MECH 100
Introduction to Mechanical Engineering
WHAT IS ENGINEERING?

*The word ‘Engineering’ derives from the Latin root *ingeniere*, meaning **to design** or to devise, Latin root “in generate” meaning “to create”

*“Mühendis” in Turkish derives from “hendese” which means “geometry” and thus mühendis is the one who makes calculations. “Hendesehane” means “School of Engineering”

*Engineers are individuals who *combine knowledge of science, mathematics and economics* to design an industrial product, to develop the technology for outputing a product, to solve technical problems for the benefit of people.

Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems.

A profession
Science is the process of gaining knowledge and investigating by making observations, experiments

- Scientists are people who try to explain why and how things happen.

1. Formulate a hypothesis to explain a natural phenomenon
2. Conceive and execute experiments to test the hypothesis
3. Analyze test results and state conclusions
4. Generalize the hypothesis into the form of a law or theory if experimental results verify the hypothesis
5. Publish the new knowledge

- A scientist tries to understand how our world, or other things, work.
- Some like to learn about living organisms. They are called biologists.
- Some like to study rocks. They are called geologists.
Science: Theory of combustion,
\[ C + O_2 \rightarrow CO_2 \]

Engineering: Thermal Power Plant
**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.” Those meanings are quite appropriate summaries of the traits of a good engineer. At the most fundamental level, engineers apply their knowledge of mathematics, science, and materials—as well as their skills in communications and business—in order to develop new and better technologies. Rather than experiment solely through trial and error, engineers are educated to use mathematics, scientific principles, and computer simulations as tools to create faster, accurate, and economical designs.

In that sense, the work of an engineer differs from a scientist’s, who would normally emphasize the discovery of physical laws rather than apply those phenomena to develop new products. Engineering is essentially a bridge between scientific discovery and product applications. Engineering does not exist for the sake of furthering or applying mathematics, science, or computation by themselves. Rather, engineering is a driver of social and economic growth and an integral part of the business cycle.
Engineers combine their skills in mathematics, science, computers, and hardware.
Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications. Engineers design products, machinery to build those products, plants in which those products are made, and the 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. They develop and implement improved ways to extract, process, and use raw materials, such as petroleum and natural gas. They develop new materials that both improve the performance of products and take advantage of advances in technology.
What is Engineering?

The Technological Team
What is Engineering?

The Technological Team

Engineers usually work in a team of:

- Scientists,
- Engineers,
- Technologists,
- Technicians,
- Craftsmans

which brings together complementary skills to solve a problem;
What is Engineering?

Scientists

**Scientists:**
Search for new fundamental understanding of the world and develop existing knowledge

**Applied Scientists:**
Apply knowledge gained by theoretical advances to develop new products and devices
What is Engineering?

Engineers

- Usually lead the team,
- Function: design of a new product, project or system
Engineering and Engineering Technology

Spectrum of Technical Job Functions

Test and Evaluation  Product Design
Development
Complex Design
Complex Analysis
Research

More theoretical

Engineering

Engineering Technology

Manufacturing
Production
Operation, service and maintenance
Distribution and Sales

More Application
Technology refers to methods, systems, and devices which are the result of scientific knowledge being used for practical purposes.

A Technologist

- Has education with less mathematical requirement,
- Material is presented in less theoretical manner,
  - Often works with engineer and technicians,
  - Develops further changes on design,
- Initiative and abilities determine the assignments,
- Often the functions of the engineer and technologist overlap at the workplace
Technicians are hands on people; 
- Draftsman, 
- Electric, Electronic Technician, 
- Mechanic, 
- etc

Craftsman
- are skilled workers, 
- they have skills to build devices and systems
SCIENCE

Non-Living Things

Physics
- Mechanics
- Thermodynamics
- Heat
- Electricity
- Sound
- Light
- Magnetism
- Atomic-Nuclear Physics

Living Things

Chemistry
- Solid Mechanics
- Deformable-Body Mechanics
- Hydrostatics

Biology
- Fluid Mechanics
- Hydrodynamics
- Incompressible Fluid Flow
- Compressible Fluid Flow

