ROHINI

COLLEGE OF ENGINEERING & TECHNOLOGY

Approved by AICTE and Affiliated to Anna University, (An ISO Certified Institution)

# BE 8252

## BASIC CIVIL & MECHANICAL ENGINEEERING

DEPARTMENT OF

## MECHANICAL ENGINEERING

**ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF MECHANICAL ENGINEERING**

# BE8252 BASIC CIVIL AND MECHANICAL ENGINEERING NOTES

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|---|---|---|
| **ACADEMIC YEAR** | : | **2019 – 2020** |
| **YEAR/ SEMESTER** | : | **I / II** |
| **REGULATION** | : | **2017** |
| **COURSE CODE** | : | **BE8252** |
| **COURSE NAME** | : | **BASIC CIVIL AND MECHANICAL ENGINEERING** |
| **L T P C** | : | **4 0 0 4** |

**Prepared By:**

**Approved By:**

**HEAD OF DEPT – MECH** **PRINCIPAL**

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**BE8252 BASIC CIVIL AND MECHANICAL ENGINEERING L T P C 4 0 0 4**

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**TEXTBOOKS:**

1. Shanmugam Gand Palanichamy MS,"Basic Civil and Mechanical Engineering",Tata McGraw Hill PublishingCo.,NewDelhi,1996.

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2. Ramamrutham S.,"Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd.1999.
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# BE8252 BASIC CIVIL AND MECHANICAL ENGINEERING
# UNIT I SCOPE OF CIVIL AND MECHANICAL ENGINEERING

## OVERVIEW OF CIVIL ENGINEERING

Civil engineering is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including public works such as roads, bridges, canals, dams, airports, sewerage systems, pipelines, structural components of buildings, and railways.

Civil engineering is traditionally broken into a number of sub-disciplines. It is considered the second-oldest engineering discipline after military engineering, and it is defined to distinguish non-military engineering from military engineering. Civil engineering takes place in the public sector from municipal through to national governments, and in the private sector from individual homeowners through to international companies.

Civil engineering is the application of physical and scientific principles for solving the problems of society, and its history is intricately linked to advances in the understanding of physics and mathematics throughout history. Because civil engineering is a wide-ranging profession, including several specialized sub-disciplines, its history is linked to knowledge of structures, materials science, geography, geology, soils, hydrology, environment, mechanics and other fields.

Throughout ancient and medieval history most architectural design and construction was carried out by artisans, such as stonemasons and carpenters, rising to the role of master builder. Knowledge was retained in guilds and seldom supplanted by advances. Structures, roads, and infrastructure that existed were repetitive, and increases in scale were incremental.

One of the earliest examples of a scientific approach to physical and mathematical problems applicable to civil engineering is the work of Archimedes in the 3rd century BC, including Archimedes Principle, which underpins our understanding of buoyancy, and practical solutions such as Archimedes' screw.

### Role of civil engineer

- Civil engineer is a person who practices civil engineering, the application of planning, designing, constructing, maintaining, and operating infrastructures while protecting the public and environmental health, as well as improving existing infrastructures that have been neglected.

- Civil engineering is one of the oldest engineering disciplines because it deals with constructed environment[1] including planning, designing, and overseeing construction and maintenance of building structures, and facilities, such as roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, and water and sewage systems.
- The term "civil engineer" was established by John Smeaton in 1750 to contrast engineers working on civil projects with the military engineers, who worked on armaments and defenses.
- Over time, various sub-disciplines of civil engineering have become recognized and much of military engineering has been absorbed by civil engineering. Other engineering practices became recognized as independent engineering disciplines, including chemical engineering, mechanical engineering, and electrical engineering.
- In some places, a civil engineer may perform land surveying; in others, surveying is limited to construction surveying, unless an additional qualification is obtained.

**Civil Engineering contributions to the welfare of Society**

1.Contributions of Civil Engineering to the welfare of Society?

Because of Civil Engineering and Civil Engineers, we have many amenities that make civilization possible.

- Water piped to our homes and other places.

  i) Sewage taken away to treatment plants.

  ii)Roads that make easy driving possible and reduce the likelihood of accidents.

  iii) Bridges and connect people who formerly were divided by water.

- Layout and construction of schools, public buildings and parking lots that make the best use of land.

**Specialized sub disciplines or branches in Civil Engineering**

There are a number of sub-disciplines within the broad field of civil engineering. General civil engineers work closely with surveyors and specialized civil engineers to design grading, drainage, pavement, water supply, sewer service, dams, electric and communications supply. General civil engineering is also referred to as site engineering, a branch of civil engineering that primarily focuses on converting a tract of land from one usage to another. Site engineers spend time visiting project sites, meeting with stakeholders, and preparing construction plans. Civil engineers apply the principles of geotechnical engineering, structural engineering, environmental engineering, transportation engineering and construction engineering to residential, commercial, industrial and public works projects of all sizes and levels of construction.

