

Post Graduate Courses Descriptions: Energy Systems Engineering

Energy Systems Engineering Curriculum

Singhania University Committee has developed an interdisciplinary ESE curriculum. It will provide a coherent approach to energy engineering by equipping its students with the tools needed to conceptualize, analyze, design and integrate advanced energy systems. This approach is informed by a broad perspective on energy production, transmission and utilization technology options and trade-offs, and an appreciation for public policy and regulatory issues.

The curriculum will focus on the science and engineering that underpins energy conversion systems and will address engineering, science, and societal issues in the areas of fossil, nuclear, and renewable power generation, including hydrogen production and generation, energy usage, conservation and optimization, and sustainable development.

Research and education in the science and engineering of fossil, nuclear, and renewable energy production are current areas of strength at UMD and are perceived to be of critical importance to the future well being of this nation. ESE students will be uniquely qualified to participate in the formulation and implementation of future energy strategies and will provide a leadership cadre for the energy engineering community.

Participating students will be expected to complete the MS or PhD degree requirements of their respective departments' programs, while taking as many courses as possible from the ESE Curriculum. The final decision on course selection is reached in coordination with the student, his/her adviser and the respective department's graduate director.

Students participating in the ESE Curriculum must be accepted as advisee by one of the faculty participating in the ESE Curriculum and should have completed a M.Tech. in an engineering discipline

Energy system design is a multidisciplinary specialization that includes science, engineering, and the development of policies that promote sustainable systems. All engineering disciplines will be increasingly engaged in finding power sources of the future. This new generation of energy technologists will also need the skills to communicate and collaborate effectively with policy-makers.

Building on U-M's leadership role in energy issues and innovative environmental applications, this new program will prepare engineers to creatively meet the needs of developed and developing economies by adapting the fundamentals of civil power supplies, transportation power and microelectric and portable power.

**M.Tech. in ENERGY SYSTEMS ENGINEERING
(FOUR SEMESTER)**

S. N.	COURSE NO.	TITLE	TYPE	L-T-P	CREDITS
		SEMISTER- I			
1	MTME101	Advance Thermal Fluid Engineering			3
2	MTME102	NANO TO MACRO TRANSPORT PROCESS			3
3	MTME103	FUNDAMENTALS OF ADVANCE ENERGY CONVERSION			3
4	MTME104	ELECTROCHEMICAL SYSTEM: FUNDAMENTALS, MATERIALS AND APPLICATIONS			3
5	MTME105	APPLICATIONS OF TECHNOLOGY IN ENERGY AND THE ENVIRONMENT			3
		SEMISTER- II			
1	MTME201	ENERGY RESOURCES AND ECONOMICS			3
2	MTME202	ENERGY SYSTEMS MODELLING AND SIMULATION			3
3	MTME203	POWER GENERATION AND SYSTEM PLANNING			3
4	MTME204	MATERIALS AND DEVICES FOR ENERGY APPLICATION			3
5	MTME205	ENERGY ENVIRONMENT AND LAW			3
6	MTME-S1	SEMINAR			6
		SEMISTER- III			
1	MTME-P1	MAJOR PROJECT- Phase-1			12
		SEMISTER- IV			
1	MTME-P2	MAJOR PROJECT- Phase-2			12

Advance Thermal Fluid Engineering

General foundations of thermodynamics from an entropy point of view, entropy generation and transfer in complex systems. Definitions of work, energy, stable equilibrium, available energy, entropy, thermodynamic potential, and interactions other than work (nonwork, heat, mass transfer). Applications to properties of materials, bulk flow, energy conversion, chemical equilibrium, combustion, and industrial manufacturing.

Examines current and future energy conversion systems. Introduction to thermochemistry and thermal radiation heat transfer. Introduction to the design of turbomachinery and the design of thermal-fluids systems. Analysis of various energy conversion systems including Rankine, Brayton, Otto, and Diesel. Special attention to combined cycle plants and fuel cells. Introduction to refrigeration plants. Applications include stationary plants and mobile plants. Consideration of pollution, environmental, and policy issues.

