

MECHANICAL & INDUSTRIAL PROFESSIONS

INTRODUCTION TO MECHANICAL & INDUSTRIAL ENGINEERING

MEC 130

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What is Engineering?

- The word “*engineering*” derives from the Latin root *ingeniere*, meaning to *design* or to *devise*, which also forms the basis of the word “*ingenious*.”
- Engineering is an application of the knowledge of mathematics, science, and materials to develop new and better technologies, devices, methods, approaches, etc.
- Engineers are equipped with knowledge of mathematics, science, and materials and skills in communications and business.
- Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems.
- Engineers are capable of taking initiatives when handling work assignments, efficiently finding answers to problems, and accepting additional responsibility with success.
- Engineers are able to communicate to a wide range of backgrounds and in all forms of verbal and written media.

What is Engineering?

Of the 13 major industry sectors, engineering is the most popular major in 9 of them:

- Business services
- Chemicals
- Communications
- Electricity and gas
- Electronic components
- Industrial and commercial machinery
- Measuring instruments
- Oil and gas extraction
- Transportation equipment

What is Engineering?

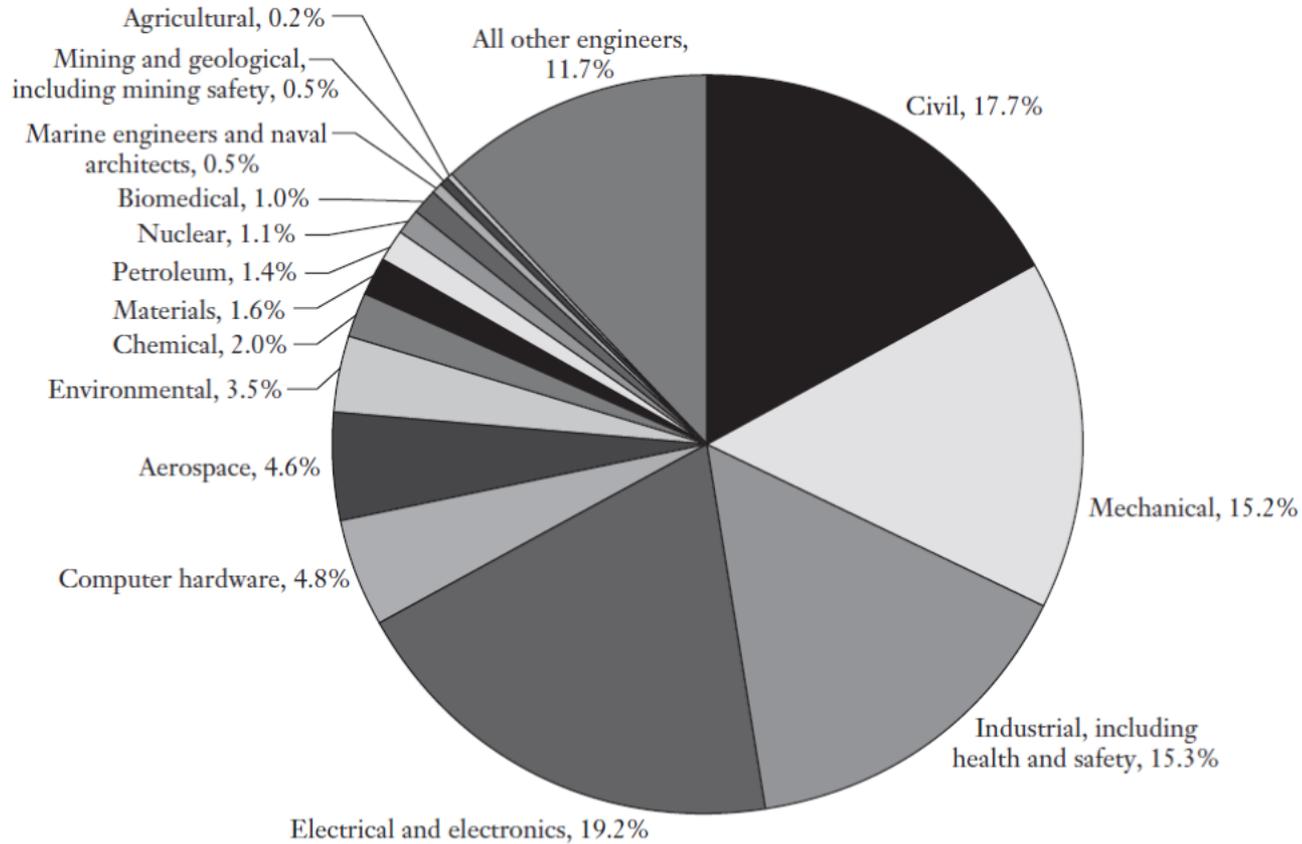


Figure 1.6

Percentages of engineers working in the traditional engineering fields and specializations.

What do Engineers do?

Engineers design:

- Products.
- Machinery to build those products.
- Plants/factories in which those products are made.
- Systems that ensure the quality of the products and the efficiency of the workforce and manufacturing process.

Engineers design, plan, and supervise:

- The construction of buildings, highways, and transit systems.

Engineers design, develop, and implement:

- Ways to extract, process, and use raw materials (*such as petroleum and natural gas*).

Engineers develop:

- New materials that both improve the performance of products and take advantage of advances in technology.

What do Engineers do?

Engineers harness:

- The power of the sun, the Earth, atoms, and electricity for use in supplying the Nation's power needs, and create millions of products using power.

Engineers analyze:

- The impact of the products they develop or the systems they design on the environment and on people using them.