Civil Engineering is the broadest of the engineering fields. It comprises of many related specialties.

Sub-disciplines of Civil Engineering are:

- Coastal Engineering
- Construction Engineering
- Environmental Engineering
- Geotechnical Engineering
- Structural Engineering
- Transportation Engineering
- Water Resources Engineering

**Coastal engineering**

Coastal engineering is concerned with managing coastal areas. In some jurisdictions, the terms sea defence and coastal protection mean defence against flooding and erosion, respectively. The term coastal defence is the more traditional term, but coastal management has become more popular as the field has expanded to techniques that allow erosion to claim land.

**Construction engineering**

Construction engineering involves planning and execution, transportation of materials, site development based on hydraulic, environmental, structural and geotechnical engineering. As construction firms tend to have higher business risk than other types of civil engineering firms do, construction engineers often engage in more business-like transactions, for example, drafting and reviewing contracts, evaluating logistical operations, and monitoring prices of supplies.

**Earthquake engineering**

Earthquake engineering involves designing structures to withstand hazardous earthquake exposures. Earthquake engineering is a sub-discipline of structural engineering. The main objectives of earthquake engineering are to understand interaction of structures on the shaky ground; foresee the consequences of possible earthquakes; and design, construct and maintain structures to perform at earthquake in compliance with building codes.

**Environmental engineering**

Environmental engineering is the contemporary term for sanitary engineering, though sanitary engineering traditionally had not included much of the hazardous waste management and environmental remediation work covered by environmental engineering. Public health engineering and environmental health engineering are other terms being used.

Environmental engineering deals with treatment of chemical, biological, or thermal wastes, purification of water and air, and remediation of contaminated sites after waste disposal or accidental contamination. Among the topics covered by environmental engineering are pollutant transport, water purification, waste water treatment, air pollution, solid waste treatment, recycling, and hazardous waste management. Environmental engineers administer pollution reduction, green engineering, and industrial ecology. Environmental engineers also compile information on environmental consequences of proposed actions.

**Forensic engineering[**

Forensic engineering is the investigation of materials, products, structures or components that fail or do not operate or function as intended, causing personal injury or damage to property. The consequences of failure are dealt with by the law of product liability. The field also deals with retracing processes and procedures leading to accidents in operation of vehicles or machinery. The subject is applied most commonly in civil law cases, although it may be of use in criminal law cases. Generally the purpose of a Forensic engineering investigation is to locate cause or causes of failure with a view to improve performance or life of a component, or to assist a court in determining the facts of an accident. It can also involve investigation of intellectual property claims, especially patents.

**Geotechnical engineering**

Geotechnical engineering studies rock and soil supporting civil engineering systems. Knowledge from the field of soil science, materials science, mechanics, and hydraulics is applied to safely and economically design foundations, retaining walls, and other structures. Environmental efforts to protect groundwater and safely maintain landfills have spawned a new area of research called geoenvironmental engineering.[22][23]

Identification of soil properties presents challenges to geotechnical engineers. Boundary conditions are often well defined in other branches of civil engineering, but unlike steel or concrete, the material properties and behavior of soil are difficult to predict due to its variability and limitation on investigation. Furthermore, soil exhibits nonlinear (stress-dependent) strength, stiffness, and dilatancy (volume change associated with application of shear stress), making studying soil mechanics all the more difficult.[22] Geotechnical engineers frequently work with professional geologists and soil scientists.[24]

**Materials science and engineering**

Materials science is closely related to civil engineering. It studies fundamental characteristics of materials, and deals with ceramics such as concrete and mix asphalt concrete, strong metals such as aluminum and steel, and thermosetting polymers including polymethylmethacrylate (PMMA) and carbon fibers.

Materials engineering involves protection and prevention (paints and finishes). Alloying combines two types of metals to produce another metal with desired properties. It incorporates elements of applied physics and chemistry.

With recent media attention on nanoscience and nanotechnology, materials engineering has been at the forefront of academic research. It is also an important part of forensic engineering and failure analysis.