Text/References:

- M. W. Zemansky, Heat and Thermodynamics 4th Edn. McGraw Hill, 1968.
- A. L. Prasuhn, Fundamentals of Fluid Mechanics, Prentice Hall, 1980
- S. P. Sukhatme, A Text book on Heat Transfer, Orient Longman, 1979.

Nano-to-Macro Transport Processes

Parallel treatments of photons, electrons, phonons, and molecules as energy carriers; aiming at a fundamental understanding of descriptive tools for energy and heat transport processes, from nanoscale to macroscale. Topics include energy levels; statistical behavior and internal energy; energy transport in the forms of waves and particles; scattering and heat generation processes; Boltzmann equation and derivation of classical laws; and deviation from classical laws at nanoscale and their appropriate descriptions. Applications in nanotechnology and microtechnology. Students taking the graduate version complete additional assignments.

Fundamentals of Advanced Energy Conversion

Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO₂ separation and capture. Biomass energy. Students taking the graduate version complete additional assignments.

Text/References:

- Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970

- Angrist S.W. ,Direct Energy Conversion. 4th Ed. Allyn And Bacon, Boston, 1982
- Green M.A. ,Solar Cells, Prentice-Hall, Englewood Cliffs, 1982
- Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.

Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications

Fundamental concepts, tools, and applications in electrochemical science and engineering. Introduces thermodynamics, kinetics and transport of electrochemical reactions. Describes how materials structure and properties affect electrochemical behavior of particular applications, for instance in lithium rechargeable batteries, electrochemical capacitors, fuel cells, photo electrochemical cells, and electrolytic cells. Discusses state-of-the-art electrochemical energy technologies for portable electronic devices, hybrid and plug-in vehicles, electrical vehicles. Theoretical and experimental exploration of electrochemical measurement techniques in cell testing, and in bulk and interfacial transport measurements (electronic and ionic resistivity and charge transfer cross the electrode-electrolyte interface).

Applications of Technology in Energy and the Environment

Introduces advanced undergraduates or graduate students in the Schools of Engineering and Science to the integration of technical, economic, political, and environmental consideration required for the successful implementation of new technology. Case studies are drawn from the energy and environment sectors with some emphasis on analytic techniques that serve as a "tool box" for students. Technologies considered include fossil, nuclear, solar, wind, fuel cell and energy conservation. International aspects, such as weapons proliferation and global climate effects, also discussed. Enrollment limited.

Sustainable Energy

Assessment of current and potential energy systems, covering extraction, conversion and end-use, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner. Examination of energy technologies in each fuel cycle stage for fossil (oil, gas, synthetic), nuclear (fission and fusion) and renewable (solar, biomass, wind, hydro, and geothermal) energy types, along with storage, transmission, and conservation issues. Focus on evaluation and analysis of energy technology systems in the context of political, social, economic, and environmental goals. Open to upper-class undergraduates.

Text/References:

- Energy and the Challenge of Sustainability, World energy assessment, UNDP New York, 2000.
- AKN Reddy, RH Williams, TB Johansson, Energy after Rio, Prospects and challenges, UNDP, United Nations Publications, New York, 1997.
- Nebojsa Nakicenovic, Arnulf Grubler and Alan McDonald Global energy perspectives, Cambridge University Press, 1998

- Fowler, J.M., Energy and the environment, 2nd Edn., McGraw Hill, New York, 1984
 - Solar cells: Operating principles, technology and system applications, by Martin A. Green, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981.
- Semiconductors for solar cells, H. J. Moller, Artech House Inc, MA, USA, 1993.
- Solid State electronic devices, Ben G. Streetman, , Prentice-Hall of India Pvt. Ltd.,

Recommended books:

A. Thermodynamics

1. Cengel & Bohls
2. Van Wylen
3. P.K.Nag
4. D. S. Kumar

B. Turbomachinery-Fluid Machenics

1. Jagdish Lal
2. Andersan

C. Refrigeration

1. C. P. Arora
2. Manohar Prasad

D. Analysis of various energy conversons (Rankine etc)

1. Any book of Thermodynamics Chapters - Gas Power cycle & Vapour Power Cycle

E. Heat & Mass transfer

1. Dewitt & Incropere
2. D. S. Kumar
3. S. P. Sukhatme