In-Class Activity 1

Design a method for calculating the **Area of any Shape for Computer Programming**



Engineer vs Scientist

- A scientist develops theories and physical laws and discover phenomena that engineers can use to design and invent methods and technologies that solve real world problems.
- A scientist has an interest in basic sciences while engineer is interested more in applied sciences.
- Basic science includes physics, mathematics, and biology, which is the source of most scientific theories.
- Applied science is using scientific discoveries to solve practical problems.
- Engineering is an applied science.

BSc. In Engineering vs BEng

- 95% of colleges of engineering in the world offer Bachelor's of Science in Engineering (*BSc. in Engineering*).
- A few of colleges of engineering offer Bachelor's of Engineering (*BEng*).
- A Bachelor of Science in Engineering focuses on the cross-disciplinary application of science and mathematics on structures, machines, systems and processes.
- This type of engineering degree prepares students to enter the workforce as professional engineers with skills that are applicable to a wide variety of industries.
- A BSc. degree often includes more advanced levels of applied science and mathematics than are taught in BEng degree.
- A BEng is an Engineering Technology Degree, which is usually offered by an *Engineering Technology Program*.

BSc. In Engineering vs BEng

- An Engineering Technology degree emphasizes the application of specific engineering techniques.
- Graduates with an Engineering Technology degree often seek employment in fields such as production, design, manufacturing and operations.
- The degrees of Engineering Technology and Bachelor of Science in Engineering contain some overlap, but they also have important characteristics that make them unique.
- Students who obtain a Bachelor of Science in Engineering begin their careers as *entry-level engineers*. They typically do not have extensive experience in the field, but are very knowledgeable about cross-disciplinary applications and processes.
- Graduates with an Engineering Technology degree are often called “technologists,” while students who complete two-year engineering technology programs are called “technicians.”

In-Class Activity 2

List five things that a mechanical engineer can do.



Who are Mechanical Engineers?