Statics

Dynamics
Birth of engineering disciplines

3000 BC
- Civil Engineering

1000 BC
- Military Engineering

AD 1700
- Mechanical Engineering

AD 1800
- Materials Engineering
  - Electrical Engineering
  - Agricultural Engineering
  - Chemical Engineering

AD 1900
- Aerospace Engineering
  - Computer Engineering
  - Industrial Engineering
  - Nuclear Engineering
- Biomedical Engineering

AD 1950
- Computer Engineering
- Industrial Engineering
- Nuclear Engineering
- Biomedical Engineering
Civil Engineering: Civil engineering is generally considered the oldest engineering discipline-its works trace back to the Egyptian pyramids and before. Many of the skills possessed by civil engineers (e.g., building walls, bridges, roads) are extremely useful in warfare, so these engineers worked on both military and civilian projects.

Civil engineers are responsible for constructing large-scale projects such as roads, buildings, airports, dams, bridges, harbors, canals, water systems, and sewage systems.
Water Supply and Sewage Treatment

- Raw Water Abstraction from Ground/Surface Water
- Design, Build, Operate and Maintain Water Treatment Works
- Design, Build, Maintenance and Rehabilitation of Water Distribution Networks
- Domestic and Non-Domestic Water Metering
- Design, Build, Maintenance and Rehabilitation of Wastewater Treatment Works
- Design, Build, Maintenance and Rehabilitation of Sewage Collection Networks
Electrical Engineering: Soon after physicists began to understand electricity, the electrical engineering profession was born. Electricity has served two main functions in society: electricity generation, the transmission of power and of information. Those electrical engineers who specialize in power transmission design and build electric generators, transformers, electric motors, and other high-power equipment. Those who specialize in information transmission design and build radios, televisions, computers, antennae, instrumentation, controllers, and communications equipment.

Modern life is largely characterized by electronic equipment. Daily, we rely on many electronic devices—televisions, telephones, computers, calculators, and so on.
Chemical Engineering: Chemical engineering was born in 1880s as a combination of mechanical engineers and industrial chemists. Chemical engineers are responsible for the industrial-scale production of chemicals and pharmaceuticals and for managing the by-products of operations in petroleum, electronics, and biotechnology industries. Chemical engineering is characterized by a concept called unit operations. A unit operation is an individual piece of process equipment (chemical reactor, heat exchanger, pump, compressor, distillation column). Chemical engineers assemble chemical plants by combining unit operations together.
**Materials Engineering:** Materials engineers are concerned with obtaining the materials required by modern society. Materials engineers work to develop new compositions of matter. Metals and their alloys, plastics, ceramics, composites, rocks, concrete, and many others are commonly used engineering materials.

**CLASSIFICATION OF ENGINEERING MATERIALS**

- **ENGINEERING MATERIALS**
  - **METALS**
    - FERROUS (CONTAINS IRON)
      - WROUGHT IRON
      - CARBON STEELS
      - ALLOY STEELS
      - CAST IRONS
    - NON-FERROUS (CONTAINS NO IRON)
      - ALUMINIUM COPPER LEAD
      - SILVER TIN
      - ZINC, etc
  - **NON-METALS**
    - POLYMERS
      - THERMO SETTING POLYMERS (PLASTICS)
        - PHENOLFORM ALDEHYDE (BAKELITE)
        - POLYSTERS
        - EPOXRESINS
      - THERMO PLASTIC
        - PVC
        - POLYTHENE
        - ACRYLIC RESINS
    - CERAMICS
      - REFRACTORIES
      - ABRASIVES
      - GLASS
      - CEMENT
      - CONCRETE

**Fundamentals of materials science**

- Structure
- Characterization
- Properties
- Processing
- Performance
Mechanical Engineering: Mechanical engineering was practiced concurrently with civil engineering because many of the devices needed to construct great civil engineering projects were mechanical in nature. During Industrial Revolution (1750-1780), some machines were developed: steam engines, internal combustion engines, mechanical looms, sewing machines, and more. Thus, the birth of mechanical engineering took place as a discipline distinct from civil engineering.

Mechanical engineers research, develop, design, manufacture, test, maintain tools, machines, engines, vehicles (automobiles, trains, planes, ships), machine tools, heat exchangers, industrial process equipment, power plants, consumer items,.....), and systems for heating, refrigeration, air conditioning, and ventilation.

