 – Environmental Advances in Coal Based Power Plants (4 quarter credits).
  Coal as a source of thermal energy – historical perspective; sources of coal in the world; future dependence on coal for energy; power production using coal; general process description and flowsheeting; principles of combustion, conventional combustion reactors, environmental impact due to emissions of sulfur and nitrous oxides; fluidized bed reactors, design, process improvements in minimizing emissions; recent advances in fludized bed reactors and discussions on future innovations in technology for clean coal power production. **Prerequisites:** ME 318 or ME 518.
- UD/MEE/CME 524 – Fundamentals and Applications of Fuel Cells (3 semester credits)
  The course will cover fundamental as well as engineering aspects of fuel cell technology. Specifically, the course will cover basic principles of electrochemistry, electrical conductivity (electronic and ionic) of solids, and development/design of major fuel cells (alkaline, polymer electrolyte, phosphoric acid, molten carbonate and solid oxide). A major part of the course will focus on solid oxide fuel cells (SOFC), as it is emerging to be dominant among various fuel cell technologies. The SOFC can readily

and safely use many common hydrocarbon fuels such as natural gas, diesel, gasoline, alcohol and coal gas. **Prerequisites:** CME 311 (ME315) and CME 324 (ME318)

- UD/MEE/AEE 526 – Advanced Fuels (3 semester credits)
  Basic elements of hydrocarbon fuel production including petroleum based fuels and alternative fuels. Fuel properties, specifications, handling, and logistics. Introduction to chemical kinetics and the chemistry associated with liquid phase thermal-oxidative degradation of fuels. Introduction to the computational modeling of fuel thermal stability and fuel systems. **Prerequisites:** permission of instructor
- AFIT/NENG620 – Nuclear Reactor Theory and Engineering (4 quarter credits)
  This course presents nuclear reactor theory, building upon the coverage of nuclear physics (reactions, radiations, fission, etc.) and the coverage of neutron diffusion, prompt fast criticality and prompt kinetics. Delayed and thermal neutrons are incorporated into the treatment of criticality and kinetics. Reactor dynamics are examined, including aspects of reactor core and system design which provide reactivity feedback for reactor control. Nuclear reactor engineering topics include thermal management, energy conversion, radiation shielding, and mechanical and structural aspects of reactor and system design. This course provides a broadened exposure to applications of nuclear science, and provides the necessary foundation for the study of space nuclear power and of the nuclear fuel cycle. **Prerequisites:** ME744 or ME760 or MEE511 or PHYS635.

- **Energy Efficiency**

- WSU/ ME642 – Vehicle Engineering (3.0 quarter credits)
  Develops students' abilities to derive and solve vehicle equations, and introduce dynamic analysis in vehicle design. Various performance criteria, control concepts, and HEVs will be studied. **Prerequisites:** ME 213
- UD/MEE569 – Energy Efficient Buildings (3 semester credits)
  Topics dealing with thermal environments and methods of control. Included are psychometrics, solar radiation, heat transmission through solid boundaries, industrial and residential environments, residential heating and cooling load calculations. **Prerequisites:** MEE 410 (ME318)
- UD/MEE571 – Design of Thermal Systems (3 semester credits)
  Integration of thermodynamics, heat transfer, engineering economics, and simulation and optimization techniques in a design framework. Topics include design methodology, exergy analysis, heat exchanger networks, thermal-system simulation and optimization techniques. **Prerequisites:** MEE 410 (ME318)
- UD/MEE 572 – Design for Environment (3 semester credits)
  Emphasis on design for environment over the life cycle of a product or process, including consideration of mining, processing, manufacturing, use, and post-life stages. Course provides knowledge and experience in invention for the purpose of clean design, life cycle assessment strategies to estimate the environmental impact of products and processes, and cleaner manufacturing practices. Course includes a major design project. **Prerequisites:** MEE 410 (ME318)
- UD/MEE 578 – Energy Efficient Manufacturing (3 semester credits)
  This course presents a systematic approach for improving energy efficiency in the manufacturing sector. Current patterns of manufacturing energy use, the need for increased energy efficiency, and models for sustainable manufacturing are reviewed. The lean-energy paradigm is applied to identify energy efficiency opportunities in industrial electrical, lighting, space conditioning, motor drive, compressed air, process heating, process cooling, and combined heat and power systems**. Prerequisites:** EGR 202 (ME315) or equivalent; MEE 344 (manufacturing process) or permission of instructor.

