

Chemical Engineering Fundamentals and Design

Lecture 01

Team Presentation Subjects

Team presentation subjects

Grand challenges (<http://www.engineeringchallenges.org/cms/8996.aspx>)

Make solar energy economical

Solar energy provides less than 1% of the world's total energy, but it has the potential to provide much, much more.

- New materials for solar collectors
- New materials for battery
- Unique properties
- Reducing cost
- Increasing efficiency

Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.

- Limitless and clean energy
- Designing conditions and materials
- Development of reactors

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The graphic features a background of an industrial facility with smokestacks emitting thick plumes of smoke against a hazy, yellowish sky. A large green puzzle piece is positioned on the left, containing a white icon of a CO₂ molecule. Below the puzzle piece, the text 'Develop carbon sequestration methods' is written in a clean, sans-serif font. Underneath this, a smaller line of text reads: 'Engineers are working on ways to capture and store excess carbon dioxide to prevent global warming.' A horizontal row of various white icons is overlaid on the bottom right of the graphic, including symbols for a smartphone, VR, a gear, a building, a water drop, a radiation symbol, a CO₂ molecule, and a recycling symbol.

Develop carbon sequestration methods

Engineers are working on ways to capture and store excess carbon dioxide to prevent global warming.

- Decreasing greenhouse effect
- Capture and storage
- Conversion



The graphic shows a close-up of a person wearing a white lab coat and a white face mask, holding a small green plant seedling with both hands. The person's hands are wearing blue nitrile gloves. A wooden ruler is visible in the background, showing measurements in centimeters. A large green puzzle piece is on the left, containing a white icon of a nitrogen atom (N). Below the puzzle piece, the text 'Manage the nitrogen cycle' is displayed. Below this, a smaller line of text reads: 'Engineers can help restore balance to the nitrogen cycle with better fertilization technologies and by capturing and recycling waste.' A horizontal row of various white icons is overlaid on the bottom right of the graphic, including symbols for a smartphone, VR, a gear, a building, a water drop, a radiation symbol, a nitrogen atom, and a recycling symbol.

Manage the nitrogen cycle

Engineers can help restore balance to the nitrogen cycle with better fertilization technologies and by capturing and recycling waste.

- Fertilizer, fuel combustion
- Ozone layer, smog, acid rain...
- Increasing denitrification
- NO_x to N₂ conversion

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Provide access to clean water

The world's water supplies are facing new threats: affordable, advanced technologies could make a difference for millions of people around the world.

Icons: smartphone, VR, gear, building, water drop, radiation, CO2, brain, laptop, padlock, gear, N, microscope

- Removing microbes and toxins
- Removing salt



Restore and improve urban infrastructure

Good design and advanced materials can improve transportation and energy, water, and waste systems, and also create more sustainable urban environments.

Icons: smartphone, VR, gear, building, water drop, radiation, CO2, brain, laptop, padlock, gear, N, microscope

- Water-treatment systems
- Power plant
- Reducing automobile pollution

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Advance health informatics

Stronger health information systems not only improve everyday medical visits, but they are essential to counter pandemics and biological or chemical attacks.

- Developing sensors
- Preventing biological/chemical terror
- Mass production of antidotes



Engineer better medicines

Engineers are developing new systems to use genetic information, sense small changes in the body, assess new drugs, and deliver vaccines.

- Personalized medicine
- Identification of disease
- Diagnostic technique and instrument
- Drug-delivery systems

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Reverse-engineer the brain

The intersection of engineering and neuroscience promises great advances in health care, manufacturing, and communication.

The graphic features a glowing blue brain in the center. To the left, a green puzzle piece contains a white brain icon. Below the brain, a horizontal row of various white icons is displayed on a dark blue background, including symbols for a smartphone, VR, a gear, a building, a water drop, a radiation symbol, a clipboard, a sun, a brain, a laptop, a padlock, a gear with a plus sign, a refresh symbol, and a chemical structure.

- Information patterns of the brain
- Effective diagnosis
- Treatment of neurological disease



Prevent nuclear terror

The need for technologies to prevent and respond to a nuclear attack is growing.

The graphic shows a person in a yellow hazmat suit and goggles pouring liquid from a test tube into a beaker. To the left, a green puzzle piece contains a white radiation symbol. Below the scene, a horizontal row of various white icons is displayed on a dark blue background, including symbols for a smartphone, VR, a gear, a building, a water drop, a radiation symbol, a clipboard, a sun, a brain, a laptop, a padlock, a gear with a plus sign, a refresh symbol, and a chemical structure.

- Tracking nuclear materials in reactor

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A graphic titled "Secure cyberspace" featuring a smartphone with a fingerprint scanner, a "SCAN COMPLETE" notification, and a "HACKING DETECTED" warning. The background is dark blue with glowing lines and icons. A green puzzle piece icon with a lock symbol is on the left. Below the title is a row of various icons including a smartphone, VR, a gear, a padlock, a water drop, a radiation symbol, a clipboard, and a brain.

Secure cyberspace

It's more than preventing identity theft. Critical systems in banking, national security, and physical infrastructure may be at risk.

- Preventing cyberattack
- Protecting data during transfer



A graphic titled "Enhance virtual reality" showing a person wearing a VR headset. The background is light blue with glowing lines and icons. A green puzzle piece icon with "VR" is on the left. Below the title is a row of various icons including a smartphone, VR, a gear, a padlock, a water drop, a radiation symbol, a clipboard, and a brain.

Enhance virtual reality

True virtual reality creates the illusion of actually being in a different space. It can be used for training, treatment, and communication.

- Training professionals
- Psychotherapy
- Behavioral-research

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Advance personalized learning

Instruction can be individualized based on learning styles, speeds, and interests to make learning more reliable.

- To professional training
- Systems/programs for all level



Engineer the tools of scientific discovery

In the century ahead, engineers will continue to be partners with scientists in the great quest for understanding many unanswered questions of nature.

- Advanced and cheaper instruments