*Mechanical engineers do **research, develop, design, manufacture and test tools, engines, machines, and other mechanical devices.***

*They also work on **power-producing machines** such as **electricity-producing generators, internal combustion engines, steam and gas turbines, and jet and rocket engines.***

*They also develop **power-using machines** such as **refrigeration and air-conditioning equipment, robots used in manufacturing, machine tools, materials handling systems, and industrial production equipment.***

Career Paths of Mechanical Engineers

- Mechanical engineers can work as *designers, researchers, and technology managers* for companies that range in size from small start-ups to large multinational corporations.
- Mechanical engineers can:
 - ✓ Design and analyze any component, material, module, or system for the next generation of **automobiles**.
 - ✓ Design and analyze **medical devices**, including aids for the disabled, surgical and diagnostic equipment, prosthetics, and artificial organs.
 - ✓ Design and analyze efficient **refrigeration, heating, and air-conditioning systems**.
 - ✓ Design and analyze the **power and heat dissipation systems** for any number of **mobile computing and networking devices**.
 - ✓ Design and analyze advanced **transportation and vehicle safety systems**.
 - ✓ Design and analyze **sustainable forms of energy** that are more readily accessible by nations, states, cities, villages, and people groups.

Career Paths of Mechanical Engineers

Mechanical engineers can:

- ✓ **Design and analyze** the next generation of space exploration systems.
- ✓ **Design and analyze** revolutionary manufacturing equipment and automated assembly lines for a wide range of consumer products.
- ✓ **Manage** a diverse team of engineers in the development of a global product platform, identifying customer, market, and product opportunities.
- ✓ **Provide consultant services** to any number of industries, including chemical, plastics, and rubber manufacturing; petroleum and coal production; computer and electronic products; food and beverage production; printing and publishing; utilities; and service providers.
- ✓ **Work in public service** for such governmental agencies as the National Aeronautics and Space Administration, Department of Defense, National Institute of Standards and Technology, Environmental Protection Agency, and national research laboratories.
- ✓ **Teach mathematics, physics, science, or engineering** at the high school, 2-year college, or 4-year university level.
- ✓ Pursue significant careers in law, medicine, social work, business, sales, or finance.

Career Opportunities of Mechanical Engineers

Job openings historically labeled as “mechanical engineer” now include a number of diverse titles that reflect the changing nature of the profession. For example, the following job position titles all require a degree in mechanical engineering:

- Product engineer
- Systems engineer
- Manufacturing engineer
- Renewable energy consultant
- Applications engineer
- Product applications engineer
- Mechanical device engineer
- Process development engineer
- Principal engineer
- Sales engineer
- Design engineer
- Power engineer
- Packaging engineer
- Electro-mechanical engineer
- Facilities design engineer
- Mechanical product engineer
- Energy efficiency engineer
- Mechatronics engineer
- Project capture engineer
- Plant engineer

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Program of Study Mechanical Engineering

General Outline:

As you begin to study mechanical engineering, your program will include the following four components:

- General education courses in the humanities, social sciences, and fine arts.
- Preparatory courses in mathematics, science, and computer programming
- Core courses in fundamental mechanical engineering subjects
- Elective courses on specialized topics that you find particularly interesting.

Curriculum

Total Credit Hours: 135

General Education Requirements	30 credit hours
College Requirements	35 credit hours
Major Requirements	61 credit hours
Major Electives	6 credit hours
Open Electives	3 credit hours



ENGINEERING

Program of Study Mechanical Engineering

Topics to Study:

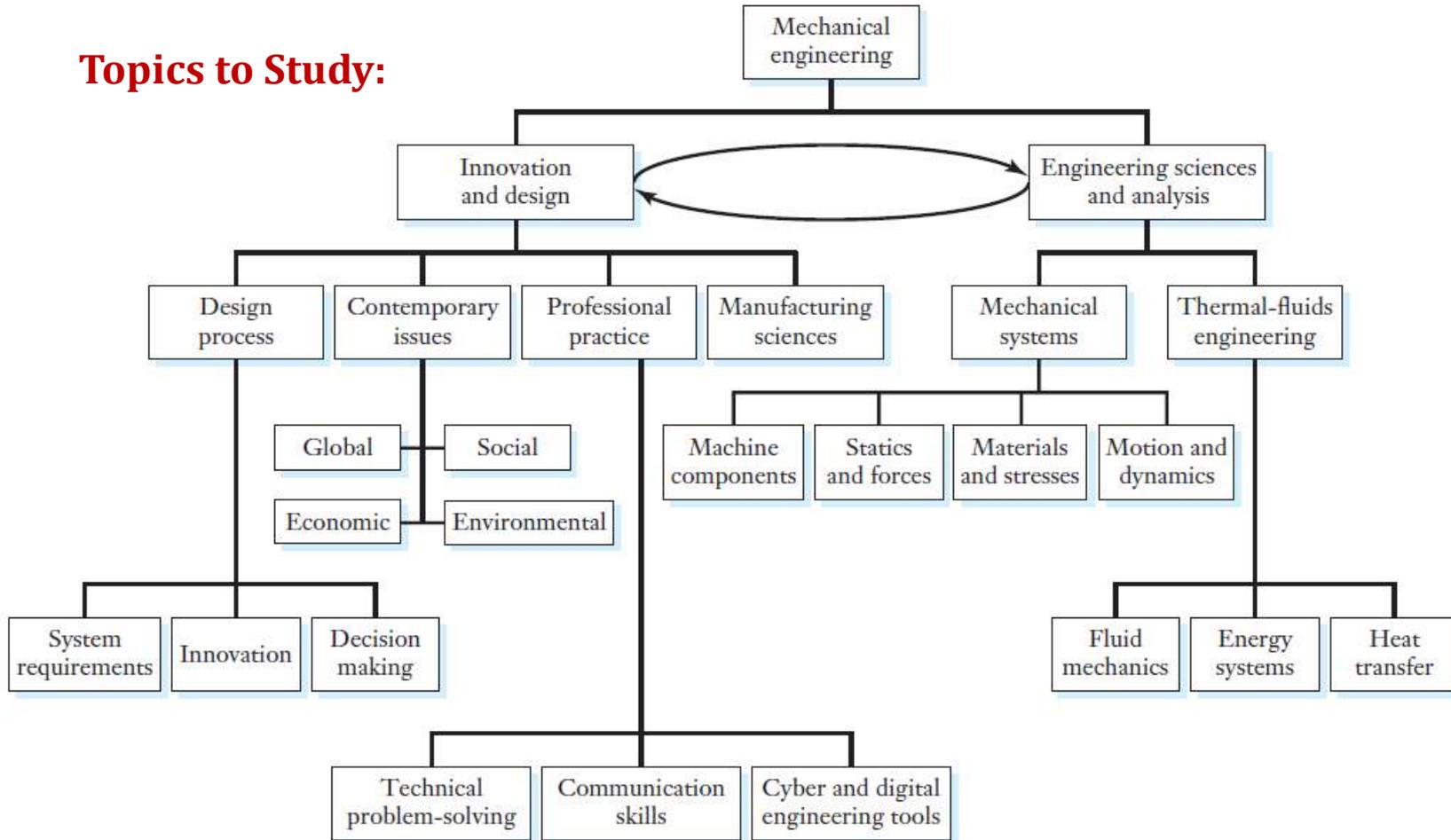


Figure 1.19

Hierarchy of topics and courses studied in a typical mechanical engineering curriculum.

ENGINEERING

Program of Study Mechanical Engineering

Detailed Curriculum in ADU:

General education courses in the humanities, social sciences, and fine arts.