REQUIRED MATH COURSE

Students are required to take 1 graduate level math course. Some possible math courses at Wright State are:

- WSU/MTH504 – Advanced Engineering Mathematics I (3 quarter credits)
  Topics may include ordinary differential equations, linear algebra orthogonality, Fourier series and integrals, multivariable calculus, and partial differential. **Prerequisites:** MTH232 and MTH235 or MTH233 and MTH253.
- WSU/MTH505 – Advanced Engineering Mathematics II (3 quarter credits)
  Topics may include multivariable calculus, partial differential equations, numerical methods, linear algebra, complex variables, conformal mapping, calculus of variations, and wavelets. **Prerequisites:** MTH304 or MTH 504.
- WSU/MTH517 – Numerical Methods for Digital Computers II (4 quarter credits) An introduction to numerical methods used in the sciences. Includes methods of interpolation, data smoothing, functional approximation, integration, solutions of systems of equations, and solutions of ordinary differential equations.. **Prerequisites:** MTH 233 and MTh 316 or MTH516 and MTH253 or MTH355 or MTH555.
- WSU/MTH532 – Complex Variables (3 quarter credits) Partial differential equations, boundary value problems, eigenfunctions, Fourier series, and applications. **Prerequisites:** MTH232.
- WSU/MTH533 – Partial Differential Equations and Boundary Value Problems (3 quarter credits) Partial differential equations, boundary value problems, eigenfunctions, Fourier series, and applications. **Prerequisites:** MTH232 and MTH 233.
- WSU/MTH606 – Mathematical Modeling (3 quarter credits) Structure and properties of mathematical models. Size effects, dimensional analysis, graphical methods, comparative statics, stability, optimization techniques, probabilistic models, and Monte Carlo simulation. **Prerequisites:** MTH233, MTH253 or MTH 455 or 655.
- WSU/MTH607 – Optimization Techniques (3 quarter credits) Concepts of minima and maxima; linear programming; simplex method, sensitivity, and duality; transportation and assignment problems; and dynamic programming. **Prerequisites:** MTH233 and MTH 253 or MTH255.
- WSU/MTH616 – Matrix Computations (4 quarter credits) Survey of numerical methods in linear algebra emphasizing practice with high-level computer tools. Topics include Gaussian elimination, LU decomposition, numerical eigenvalue problems, QR factorization, least squares, singular value decompositions, and iterative methods. **Prerequisites:** MTH253 or MTH 455 or MTH655 and CS142 or CS 241.
- WSU/MTH631 – Real Variables (3 quarter credits) Functions, sequences, limits, continuity, differentiability, integration, and mean-value theorems. **Prerequisites:** MTH232.
- WSU/MTH655 – Advanced Linear Algebra (3 quarter credits) Vector spaces and subspaces, basis and dimension, linear transformations and matrices, eigenvalues and eigenvectors, inner product spaces. **Prerequisites:** MTH255.
- Additional math courses can be found in the Course Catalog located at http://www.wright.edu/academics/catalog/grad/descriptions.html

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ELECTIVES

Students are required to take 2 or 3 graduate elective courses. These electives can be taken in the Engineering, Computer Science, Physics, Chemistry, Biology, Microbiology, Geology, Environmental Sciences, Mathematics, and Statistics disciplines. It is recommended that these course be used to strengthen the students thesis work. This wide selection of courses can be found in the Course Catalog located at http://www.wright.edu/academics/catalog/grad/descriptions.html

THESIS OPTION

- WSU/ME899 – Thesis (1- 12 quarter credits) Thesis research. Can register for these credits any quarter. **Prerequisites:** none

NON-THESIS OPTION

- WSU/ME890 – Independent study. (1- 4 quarter credits). This class can be used to fulfill the project requirement. This course is an independent study under the direction of a faculty advisor. The details of the project are worked out with the faculty advisor. **Prerequisites:** none

BACKGROUND REQUIREMENTS

- WSU/ ME315 or ME515 – Thermodynamics I (4 quarter credits)
  Classical thermodynamics which focuses on thermodynamic properties of fluids, conservation of mass, conservation of energy, and the second law of thermodynamics. These principles are applied to engineering problems. **Prerequisites:** PHY 244 and MTH 232.
- WSU/ ME316 or ME516 – Thermodynamics II (4 quarter credits)
  Concepts of energy, power cycles, refrigeration cycles, gas mixtures, vapor-gas-mixtures, and combustion. **Prerequisites**: ME315 or ME515.
- WSU/ ME317 or ME517 – Fluid Dynamics (4 quarter credits)
  Study of fluid properties, fluid statics, incompressible flows, real fluid flows, and flow measurement. **Prerequisites**: ME315 or ME515.
- WSU/ ME318 or ME518 – Fluid Dynamics (4 quarter credits)
  Study of the movement of energy due to a temperature difference. The three modes of heat transfer are investigated: conduction, convection, and radiation. Detailed look at Heat Equation. **Prerequisites**: ME317 or ME517.
- WSU/ ME370 or ME570 – Materials Engineering Science: Introduction (4 quarter credits)
  Effect of atomic, molecular, and crystalline structures on the properties of materials with emphasis on electronic materials and ceramics, characterization of materials, and device fabrication **Prerequisites**: CHM121 and PHY244.
- WSU/ ME375 or ME575 – Thermodynamics of Materials (4 quarter credits)
  Application of classical thermodynamics to engineering materials. Heats of formation and reaction; behavior of solutions; free energy concepts; thermodynamic fundamentals of phase equilibria. **Prerequisites**: ME315 or ME515 and ME371 or ME571.

Additional Background Course that may be used as a prerequisite for other courses.

- WSU/ ME371 or ME571 – Structure and Properties f Engineering Materials (3 quarter credits)
  Effect of microstructure, phase equilibrium, and processing on properties of structural materials including metallic alloys, polymers, and composites. **Prerequisites**: ME313 or ME513 and ME370 or ME570.