**Structural engineering**

Structural engineering is concerned with the structural design and structural analysis of buildings, bridges, towers, flyovers (overpasses), tunnels, off shore structures like oil and gas fields in the sea, aerostructure and other structures. This involves identifying the loads which act upon a structure and the forces and stresses which arise within that structure due to those loads, and then designing the structure to successfully support and resist those loads. The loads can be self weight of the structures, other dead load, live loads, moving (wheel) load, wind load, earthquake load, load from temperature change etc. The structural engineer must design structures to be safe for their users and to successfully fulfill the function they are designed for (to be *serviceable*). Due to the nature of some loading conditions, sub-disciplines within structural engineering have emerged, including wind engineering and earthquake engineering.

Design considerations will include strength, stiffness, and stability of the structure when subjected to loads which may be static, such as furniture or self-weight, or dynamic, such as wind, seismic, crowd or vehicle loads, or transitory, such as temporary construction loads or impact. Other considerations include cost, constructability, safety, aesthetics and sustainability.

**Surveying**

Surveying is the process by which a surveyor measures certain dimensions that occur on or near the surface of the Earth. Surveying equipment such as levels and theodolites are used for accurate measurement of angular deviation, horizontal, vertical and slope distances. With computerisation, electronic distance measurement (EDM), total stations, GPS surveying and laser scanning have to a large extent supplanted traditional instruments. Data collected by survey measurement is converted into a graphical representation of the Earth's surface in the form of a map. This information is then used by civil engineers, contractors and realtors to design from, build on, and trade, respectively. Elements of a structure must be sized and positioned in relation to each other and to site boundaries and adjacent structures.

Although surveying is a distinct profession with separate qualifications and licensing arrangements, civil engineers are trained in the basics of surveying and mapping, as well as geographic information systems. Surveyors also lay out the routes of railways, tramway tracks, highways, roads, pipelines and streets as well as position other infrastructure, such as harbors, before construction.

**Land surveying**

In the United States, Canada, the United Kingdom and most Commonwealth countries land surveying is considered to be a separate and distinct profession. Land surveyors are not considered to be engineers, and have their own professional associations and licensing requirements. The services of a licensed land surveyor are generally required for boundary surveys (to establish the boundaries of a parcel using its legal description) and subdivision plans (a plot or map based on a survey of a parcel of land, with boundary lines drawn inside the larger parcel to indicate the creation of new boundary lines and roads), both of which are generally referred to as Cadastral surveying.

**Construction surveying**

Construction surveying is generally performed by specialised technicians. Unlike land surveyors, the resulting plan does not have legal status. Construction surveyors perform the following tasks:

- Surveying existing conditions of the future work site, including topography, existing buildings and infrastructure, and underground infrastructure when possible;
- "lay-out" or "setting-out": placing reference points and markers that will guide the construction of new structures such as roads or buildings;
- Verifying the location of structures during construction;
- As-Built surveying: a survey conducted at the end of the construction project to verify that the work authorized was completed to the specifications set on plans.

**Transportation engineering**

Transportation engineering is concerned with moving people and goods efficiently, safely, and in a manner conducive to a vibrant community. This involves specifying, designing, constructing, and maintaining transportation infrastructure which includes streets, canals, highways, rail systems, airports, ports, and mass transit. It includes areas such as transportation design, transportation planning, traffic engineering, some aspects of urban engineering, queueing theory, pavement engineering, Intelligent Transportation System (ITS), and infrastructure management.

**Municipal or urban engineering**

Municipal engineering is concerned with municipal infrastructure. This involves specifying, designing, constructing, and maintaining streets, sidewalks, water supply networks, sewers, street lighting, municipal solid waste management and disposal, storage depots for various bulk materials used for maintenance and public works (salt, sand, etc.), public parks and cycling infrastructure. In the case of underground utility networks, it may also include the civil portion (conduits and access chambers) of the local distribution networks of electrical and telecommunications services. It can also include the optimizing of waste collection and bus service networks. Some of these disciplines overlap with other civil engineering specialties, however municipal engineering focuses on the coordination of these infrastructure networks and services, as they are often built simultaneously, and managed by the same municipal authority. Municipal engineers may also design the site civil works for large buildings, industrial plants or campuses (i.e. access roads, parking lots, potable water supply, treatment or pretreatment of waste water, site drainage, etc.)

**Water resources engineering**

Water resources engineering is concerned with the collection and management of water (as a natural resource). As a discipline it therefore combines elements of hydrology, environmental science, meteorology, conservation, and resource management. This area of civil engineering relates to the prediction and management of both the quality and the quantity of water in both underground (aquifers) and above ground (lakes, rivers, and streams) resources. Water resource engineers analyze and model very small to very large areas of the earth to predict the amount and content of water as it flows into, through, or out of a facility. Although the actual design of the facility may be left to other engineers.

