Virginia Tech Green Engineering:

Integrating Concepts of Sustainability and Environmental Impact into Undergraduate Engineering Education

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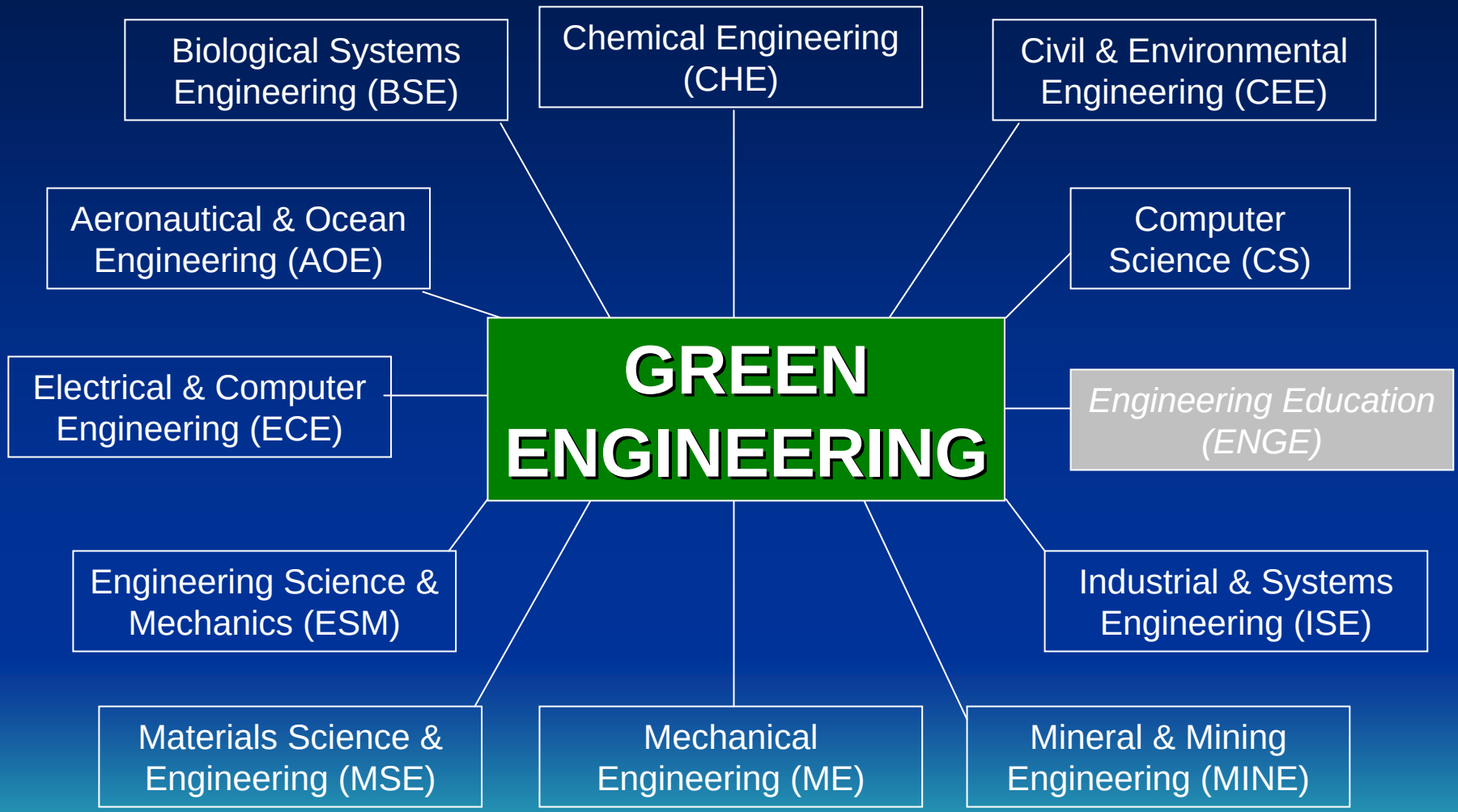


VirginiaTech
Invent the Future

What Is Green Engineering?

- **Virginia Tech**
  - the design of materials, processes, systems, and devices with the objective of minimizing overall environmental impact throughout a product's entire life cycle.