Mechanical engineers work on power-producing machines such as electricity-producing generators, internal combustion engines, steam and gas turbines, jet and rocket engines. They also develop power-using machines such as refrigeration and air-conditioning equipment, robots used in manufacturing, machine tools, material handling systems, and industrial production equipment.
The Spectrum of Mechanical Engineering Functions

1. Research
2. Development
3. Design
4. Testing
5. Manufacturing
6. Operation and Maintenance
7. Marketing and Sales
8. Administration and Management
Engineering as a whole is generally broken down into five traditional fields: mechanical, electrical, materials, civil, and chemical engineering.

Electrical engineers work in such areas as the design and production of integrated circuits, wireless communication networks, aviation electronics, robot control systems, and the transmission and distribution of electrical power. Materials engineers work at the boundary of engineering and science in order to develop new compositions of matter that are used in applications encompassing semiconductors, lasers, advanced steel and aluminum alloys, and even the magnetic media used to store information in a computer’s hard disk drive. Among their other activities, civil engineers design and construct roads, buildings, airports, tunnels, dams, bridges, and water-supply systems. Environmental concerns are often central to the work of a civil engineer and can encompass environmental biology to reduce the contamination of groundwater, soil, and the atmosphere. Chemical engineers are responsible for the industrial-scale production of chemicals and pharmaceuticals and for managing the by-products of operations in the petroleum, electronics, and biotechnology industries. Even within these disciplines, there are literally dozens of other specializations.
**Who Are Mechanical Engineers?**

The field of mechanical engineering encompasses the properties of forces, materials, energy, fluids, and motion and the application of those elements to devise products that advance society and improve people's lives.

Mechanical engineers research, develop, design, manufacture and test tools, engines, machines, and other mechanical devices. They 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.
Percentages of engineers working in the traditional engineering fields and their specializations.

Compiled by United States Department of Labor.
. ENGINEERING FUNCTIONS

Regardless of their disciplines, engineers can be classified by the function they perform:

- **Research engineers** search for new knowledge to solve difficult problems that do not have readily apparent solutions. They require the greatest training, generally an MS or PhD degree.

- **Development engineers** apply existing and new knowledge to develop prototype of new devices, structures, and processes.

- **Design engineers** apply the results of research and development engineers to produce detailed designs of devices, structures, and processes that will be used by the public.

- **Production (construction) engineers** are concerned with specifying production schedules, determining raw materials availability, and optimizing assembly lines to mass produce the devices conceived by design engineers.

- **Testing engineers** perform tests on engineered products to determine their reliability and suitability by design engineers.

- **Operations engineers** run and maintain production facilities such as factories and chemical plants.

- **Sales engineers** have the technical background required to sell technical products.

- **Managing engineers** are needed in industry to coordinate the activities of the technology team.

- **Consulting engineers** are specialists who are called upon by companies to supplement their in-house engineering talent.
A flow diagram for the categories of engineering design.
Salary Information for Drafters, Architects, and Engineers

Earnings for drafters vary depending on the specialty

- Civil drafters were $44,490
- Architects were $70,325
- Civil engineers were $74,610
- Mechanical drafters were $46,640
- Mechanical engineers were $74,922
- Electrical and electronics drafters were $51,320
- Electrical engineers were $82,160

According to the U.S. Department of Labor, approximately 251,900 people were employed as drafters nationwide in 2008. Overall employment for drafters is expected to grow by 4% - 9% between 2008 and 2018.
Acreditation Board for Engineering and Technology- ABET

An organization formed by over two dozen technical and professional societies, including ASME. *ABET is responsible for accrediting the educational programs that grant engineering degrees in the USA, the board has identified a set of skills that new engineering graduates are expected to have*

A nonprofit, non-governmental agency that accredits programs in applied and natural science, computing, engineering and engineering technology.

*ABET accreditation provides assurance that a college or university program meets the quality standards of the profession for which that program prepares graduates.*

ABET accreditation is voluntary, and to date, 4,005 programs at 793 colleges and universities in 32 countries have received ABET accreditation. Over 100,000 students graduate from ABET-accredited programs each year, and millions of graduates have received degrees from ABET-accredited programs since 1932.