**Hydraulic engineering**

Hydraulic engineering is concerned with the flow and conveyance of fluids, principally water. This area of civil engineering is intimately related to the design of pipelines, water supply network, drainage facilities (including bridges, dams, channels, culverts, levees, storm sewers), and canals. Hydraulic engineers design these facilities using the concepts of fluid pressure, fluid statics, fluid dynamics, and hydraulics, among others.

**Civil engineering systems**

Civil engineering systems are a discipline that promotes the use of systems thinking to manage complexity and change in civil engineering within its wider public context. It posits that the proper development of civil engineering infrastructure requires a holistic, coherent understanding of the relationships between all of the important factors that contribute to successful projects while at the same time emphasising the importance of attention to technical detail. Its purpose is to help integrate the entire civil engineering project life cycle from conception, through planning, designing, making, operating to decommissioning.

## OVERVIEW OF MECHANICAL ENGINEERING

### Mechanical Engineering contributions to the welfare of Society

Mechanical engineering is an engineering discipline that combines engineering physics and mathematics principles with materials science to design, analyze, manufacture, and maintain mechanical systems. It is one of the oldest and broadest of the engineering disciplines.

### Functions of mechanical engineering

Mechanical engineers design **power**-producing machines such as electric generators, internal combustion engines, and steam and gas turbines as well as power-using machines, such as refrigeration and air-conditioning systems. Mechanical engineers design other machines inside buildings, such as elevators and escalators.

### Mechanical engineers typically do the following:

- Analyze problems to see how a mechanical device might help solve the problem
- Design or redesign mechanical devices, creating blueprints so the device can be built
- Develop a prototype of the device and test the prototype
- Analyze the test results and change the design as needed
- Oversee the manufacturing process

### Mechanical engineers use many types of tools, engines, and machines, such as:

- Electric generators, internal combustion engines, and steam and gas turbines
- Power-using machines, such as refrigeration and air-conditioning
- Industrial production equipment, including robots used in manufacturing
- Other machines inside buildings, such as elevators and escalators

- Machine tools and tools for other engineers
- Material-handling systems, such as conveyor systems and automated transfer stations

The following are examples of different types of mechanical engineers:

**Automotive Research Engineers**

Automotive research engineers try to improve the performance of cars by working to improve traditional features of cars such as suspension, and work on aerodynamics and new possible fuels. Automotive research engineers focus on the development of passenger cars, trucks, buses, motorcycles or off-road vehicles. They design new products, modify existing ones, troubleshoot, and solve engineering problems.

**Heating and Cooling Systems Engineers**

Heat engineering, also known as heat transfer or thermal sciences, is an academic specialty of mechanical engineering. Heating and cooling systems engineers develop environmental systems (systems that keep temperatures and humidity within certain limits) for airplanes, trains, cars, computer rooms, and schools. They design test control apparatus as well as equipment, and develop procedures for testing products. They also calculate energy losses for buildings, using equipment such as computers, combustion analyzers, or pressure gauges.

**Robotics Engineers**

A robotics engineer is a behind-the-scenes designer, who is responsible for creating robots and robotic systems that are able to perform duties that humans are either unable or prefer not to complete.

Robotics engineers will spend the majority of their time designing the plans needed to build robots, and will also design the processes necessary for the robot to run correctly. Through their creations, a robotics engineer helps to make jobs safer, easier, and more efficient, particularly in the manufacturing industry.

**Materials Engineers**

Materials engineers attempt to solve problems in several different engineering fields, such as mechanical, chemical, electrical, civil, nuclear, and aerospace. They do this by developing, processing, and testing materials in order to create new materials that meet certain mechanical, electrical, and chemical requirements.

Materials engineers study the chemical properties, structures, and mechanical uses of plastics, metals, nanomaterials (extremely small substances), ceramics, and composites according to the place of usage.

## SPECIALIZED SUB DISCIPLINES IN MECHANICAL ENGINEERING

The field of mechanical engineering can be thought of as a collection of many mechanical engineering science disciplines. Several of these subdisciplines which are typically taught at the undergraduate level are listed below, with a brief explanation and the most common application of each. Some of these subdisciplines are unique to mechanical engineering, while others are a combination of mechanical engineering and one or more other disciplines. Most work that a mechanical engineer does uses skills and techniques from several of these subdisciplines, as well as specialized subdisciplines. Specialized subdisciplines, as used in this article, are more likely to be the subject of graduate studies or on-the-job training than undergraduate research. Several specialized subdisciplines are discussed in this section.