- **Environmental Protection Agency**
  - the design, commercialization, and use of processes and products, which are feasible and economical while minimizing the generation of pollution at the source and the risk to human health and the environment

- *Green Engineering recognizes environmental impacts as an initial design constraint and considers them throughout the entire life cycle*

VT Green Engineering Program Goals

1. Increase awareness among engineering students about the impact of their decisions on the environment

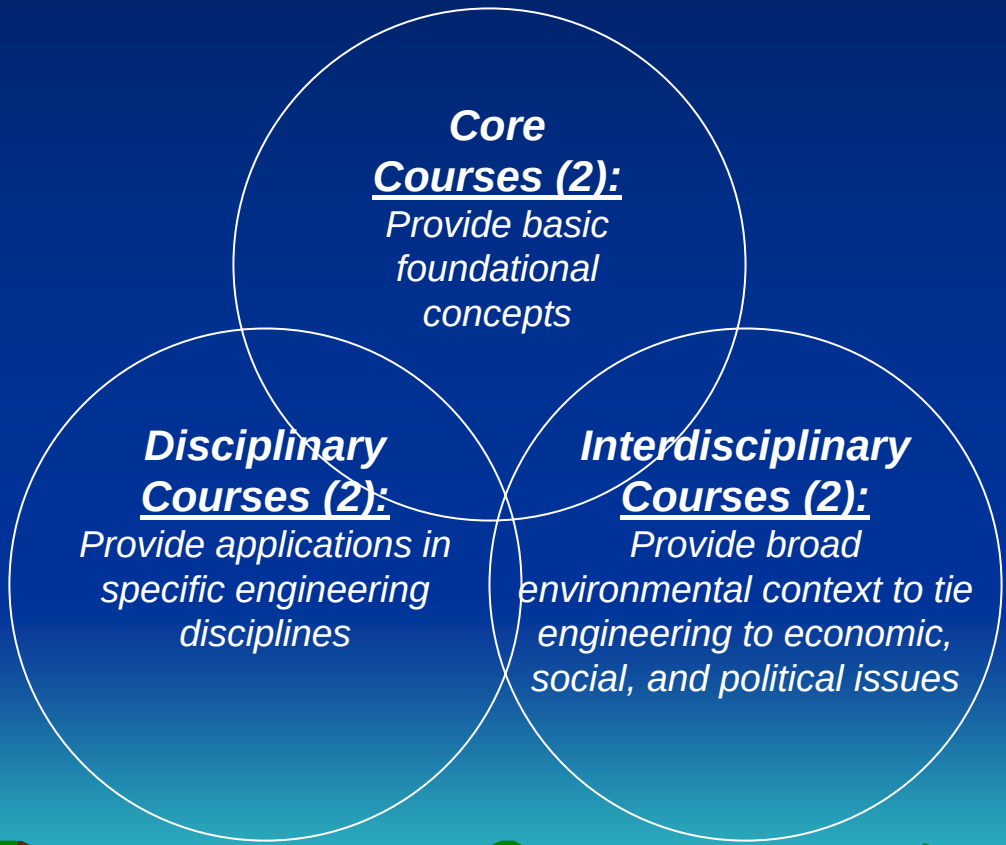
2. Provide students with engineering design and analytical skills to help solve or minimize environmental issues

3. Identify interdisciplinary research opportunities for students and faculty

4. Engage the broader community in this topic to help further the above goals

VT Green Engineering Curriculum

- A Green Engineering Concentration is currently available to students completing 18 credit hours (6 courses):



Green Engineering Core Courses

Introduction to Green Engineering:

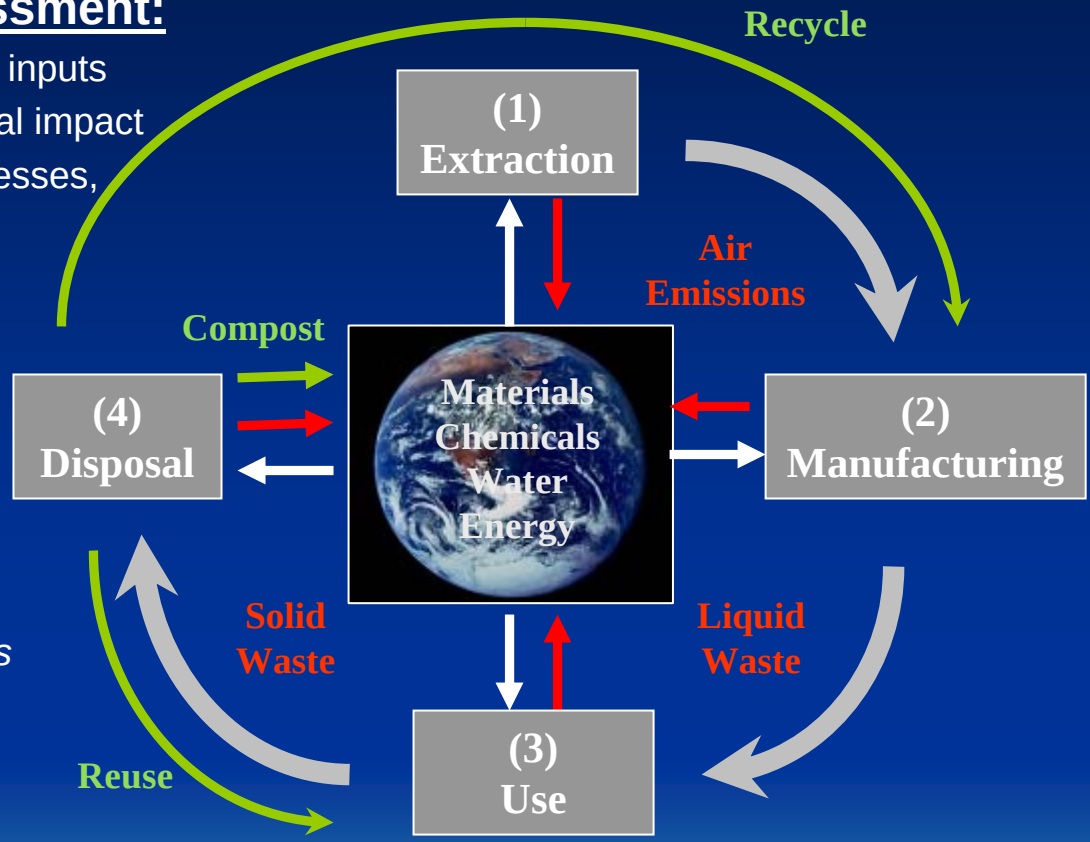
- Introduces students to current and future environmental issues, for example:
  - *Natural resource limitations*
  - *Energy issues*
  - *Climate Change*
  - *Ecosystems*
  - *Pollution and Waste*
  - *Water*
  - *Agriculture*
  - *Transportation*

- Explores how engineering practice impacts the environment and how engineers can design products, processes, and system to help solve or minimize environmental problems

Green Engineering Core Courses

Environmental Life Cycle Assessment:

- Examines and quantitatively analyzes all inputs and outputs as well as their environmental impact for all life cycle phases of products, processes, and systems.



- **Key Concepts:**
  - *Design w/ environmental constraints*
  - *Materials selection*
  - *Minimize mass*
  - *Mass balance of the system*
  - *Waste as a design flaw*
  - *Data driven decision-making*

Green Engineering Disciplinary Courses

Aerospace Engineering

AOE 4064	Fluid Flows in Nature

Biological Science and Engineering

BSE 3305	Land and Water Resources Engineering
BSE 3306	Land and Water Resources Engineering
BSE 4125	Comprehensive Design Project
BSE 4126	Comprehensive Design Project
BSE 4304	Non-point Source Pollution Modeling & Management
BSE 4324	Non-point Source Pollution
BSE 4394	Water Supply & Sanitation in Developing Countries
BSE 5134	Land Application of Wastes
BSE 5244	Advanced GIS in Hydrological Analysis
BSE 5354	Non-point Source Pollution Modeling

Chemical Engineering

CHE 3134	Separation Processes
CHE 3184	Chemical Reactor Analysis & Design

Civil and Environmental Engineering

CEE 3104	Introduction to Environmental Engineering
CEE 4104	Water and Wastewater Treatment Design
CEE 4114	Fundamentals of Public Health Engineering
CEE 4144	Air Resources Engineering
CEE 4164	Environmental Microbiology
CEE 4174	Solid and Hazardous Waste Management
CEE 4304	Hydrology
CEE 4354	Environmental Hydrology
CEE 4554	Natural Disaster Mitigation
CEE 4594	Soil and Groundwater Pollution
CEE 4984	Pollution Control & Design for the Aquatic Environment