General Education Requirements

30 Credit Hours

Course Code	Course Title	Prerequisite(s)	Credit Hours
ARL 100 (A/E)	Communication Skills in Arabic I	No Prerequisite	3
FWS 100	Academic Skills for Success	No Prerequisite	3
ENG 200	English 2	* EPT/ENG 102 (C grade) + (Co) UNS 102	3
FWS 305	Technical Communication for Work Place	ENG 200 + Completion of 45 CHs	3
ISL 100 (A/E)	Islamic Culture	No Prerequisite	3
MTT 102	Calculus I	"C" grade in MTT 101 or Math Placement Test	3
FWS 205	UAE and GCC Society	ENG 102 + (Co) UNS 102	3
STT 100	General Statistics	No Prerequisite	3
FWS 310	Fundamentals of Innovation and Entrepreneurship	ENG 200 + Completion of 60 CHs	3

ENGINEERING

Program of Study Mechanical Engineering

Detailed Curriculum in ADU:

Preparatory courses in mathematics, science, and computer programming

College Requirements

36 Credit Hours

Course Code	Course Title	Prerequisite(s)	Credit Hours
MTT 200	Calculus II	MTT 102	3
MTT 201	Calculus III	MTT 200	3
MTT 204	Introduction to Linear Algebra	MTT 200	3
MTT 205	Differential Equations	MTT 200 + MTT 204 co-requisite	3
PHY 102	Physics and Engineering Applications I	MTT 102	3
PHY 102L	Physics and Engineering Applications I Lab	MTT 102 + PHY 102 co-requisite	1
PHY 201	Physics and Engineering Applications II	PHY 102	3
PHY 201L	Physics and Engineering Applications II Lab	PHY 102 + PHY 201 co-requisite	1
CHE 205	Chemistry	ENG 100	3
CHE 201L	Chemistry Lab	ENG 200 + CHE 205 co-requisite	1
MEC 200	Introduction to Mechanical Engineering	PHY 102 (co-req) + MEC 330 co-requisite	3
CSC 201	Structured Programming	MTT 101 or MTT 102	3
GEN 200	Engineering Economy	ENG 200 + MTT 102	3
CIV 402	Engineering Ethics	Senior level	3

ENGINEERING

Program of Study Mechanical Engineering

Detailed Curriculum in ADU:

Core courses in fundamental mechanical engineering subjects

Major Requirements Hours

57 Credit

Course Code	Course Title	Prerequisite(s)	Credit Hours
CIV 201	Statics	MTT 102 + PHY 102	3
MEC 300	Materials Science	CHE 205	3
MEC 301	Manufacturing Processes	MEC 300	3
MEC 302	Mechanics of Materials	CIV 201	3
MEC 310	Dynamics	CIV 201 + MTT 204	3
MEC 320	Thermodynamics I	PHY 102	3
MEC 321	Thermodynamics II	MEC 320	3
MEC 330	Computer Aided Drawing	MEC 200 co-requisite	2
MEC 350	Fluid Mechanics	CIV 201 + MTT 205	3
MEC 351	Fluid Mechanics Lab	MEC 350 co-requisite	1
MEC 390	Electromechanical Devices	PHY 201	3
MEC 410	Control Systems	MEC 310 + MEC 390	3

ENGINEERING

Program of Study Mechanical Engineering

Detailed Curriculum in ADU:

Core courses in fundamental mechanical engineering subjects

MEC 411	Kinematics and Dynamics of Machinery	MEC 310	3
MEC 412	Dynamic and Control Systems lab	MEC 410 co-requisite	1
MEC 420	Heat Transfer	MEC 320 + MEC 350	3
MEC 421	Thermal Engineering Lab	MEC 420 co-requisite	1
MEC 430	Machine Design	MEC 302 + MEC 330	3
MEC 432	Design and manufacturing lab	MEC 430 co-requisite	1
MEC 399	Internship	90 credit hours	3
MEC 465	Numerical & FE Simulation of Engineering Problems	MEC 302 + MTT 204 + MEC 420 (co-req)	3
MEC 480	Mechanical Vibration	MEC 310 + MEC 410	3
MEC 499	Design Project (Capstone)	Senior Level	3

ENGINEERING

Program of Study Mechanical Engineering

Detailed Curriculum in ADU:

Elective courses on specialized topics that you find particularly interesting.