### Mechanics

Mechanics is, in the most general sense, the study of forces and their effect upon matter. Typically, engineering mechanics is used to analyze and predict the acceleration and deformation (both elastic and plastic) of objects under known forces (also called loads) or stresses. Sub disciplines of mechanics include

- Statics, the study of non-moving bodies under known loads, how forces affect static bodies
- Dynamics the study of how forces affect moving bodies. Dynamics includes kinematics (about movement, velocity, and acceleration) and kinetics (about forces and resulting accelerations).
- Mechanics of materials, the study of how different materials deform under various types of stress
- Fluid mechanics, the study of how fluids react to forces

- Kinematics, the study of the motion of bodies (objects) and systems (groups of objects), while ignoring the forces that cause the motion. Kinematics is often used in the design and analysis of mechanisms.
- Continuum mechanics, a method of applying mechanics that assumes that objects are continuous (rather than discrete)

Mechanical engineers typically use mechanics in the design or analysis phases of engineering. If the engineering project were the design of a vehicle, statics might be employed to design the frame of the vehicle, in order to evaluate where the stresses will be most intense. Dynamics might be used when designing the car's engine, to evaluate the forces in the pistons and cams as the engine cycles. Mechanics of materials might be used to choose appropriate materials for the frame and engine. Fluid mechanics might be used to design a ventilation system for the vehicle , or to design the intake system for the engine.

**Mechatronics and robotics**

Mechatronics is a combination of mechanics and electronics. It is an interdisciplinary branch of mechanical engineering, electrical engineering and software engineering that is concerned with integrating electrical and mechanical engineering to create hybrid systems. In this way, machines can be automated through the use of electric motors, servo-mechanisms, and other electrical systems in conjunction with special software. A common example of a mechatronics system is a CD-ROM drive. Mechanical systems open and close the drive, spin the CD and move the laser, while an optical system reads the data on the CD and converts it to bits. Integrated software controls the process and communicates the contents of the CD to the computer.

Robotics is the application of mechatronics to create robots, which are often used in industry to perform tasks that are dangerous, unpleasant, or repetitive. These robots may be of any shape and size, but all are preprogrammed and interact physically with the world. To create a robot, an engineer typically employs kinematics (to determine the robot's range of motion) and mechanics (to determine the stresses within the robot).

Robots are used extensively in industrial engineering. They allow businesses to save money on labor, perform tasks that are either too dangerous or too precise for humans to perform them economically, and to ensure better quality. Many companies employ assembly lines of robots, especially in Automotive Industries and some factories are so robotized that they can run by themselves. Outside the factory, robots have been employed in bomb disposal, space exploration, and many other fields. Robots are also sold for various residential applications, from recreation to domestic applications.

**Structural analysis**

Structural analysis is the branch of mechanical engineering (and also civil engineering) devoted to examining why and how objects fail and to fix the objects and their performance. Structural failures occur in two general modes: static failure, and fatigue failure. *Static structural failure* occurs when; upon being loaded (having a force applied) the object being analyzed either breaks or is deformed plastically, depending on the criterion for failure. *Fatigue failure* occurs when an object fails after a number of repeated loading and unloading cycles. Fatigue failure occurs because of imperfections in the object: a microscopic crack on the surface of the object, for instance, will grow slightly with each cycle (propagation) until the crack is large enough to cause ultimate failure.

Failure is not simply defined as when a part breaks, however; it is defined as when a part does not operate as intended. Some systems, such as the perforated top sections of some plastic bags, are designed to break. If these systems do not break, failure analysis might be employed to determine the cause.

Structural analysis is often used by mechanical engineers after a failure has occurred, or when designing to prevent failure. Engineers often use online documents and books such as those published by ASM to aid them in determining the type of failure and possible causes.
Once theory is applied to a mechanical design, physical testing is often performed to verify calculated results. Structural analysis may be used in an office when designing parts, in the field to analyze failed parts, or in laboratories where parts might undergo controlled failure tests.

**Thermodynamics and thermo-science**

Thermodynamics is an applied science used in several branches of engineering, including mechanical and chemical engineering. At its simplest, thermodynamics is the study of energy, its use and transformation through a system. Typically, engineering thermodynamics is concerned with changing energy from one form to another. As an example, automotive engines convert chemical energy (enthalpy) from the fuel into heat, and then into mechanical work that eventually turns the wheels.

Thermodynamics principles are used by mechanical engineers in the fields of heat transfer, thermofluids, and energy conversion. Mechanical engineers use thermo-science to design engines and power plants, heating, ventilation, and air-conditioning (HVAC) systems, heat exchangers, heat sinks, radiators, refrigeration, insulation, and others.