- **Engineering Accreditation Commission (EAC)**
  - Programs: Engineering
  - Levels: Bachelor, Master

- **Engineering Technology Accreditation Commission (ETAC)**
  - Programs: Engineering Technology
  - Levels: Associate, Bachelor
responsible for setting standards within the independent further and higher education sector. BAC accreditation is held by hundreds of colleges and training providers in the UK and overseas.

Association for Evaluation and Accreditation of Engineering Programs (MÜDEK), is a non-governmental organization operating for the purpose of contributing to the enhancement of quality of engineering education by means of the accreditation and evaluation of and providing information services for engineering education programs in various disciplines.

MÜDEK was initially established with a name Engineering Evaluation Board as an independent, non-governmental platform in 2002 by the Engineering Deans Council (MDK), which is formed by the deans of faculties administering engineering education programs in Turkey and TRNC, in order to prepare and conduct a comprehensive program for the evaluation of engineering undergraduate programs run by these faculties and started the evaluation of engineering programs in 2003. MÜDEK became an association in 2007.
• According to ABET (Accreditation Board for Engineering and Technology, USA) engineering programs must demonstrate that their students attain the following outcomes:

a. an ability to apply knowledge of mathematics, science and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. An ability to design mechanical and thermal systems, components, or processes to meet the desired needs within realistic constraints
d. An ability to function on multidisciplinary teams
e. An ability to identify, formulate and solve engineering problems
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 social context.
i. A recognition of the need for, and an ability to engage in life-long learning
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
Elements of engineering curricula.
• The Mechanical Engineering program at METU NCC aims at graduating students who:

1. have mastered the fundamental notions of engineering and principles of mechanical engineering discipline.
2. are able to independently learn various applications, think critically, evaluate and find solutions and improve their knowledge and skills.
3. are open to team work, inquisitive, innovative and take initiatives.
4. communicate effectively through oral, written and graphical means, are sociable, well rounded culturally in a diverse and multilingual environment and have broad interests.
5. are aware of their professional and ethical responsibilities.
4 years (8 semesters) → 44 credit courses (=143 credits)
9 non-credit

Technical Elective Courses, Graduation Project

Junior
- Manuf
- Control
- Design
- Heat Transfer
- Fluids
- Machine Theory

Sophomore
- Statics
- Dynamics
- Materials
- Thermo

Freshmen
- Math
- Physics
- Chemistry
- Tech. Drawing
- English
- Computer

Fund. Sciences
Fund. Engineering
Field

Mech. Eng. Lab. III Systems
Mech. Eng. Lab. II Practice theory
Mech. Eng. Lab I Measurements
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<tr>
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<th>Credits (Hours)</th>
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<td><strong>MAT 119</strong> (a)</td>
<td>Calculus with Analytic Geometry</td>
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<td><strong>PHY 105</strong></td>
<td>General Physics I</td>
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<tr>
<td><strong>CNG 230</strong></td>
<td>Introduction to C Programming</td>
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<td>Computer Aided Engineering Drawing – I</td>
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<tr>
<td><strong>ENGL 101</strong></td>
<td>Development of Reading and Writing Skills I</td>
<td>(4-0) 4</td>
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<td><strong>GPC 100</strong></td>
<td>First Year on Campus Seminar</td>
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<td><strong>CNG 100</strong></td>
<td>Introduction to Information Technologies and Applications</td>
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<td><strong>MAT 120</strong></td>
<td>Calculus for Functions of Several Variables</td>
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<td><strong>PHY 106</strong></td>
<td>General Physics II</td>
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<td>General Chemistry</td>
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<td><strong>MECH 114</strong></td>
<td>Computer Aided Engineering Drawing – II</td>
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<td>Development of Reading and Writing Skills II</td>
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<td><strong>OCHS 101</strong></td>
<td>Occupational Health and Safety-I</td>
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<td>MAT 219</td>
<td>Differential Equations</td>
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<td>MECH 202</td>
<td>Manufacturing Technologies</td>
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<td>MECH 203</td>
<td>Thermodynamics</td>
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<td>MECH 205</td>
<td>Statics</td>
<td>(3-0) 3</td>
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<td>MECH 227</td>
<td>Engineering Materials</td>
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<td>TUR 101</td>
<td>Turkish I</td>
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**Fourth Semester**