Major Electives

6 Credit Hours

Course Code	Course Title	Prerequisite(s)	Credit Hours
ME 1	Major Elective I	-	3
ME 2	Major Elective II	-	3

List of Major Elective Themes *				
Themes options	Course Code	Course Title	Prerequisite(s)	Credit Hours
Energy Systems	MEC 460	Air Conditioning Systems	MEC 420	3
	MEC 461	Internal Combustion Engines	MEC 320	3
	MEC 462	Energy Management	MEC 420	3
	MEC 463	Turbomachinery	MEC 420	3
	MEC 464	Power Plants	MEC 321 + MEC 420	3
Materials and Manufacturing	MEC 431	Computer Aided Machine Design	MEC 430	3
	MEC 470	Composites Materials Design	MEC 300 + MEC 302	3
	MEC 471	Introduction to Computer Aided Manufacturing	MEC 301	3
	MEC 472	Mechanics of Materials II	MEC 302	3
	MEC 473	Non-Conventional Manufacturing	MEC 301	3
	MEC 474	Fracture & Fatigue Control in Design	MEC 450 + MEC 465 co-requisite	3
Mechatronics	MEC 481	Introduction to Robotics	CSC 201	3
	MEC 482	Introduction to Mechatronics	MEC 390 + MEC 410	3
	MEC 483	Mechatronics System Design	MEC 482	3
Aerospace	MEC 490	Compressible Fluid Mechanics	MEC 350	3
	MEC 491	Aerodynamics	MEC 350	3
	MEC 492	Aerospace Propulsion	MEC 350	3
	MEC 493	Aerospace Structures	MEC 302 + MEC 350	3

*To satisfy the requirements of a Theme, three courses must be taken; at least two courses must be taken from the same theme

In-Class Activity 2

List two things that an industrial engineer can do.



Who are Industrial Engineers, and What They Can Do?

Industrial engineers use the rules of physics, mathematics, statistics, human factor related knowledge, law, and ethics to do the following:

- *Design processes and perform projects that may involve facilities, products, and systems taking into account the human factor.*
- *Design ways of the best utilization of the resources of an organization.*