**Design and drafting**

Drafting or technical drawing is the means by which mechanical engineers design products and create instructions for manufacturing parts. A technical drawing can be a computer model or hand-drawn schematic showing all the dimensions necessary to manufacture a part, as well as assembly notes, a list of required materials, and other pertinent information.[38] A U.S. mechanical engineer or skilled worker who creates technical drawings may be referred to as a drafter or draftsman. Drafting has historically been a two-dimensional process, but computer-aided design (CAD) programs now allow the designer to create in three dimensions.

Instructions for manufacturing a part must be fed to the necessary machinery, either manually, through programmed instructions, or through the use of a computer-aided manufacturing (CAM) or combined CAD/CAM program. Optionally, an engineer may also manually manufacture a part using the technical drawings. However, with the advent of computer numerically controlled (CNC) manufacturing, parts can now be fabricated without the need for constant technician input. Manually manufactured parts generally consist of spray coatings, surface finishes, and other processes that cannot economically or practically be done by a machine.

Drafting is used in nearly every subdiscipline of mechanical engineering, and by many other branches of engineering and architecture. Three-dimensional models created using CAD software are also commonly used in finite element analysis (FEA) and computational fluid dynamics (CFD).

**PRODUCTION ENGINEERING**

Production engineering is a combination

of manufacturing technology, engineering sciences with management science. A production engineer typically has a wide knowledge of engineering practices and is aware of the management challenges related to production. The goal is to accomplish the production process in the smoothest, most-judicious and most-economic way.

Production engineering encompasses the application of castings, machining processing, joining processes, metal cutting & tool design, metrology, machine tools, machining systems, automation, jigs and fixtures, die and mould design, material science, design of automobile parts, and machine designing and manufacturing. Production engineering also overlaps substantially with manufacturing engineering, industrial engineering, and supply chain engineering. The names are often interchangeable.

In industry, once the design is realized, production engineering concepts regarding work-study, ergonomics, operation research, manufacturing management, materials management, production planning, etc., play important roles in efficient production processes. These deal with integrated design and efficient planning of the entire manufacturing system, which is becoming increasingly complex with the emergence of sophisticated production methods and control systems.

**Production engineer**

The production engineer possesses a wide set of skills, and also competences and attitudes based on market and scientific knowledge. These abilities are fundamental for the performance of coordinating and integrating professionals of multidisciplinary teams. The production engineer should be able to:

- Scale and integrate resources. Usually required to consider physical, human and financial resources at high efficiency and low cost, yet considering the possibility of continuous further improvement;
- Make proper use of math and statistics to model production systems during decision making process;
- Design, implement and refine products, services, processes and systems taking in consideration that constraints and particularities of the related communities;
- Predict and analyze the demand. Select among scientific and technological appropriate knowledge in order to design, redesign or improve product/service functionality;

- Incorporate concepts and quality techniques along all the productive system. Deploy organizational standards for control proceedings and auditing;
- Stay up-to-date with technological developments, enabling them to enterprises and society;
- Understand the relation between production systems and the environment. This relates to the use of scarce resources, production rejects and sustainability;
- Manage and optimize flow (information and production flow).

Work opportunities are available in public and private sector manufacturing organizations engaged in implementation, development and management of new production processes, information and control systems, and computer controlled inspection, assembly and handling.

## AUTOMOBILE ENGINEERING

Automobile engineering is a branch study of engineering which teaches manufacturing, designing, mechanical mechanisms as well operations of automobiles. It is an introduction to vehicle engineering which deals with motorcycles, cars, buses, trucks, etc. It includes branch study of mechanical, electronic, software and safety elements. Some of the engineering attributes and disciplines that are of importance to the automotive engineer and many of the other aspects are included in it:

### Safety engineering:

Safety engineering is the assessment of various crash scenarios and their impact on the vehicle occupants. These are tested against very stringent governmental regulations. Some of these requirements include: seat belt and air bag functionality testing, front and side impact testing, and tests of rollover resistance. Assessments are done with various methods and tools, including Computer crash simulation (typically finite element analysis), crash test dummy, and partial system sled and full vehicle crashes.

### Fuel economy/emissions:

Fuel economy is the measured fuel efficiency of the vehicle in miles per gallon or kilometres per litre. Emissions testing includes the measurement of vehicle emissions, including hydrocarbons, nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide ($CO_2$), and evaporative emissions.

