# Summary of Engineering Disciplines/Innovation Topics

**Read the summaries below and respond to the two questions at the end of each section.**

## Engineering Disciplines

Below is a list of some of the more popular disciplines of engineering. This is by no means a complete list. In fact, most schools will have only the traditional disciplines available as majors. However, within these disciplines, you will most likely be involved in research or coursework that encompass several others. You may also notice that there is a great deal of overlap among disciplines.

By choosing a specific discipline, it should be emphasized that you are not "pigeon holed" into a specific job description or role. Employers from all industries solicit and recruit engineers from all disciplines based on their problem solving skills and critical thinking skills. Just because you choose one specific field of engineering does not mean that you are "locked in" to that field of engineering forever.

**Aerospace** engineering encompasses the entire field of aerodynamics in the earth's atmosphere and in space. Aerospace engineers concentrate on a number of areas related to vehicle design, such as the development of power units, vehicle structures, aerodynamics, guidance control, and the launching of missiles and satellites.

**Agricultural** engineering is concerned with the design of machines and systems used in producing food and fiber. Agricultural engineers are also called upon to develop new ideas and methods and to apply general engineering techniques to soil, water, and air resources, power and energy sources, plant and animal environment, and food handling, processing and storing.

**Architectura**l engineering is closely related to architecture. Whereas architecture emphasizes the esthetics, design and function of the built environment viewed as a whole, architectural engineering is concerned with the soundness of the structure itself and its components, such as the mechanical and environmental systems.

**Bioengineering and biomedical** engineering merge the disciplines of engineering, biology, and medicine to create techniques and devices that are based on an understanding of living systems and serve the objective of improving the quality of human and animal life.

**Chemical** engineering combines the science of chemistry with the discipline of engineering. Chemical engineers design nearly all of the equipment and processes needed for various types of manufacturing plants. Chemical engineers are also involved in developing pollution control processes and equipment, and construction and operations of manufacturing facilities.

**Civil** engineering deals primarily with planning the design and construction of all the nation's constructed facilities (buildings, bridges, canals, dams, airports, railroads, etc.). The civil engineer is also involved in the operation of transportation facilities and environmental protection facilities relating to water, air, and solid wastes.

**Computer** engineering, computer information systems, computer science and information science all deal with digital equipment (computers). The spectrum covers the theory, design, and applications of computers (hardware) and information processing techniques (software). Design of hardware and systems is a predominant area of programs in computer engineering. Computer science programs emphasize theory of computation, probability, matrices, and similar subject matter. Computer information systems or information science programs, on the other hand, emphasize arrangement of input and output, rather than the mechanics of computing.

**Electrical** engineering and electronics engineering cover everything related to electricity. Electric power engineers concentrate on making electrical energy available and properly utilized. Electrical and electronics engineers are concerned with systems, circuits, and devices used in communication, computer and entertainment systems, health care instruments, and automated control systems. A great number of electrical and electronics engineers go directly into the design and production of computers.

**Environmental** engineering is a field that has emerged in response to the public's demand for clean air and water and a concern over the damage being done to the earth and ecological systems by pollution. Environmental engineers design or operate facilities for environmental protection.

**Industrial** engineering has to do with the organization of materials, people, and equipment in the production process. Industrial engineers design systems and facilities with a view toward ensuring both quality and efficiency. A subdiscipline called operations research is concerned with decision making based on the management of organizational systems (Management of Technology).

**Materials** engineering, metallurgical engineering, ceramic engineering, materials science, and metallurgyhave many things in common. They are concerned with the extraction, processing, refinement, combination, manufacture, and use of different natural substances. Engineers in metallurgy and metals deal with metals; those in materials may work with a broad scope of substances; and those in ceramics work with nonmetallic minerals.

**Mechanical** engineering is concerned with the design, manufacture, and operation of a wide range of mechanical components, devices, and systems. Many mechanical engineers are involved in the design and production of machines to lighten the burden of human work while others practice in the areas of heating and air-conditioning, automotive, manufacturing, and refrigeration engineering.

**Nuclear** engineering is concerned with the development, design, maintenance, repair, and control of nuclear power plants and fuel processing facilities.

**Petroleum** engineering is concerned with exploration, drilling, and production of oil and gas. Petroleum engineers also are involved in developing and using increasingly sophisticated recovery methods to obtain economical supplies of oil and natural gas.

**Plastics** engineering and polymer science is concerned with the production of nonmetallic synthetic polymers, with the goal of optimizing the process and achieving desired properties of the manufactured material. In general, the field of polymer science limits itself to determining properties of polymers and does not deal with their application.

**Systems** engineering is concerned with designing a number of components that work together in a given situation. A growing number of systems engineers are involved with the integration of various pieces of computer hardware to accomplish specified tasks.

(http://newsite.vuse.vanderbilt.edu/GeneralEngineering/ES140/Otherlinks/Summary.aspx)

**Assignments**

1. Pick one discipline from the above list that stands out to you more than most. Obtain more information about it. The Sloan Career Cornerstone Center offers in-depth information on a continually expanding list of disciplines (including some not on the above list. (http://www.careercornerstone.org/pdf/engineering/engineering.pdf).

Discuss the discipline (activities, challenges, education requirements etc.) in more detail. Include the reason why the discipline caught your interest. (1 page)

The table below contains lists of innovation topics that appear on the National Academy of Engineering website. Although these entries are quite subjective, they provide a good starting point.

## 21st Century Innovation Topics

2. This list was made a few years ago.  Certainly, by the end of the century, it will look considerably different.  As a reference look at the 20th Century Innovation Topics on the right side of the table.  We are so accustomed to these technologies now, it is easy to forget they were not available to the general population 100 years ago.

Choose a topic from the 21st century list.  Research it sufficiently to be able to discuss the most difficult or most important scientific and/or engineering challenges that have to be solved in order to make significant advances in the selected area.  Be specific.  Focus on the challenges and required advances, rather than a detailed explanation of the problem. (1 Page)

| 21st Century Innovation Topics | 20th Century Innovation Topics |
|---|---|
| 1. Energy conservation<br>2. Resource protection<br>3. Food and water production and distribution<br>4. Waste management<br>5. Education and learning<br>6. Medicine and prolonging life<br>7. Security and counter-terrorism<br>8. New technology<br>9. Genetics and cloning<br>10. Global communication<br>11. Traffic and population logistics<br>12. Knowledge sharing<br>13. Integrated electronic environment<br>14. Globalization<br>15. AI, interfaces and robotics<br>16. Weather prediction and control<br>17. Sustainable development<br>18. Entertainment<br>19. Space exploration<br>20. "Virtualization" and VR<br>21. Preservation of history<br>22. Preservation of species | 1. Electrification<br>2. Automobile<br>3. Airplane<br>4. Water supply and distribution<br>5. Electronics<br>6. Radio and television<br>7. Agricultural mechanization<br>8. Computers<br>9. Telephone<br>10. Air conditioning/refrigeration<br>11. Interstate highways<br>12. Space flight<br>13. Internet<br>14. Imaging<br>15. Household appliances<br>16. Health technologies<br>17. Petrochemical technology<br>18. Laser and fiber optics<br>19. Nuclear technologies<br>20. High-performance materials |