Electrical Engineering

ECE 4304	Design in Power Engineering
ECE 4364	Alternate Energy Systems (Online course)
ECE 5364	Electric Energy & Environmental Systems

Engineering Science and Mechanics

ESM 4015	Senior Design Project*

Industrial Systems Engineering

ISE 2204	Manufacturing Processes
ISE 4644	Occupational Safety and Hazard Control

Materials Science and Engineering

MSE 2044	Elements of Materials Engineering
MSE 4055	Material Selection and Design

Mechanical Engineering

ME 4015	Engineering Design and Project
ME 4016	Engineering Design and Project
ME 4134	Thermal Environmental Systems
ME 4154	Industrial Energy Management
ME 4204	Internal Combustion Engines
ME 4214	Power Generation
ME 4554	Advanced Technology for Motor Vehicles
ME 4724	Engineering Acoustics
ME 4744	Complexity of Socio-Technical Problems
ME 4984	Hydrogen Energy Systems
ME 4984	Building Energy Systems
ME 5214	Combustion
ME 5254	Fuel Cell Systems
ME 5734	Advanced Engineering Acoustics

Mineral and Mining Engineering

MINE 3544	Mineral Processing Laboratory
MINE 3554	Resource Recovery
MINE 4554	Mine Reclamation and Environmental Management

Green Engineering Interdisciplinary Courses

Agriculture and Applied Economics

AAEC 3314	Environmental Law
AAEC 4304	Environmental & Sustainable Development Economics
AAEC 4314	Environmental Economic Analysis and Management
AAEC 4344	Sustainable Development Economics

Apparel, Housing, and Resource Management

AHRM 4604	Housing, Energy, and the Environment

Architecture

ARCH 4055	Environment and Building Systems
ARCH 4056	Environment and Building Systems

Biology

BIOL 2804	Ecology
BIOL 4004	Freshwater Ecology
BIOL 4014	Environmental Toxicology
BIOL 4044	Biogeography

Chemistry

CHEM 4984	Green Chemistry

Crop and Soil Environmental Sciences

CSES 3644	Plant Materials for Environmental Restoration
CSES 4644	Land-Based Systems for Waste Treatment
CSES	Environmental Soil Chemistry

General Engineering

ENGR 1814	Energy, Resources and the Environment

Environmental Science

ENSC 3634	Physics of Pollution
ENSC 4164	Environmental Microbiology

Fisheries and Wildlife

FIW 4614	Fish Ecology

Forestry

FOR 2554	Nature and American Values

Geography

GEOG 3104	Environmental Problems, Population, & Development
GEOG 4204	Geography of Resources
GEOG 5234	Human Impacts on the Environment

Geosciences

GEOS 1024	Resources Geology
GEOS 3014	Environmental Geosciences
GEOS 4634	Environmental Geochemistry

History

HIST 3144	American Environmental History

Political Science

PSCI 3344	Global Environmental Issues

Urban Affairs and Planning

UAP 3354	Introduction to Environmental Policy and Planning
UAP 4264	Environmental Ethics and Policy
UAP 4374	Land Use & the Environment: Planning and Policy
UAP 4394	Community Renewable Energy Systems

Wood Science

WOOD 2784	World Forests and Forest Products

Increasing the Program Scope and Impact

- **Create connections across VT colleges and departments**
  - College of Architecture and Urban Studies
    - *Architecture, Urban Affairs and Planning, etc.*
  - College of Natural Resources
    - *Horticulture, Forestry, etc.*
  - College of Agriculture and Life Sciences
    - *Crop and Soil Environmental Sciences, Food Science and Technology, etc.*
  - College of Science
    - *Biology, Chemistry, Physics, Biochemistry, Economics, etc.*
  - College of Liberal Arts and Human Sciences
    - *Political Science, Philosophy, Science and Technology in Society, etc.*

- **Challenges**
  - *Embracing interdisciplinarity*
  - *Crowded curricula*
  - *Resistance to change*