**NVH engineering (noise, vibration, and harshness):**

NVH is the customer's feedback (both tactile [felt] and audible [heard]) from the vehicle. While sound can be interpreted as a rattle, squeal, or hot, a tactile response can be seat vibration or a buzz in the steering wheel. This feedback is generated by components either rubbing, vibrating, or rotating. NVH response can be classified in various ways: power train NVH, road noise, wind noise, component noise, and squeak and rattle. Note, there are both good and bad NVH qualities. The NVH engineer works to either eliminate bad NVH or change the "bad NVH" to good (i.e., exhaust tones).

**Vehicle electronics:**

Automotive electronics is an increasingly important aspect of automotive engineering. Modern vehicles employ dozens of electronic systems. These systems are responsible for operational controls such as the throttle, brake and steering controls; as well as many comfort and convenience systems such as the HVAC, infotainment, and lighting systems. It would not be possible for automobiles to meet modern safety and fuel economy requirements without electronic controls.

**Performance:**

Performance is a measurable and testable value of a vehicle's ability to perform in various conditions. Performance can be considered in a wide variety of tasks, but it's generally associated with how quickly a car can accelerate (e.g. standing start 1/4 mile elapsed time, 0–60 mph, etc.), its top speed, how short and quickly a car can come to a complete stop from a set speed (e.g. 70-0 mph), how much g-force a car can generate without losing grip, recorded lap times, cornering speed, brake fade, etc. Performance can also reflect the amount of control in inclement weather (snow, ice, rain).

**Shift quality**:

Shift quality is the driver's perception of the vehicle to an automatic transmission shift event. This is influenced by the power train (engine, transmission), and the vehicle (driveline, suspension, engine and power train mounts, etc.) Shift feel is both a tactile (felt) and audible (heard) response of the vehicle. Shift quality is experienced as various events: Transmission shifts are felt as an up shift at acceleration (1 2), or a downshift manoeuvre in passing (4 2). Shift engagements of the vehicle are also evaluated, as in Park to Reverse, etc.

**Durability / corrosion engineering**:

Durability and corrosion engineering is the evaluation testing of a vehicle for its useful life. Tests include mileage accumulation, severe driving conditions, and corrosive salt baths.

**Drivability**:

Drivability is the vehicle's response to general driving conditions. Cold starts and stalls, RPM dips, idle response, launch hesitations and stumbles, and performance levels.

**Cost**: The cost of a vehicle program is typically split into the effect on the variable cost of the vehicle, and the up-front tooling and fixed costs associated with developing the vehicle. There are also costs associated with warranty reductions and marketing.

**Program timing**:

To some extent programs are timed with respect to the market, and also to the production schedules of the assembly plants. Any new part in the design must support the development and manufacturing schedule of the model.

**Assembly feasibility**:

It is easy to design a module that is hard to assemble, either resulting in damaged units or poor tolerances. The skilled product development engineer works with the assembly/manufacturing engineers so that the resulting design is easy and cheap to make and assemble, as well as delivering appropriate functionality and appearance.

**Quality management**:

Quality control is an important factor within the production process, as high quality is needed to meet customer requirements and to avoid expensive recall campaigns. The complexity of components involved in the production process requires a combination of different tools and techniques for quality control. Therefore, the International Automotive Task Force (IATF), a group of the world's leading manufacturers and trade organizations, developed the standard ISO/TS 16949. This standard defines the design, development, production, and when relevant, installation and service requirements. Furthermore, it combines the principles of ISO 9001 with aspects of various regional and national automotive standards such as AVSQ (Italy), EAQF (France), VDA6 (Germany) and QS-9000 (USA). In order to further minimize risks related to product failures and liability claims of automotive electric and electronic systems, the quality discipline functional safety according to ISO/IEC 17025 is applied.

**ENERGY ENGINEERING**

Energy engineering or energy systems engineering is a broad field of engineering dealing with energy efficiency, energy services, facility management, plant engineering, environmental compliance, sustainable energy and renewable energy technologies. Energy engineering is one of the more recent engineering disciplines to emerge. Energy engineering combines knowledge from the fields of physics, math, and chemistry with economic and environmental engineering practices. Energy engineers apply their skills to increase efficiency and further develop renewable sources of energy. The main job of energy engineers is to find the most efficient and sustainable ways to operate buildings and manufacturing processes.

Energy engineers audit the use of energy in those processes and suggest ways to improve the systems. This means suggesting advanced lighting, better insulation, more efficient heating and cooling properties of buildings.[1] Although an energy engineer is concerned about obtaining and using energy in the most environmentally friendly ways, their field is not limited to strictly renewable energy like hydro, solar, biomass, or geothermal. Energy engineers are also employed by the fields of oil and natural gas extraction.