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<td>MAT 210</td>
<td>Applied Mathematics For Engineers</td>
<td>(4-0) 4</td>
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<td>MECH 206</td>
<td>Strength of Materials</td>
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<td>MECH 208</td>
<td>Dynamics</td>
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<td>MECH 220</td>
<td>Mechanical Engineering Laboratory – I</td>
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<td>EEE 209</td>
<td>Fund. of Electrical and Electron. Engr.</td>
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<td>ENGL 211</td>
<td>Academic Oral Presentation Skills</td>
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<td>TUR 102</td>
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<td>MECH 301</td>
<td>Theory of Machines</td>
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<td>MECH 305</td>
<td>Fluid Mechanics</td>
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<td>MECH 307</td>
<td>Mechanical Engineering Design</td>
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<td>MECH 310</td>
<td>Numerical Methods</td>
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<td>Engineering Economy</td>
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<td>HST 201</td>
<td>Principles of Kemal Atatürk I</td>
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<td>MECH 300</td>
<td>Summer Practice – I</td>
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<td>MECH 303</td>
<td>Manufacturing Engineering</td>
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<td>MECH 304</td>
<td>Control Systems</td>
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<td>MECH 308</td>
<td>Design of Machine Elements</td>
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<td>MECH 311</td>
<td>Heat Transfer</td>
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<td>HST 202</td>
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## FOURTH YEAR

### Seventh Semester

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### Eighth Semester

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### Notes:

(a) Students who successfully completed "MAT 100 Precalculus (1-2)2" course or passed "Mathematics Proficiency Examination" can take MAT 119 course.
(b) International students are required to take TUR 201 and TUR 202 instead of TUR 101 and TUR 102.
(c) International students are required to take HST 205 and HST 206 instead of HST 201 and HST 202.
(d) Students are expected to complete their summer training prior to registering MECH 300 and MECH 400.
OHS 101

**Mechanical Engineering Program Prerequisites Flowchart**

- GPC 100
- CNG 230
- CHM 107
- OHS 101
- MECH 220
- MECH 203
- MECH 208
- MECH 301
- MECH 304
- MECH 320
- MECH 311
- MECH 307
- MECH 305
- MECH 300
- MECH 420
- MECH 400***
- MECH 458***

**Notes:**
- International students are required to take TUR 201 and TUR 202 instead of TUR 101 and TUR 102.
- ** International students are required to take HST 205 and HST 206 instead of HST 201 and HST 202.
- *** Consent of the program is required for MECH 400 Summer Practice II and MECH 458 Graduation Design Project.
<table>
<thead>
<tr>
<th>MECH 100</th>
<th>a</th>
<th>b</th>
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Advanced engineering degrees

Technology development

Engineer

Senior engineer

Advanced business degrees

Business development

Staff engineer

Principal engineer

Fellow

Technical path

Potential engineering careers encompassing technical and management responsibilities.

Project engineer

Engineering manager

Technical director

Management path
Managers

- more than 75% of engineers become managers,
- It is not always necessary to develop technologies,
- Using available technologies in industrial area is more important,

Technical Managers

- comprehend new technologies and have an intuitive,
- understanding of which opinion to accept
Managers

Engineers because of their education and training develop an intuition & can quickly learn management skills to run technical industries

Managers

- manage resources, people, money & materials,
  - interpersonal skills are necessary,
- Attend meetings,
- Read reports etc,
- Organize, direct & control several tasks and activities simultaneously

- Most management situations involve problem solving,
- Managerial difficulties also involve solving people’s problems,
  - a **skill** that can be learned &
  - an **art** that can be refined
Main Duties of Engineering Societies

• Enhance the standing of engineers,
• Maintain and improve standards of engineering education,
• To bring engineers together for exchange of information and ideas,
• To give attention to the professional and economic aspects of the practice of engineering

• Provide reports and opinions on technical issues to local and/or state administrations
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS ASME

ASME is a not-for-profit membership organization that enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines

https://www.asme.org/

Chamber of Mechanical Engineers is a professional association as a public institution which was established in the context of the constitution of Republic of Turkey in 1954. Chamber of Mechanical Engineers is one of the 24 constituent chambers of engineering of the Union of Chambers of Turkish Engineers and Architects.

https://www.mmo.org.tr/