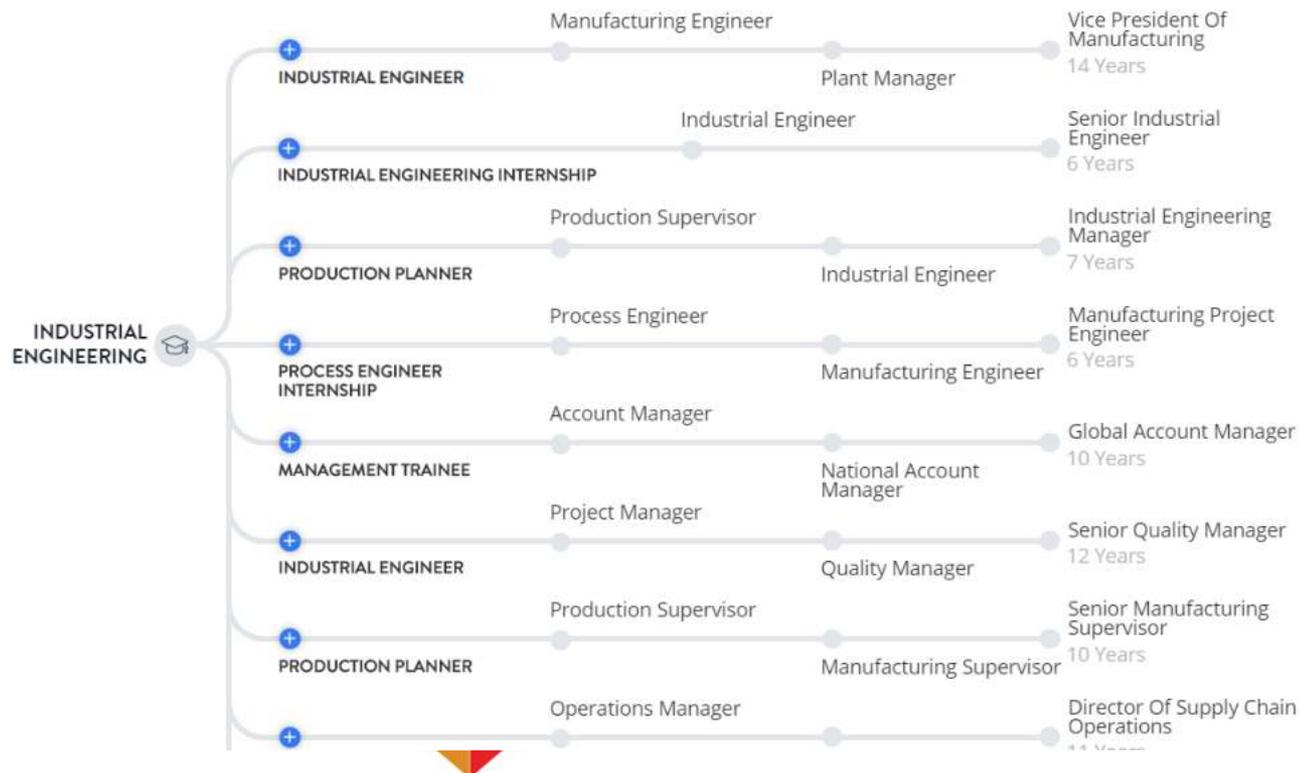
Resources such as workers, raw materials, capital, information, buildings, equipment, energy, and technological knowledge.

- *Analyzes the goals of an organization, the constraints imposed, and uncertainties to find the best solutions for the organization.*

ENGINEERING

Career Paths of Industrial Engineers

- Industrial engineers can work as *designers, researchers, and quality control managers* for companies that range in size from small start-ups to large multinational corporations.
- The following are the job position titles that require a degree in industrial engineering:



ENGINEERING

Career Paths of Industrial Engineers



ENGINEERING

Career Paths of Industrial Engineers



Teaching Industrial Engineering

Curricula in industrial engineering programs in academic institutions are based on the following principles:

Freshman (first year) curriculum usually covers all core subjects including *mathematics, physics, and information systems*, along with the course *Introduction to Industrial Engineering*.

Sophomore (second year) curriculum focuses on advanced courses in *mathematics* including courses in *operations research, probability and statistics*, as well as basic courses *related to human factors, and process-product design*.

Junior (third year) curriculum covers advanced courses on *production and service systems*.

Senior (fourth year) curriculum is usually reserved for elective courses related to *industrial engineering management and chain supply design*. Also, students perform a final project based on a real industrial engineering problem.

Learning Outcomes (ABET Accreditation Requirements)

- ABET = The Accreditation Board for Engineering and Technology.
- ABET is an organization formed by over two dozen technical and professional societies, including the American Society of Mechanical Engineers.
- ABET endorses and certifies almost 3000 engineering programs at more than 600 colleges and universities across the United States through their accreditation process.
- ABET has also begun accrediting international engineering programs. The board has identified a set of skills that new engineering graduates are expected to have, which are useful benchmarks for you to consider while monitoring progress during your studies.

ENGINEERING

Learning Outcomes (ABET Accreditation Requirements)

Previous Language	New Language
(a) an ability to apply knowledge of mathematics, science, and engineering	1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(d) an ability to function on multidisciplinary teams	3. an ability to communicate effectively with a range of audiences
(e) an ability to identify, formulate, and solve engineering problems	4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(f) an understanding of professional and ethical responsibility	
(g) an ability to communicate effectively	
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(i) a recognition of the need for, and an ability to engage in life-long learning	6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
(j) a knowledge of contemporary issues	
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