**Purpose**

Energy minimization is the purpose of this growing discipline. Often applied to building design, heavy consideration is given to HVAC, lighting, refrigeration, to both reduce energy loads and increase efficiency of current systems. Energy engineering is increasingly seen as a major step forward in meeting carbon reduction targets. Since buildings and houses consume over 40% of the United States energy, the services an energy engineer performs are in demand.

**History**

Human beings have been transferring energy from one form to another since their use of fire. The efficiency of the transfer of energy is a new field. The oil crisis of 1973 and energy crisis of 1979 brought to light the need to get more work out of less energy. The United States government passed several laws in the seventies to promote increased energy efficiency, such as United States public law 94-413, the Federal Clean Car Incentive Program.[1]

**Power engineering**

Considered a subdivision of energy engineering, power engineering applies math and physics to the movement and transfer of energy to work in a system.

**Leadership in Energy and Environmental Design**

Leadership in Energy and Environmental Design (LEED) is a program created by the United States Green Building Council (USGBC) in March 2000. LEED is a program that encourages green building and promotes sustainability in the construction of buildings and the efficiency of the utilities in the buildings.

In 2012 the United States Green Building Council asked the independent firm Booz Allen Hamilton to conduct a study on the effectiveness of LEED program. "This study confirmed that green buildings generate substantial energy savings. From 2000 2008, green construction and renovation generated $1.3 billion in energy savings. Of that $1.3 billion, LEED-certified buildings accounted for $281 million." The study also found the summation of all green construction supported 2.4 million jobs.

**Energy efficiency**

Energy efficiency is seen two ways. The first view is that more work is done from the same amount of energy used. The other perception is that the same amount of work is accomplished with less energy used in the system. Some ways to get more work out of less energy is to "Reduce, Reuse, and Recycle" the materials used in daily life. The advancement of technology has led to other uses of waste. Technology such as waste-to-energy facilities which convert solid wastes through the process of gasification or pyrolysis to liquid fuels to be burned.

The Environmental Protection Agency stated that the United States produced 250 million tons of municipal waste in 2010. Of that 250 million tons roughly 54% gets thrown in landfills, 33% is recycled, and 13% goes to energy recovery plants.[1] In European countries that pay more for fuel, such as Denmark where the price of gas neared $2.6 per litre ($10/US gal) in 2010, have more fully developed waste-to energy facilities. In 2010 Denmark sent 7% of waste to landfills, 69% was recycled, and 24% was sent to waste-to-energy facilities. There are several other developed Western European countries that also have taken energy engineering into consideration.

## INTERDISCIPLINARY CONCEPTS IN CIVIL AND MECHANICAL ENGINEERING

The main function of the civil engineering is the construction of buildings. Mechanical engineering is to concentrate in mainly involved in production work in industries, for which they need a large number of buildings which can be constructed by the civil engineers. For construction in the work, we need a large amount of cement. Through civil engineers we can buy the cement from the market, it is manufactured by the mechanical engineers in the cement factory. Nowadays multi-storeyed buildings are very common in all the countries. In olden days multi-stored buildings are very less in the amount but in the modern age, there are many and many more multi-stored buildings are presented.

One of the main functions of civil engineers is to construct the buildings and the function of mechanical engineers is to work in the production department.

- Clean room constructions for the pharmaceutical industry, R and D centers, demand great coordination of civil engineers as well as biomedical engineers.

- Few of the tough and large scale activities are constructed of the steel industry, paper industry, dams, bridges, tunnels, metal ores like iron gold, silver, and other valuable products, etc...
- In the transport sector, civil and mechanical engineers work together in executing facilities like roadways and railways and etc...
- For the construction of the automobile industry, we need civil engineers to construct it and the mechanical engineers to work in it.
- Marine engineers have to coordinate with civil and mechanical engineers to construct the containers and to lift the container blocks
- Aeronautical engineers have to combine with the civil engineers as well as the mechanical engineers to develop new inventions that are very useful in the aeronautical field. The inventions must be the eco-friendly

**Differentiate between Civil and Mechanical Engineering.**

While both disciplines are a form of engineering, each one requires specific things for the person to be successful. Here are 10 differences between civil engineering and mechanical engineering.

| Civil Engineering | Mechanical Engineering |
|---|---|
| Involves the design and construction of buildings and other structures | Involves inventing and re-inventing machinery |
| Projects are longer in duration | Projects are shorter in duration |
| Projects are generally on a large scale | Projects are smaller and require more precision |
| Must ensure that structures will be stable and efficient in its environment, i.e. the framework of the structure | Works with the living functions of the object or structure, i.e. the mechanics of elevators and such |
| Works with large team including construction manager, architect, and construction workers | Works with mainly with other engineers |