Introduction To Mechanical Engineering

- Introduction: History and broad overview of Mechanical Engineering.
- Components of Mechanical Engineering: Design, Thermal and Manufacturing, Divisions, Subdivisions and applications.
- Role of Mechanical Engineers
- Associations of Mechanical Engineers
- Recent Trends in Mechanical Engineering

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Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

Introduction

Prof. Prashant M. Patane

- 03 years Industrial experience in manufacturing industry
- 08 years of teaching experience at MIT Pune

prashant.patane@mitwpu.edu.in

Learning Objectives

- To introduce Mechanical Engineering discipline
- To impart basic concepts of Mechanical Engineering
- To understand history and development of Mechanical Engineering
- To expose students to multidisciplinary nature of engineering profession
- To introduce frontiers of Mechanical Engineering

Definition:

Engineering is the discipline, art, skill and profession of acquiring and applying scientific, mathematical, economic, social and practical knowledge to design and build structures, machines, devices, systems, materials and processes that safely realize improvements to the lives of people.

Mechanical engineering is the discipline that applies engineering physics, engineering mathematics, and materials science principles to design, analyze, manufacture, and maintain mechanical systems.

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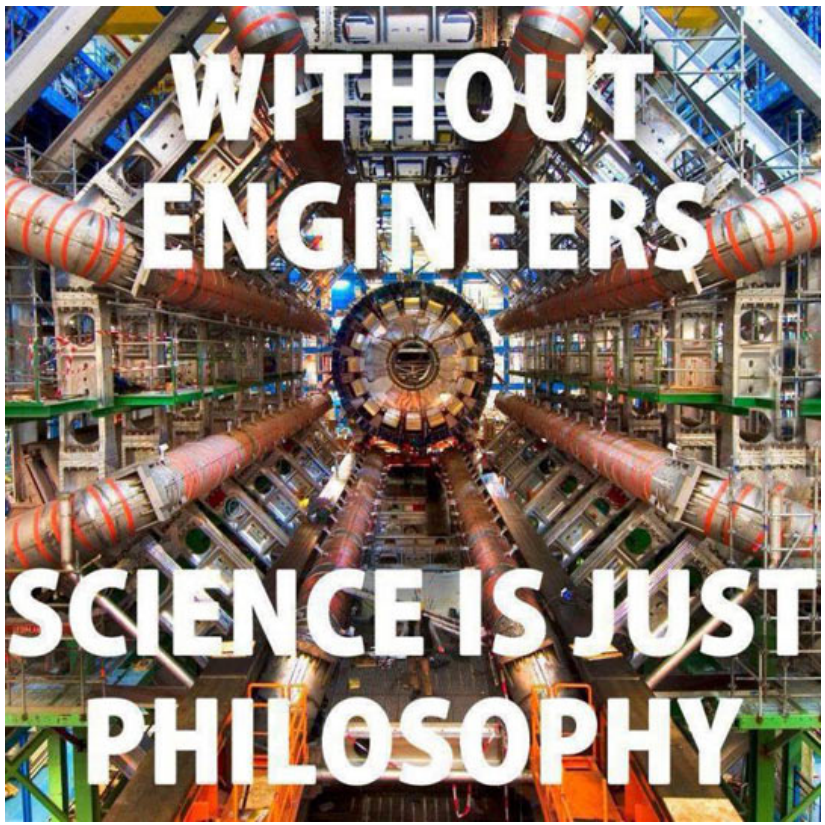
Engineering

- Structures
- Automobiles
- Space-crafts
- Computer Aided Designing
- CNC machines
- Manufacturing Processes
- Fighter Planes
- Bio-Medical Engineering
- Environment and Safety
- Heavy Engineering
- Earth moving equipment
- Cranes
- Bridges
- Nuclear Power plant
- Wind mill
- Roller Coaster

We engineers Design, Develop, Create and Innovate !



Scientists study the world as it is; engineers create the world that has never been.

Scientists try to understand nature. Engineers try to make things that do not exist in nature.

What is Mechanical Engineering?

- Mechanical engineering is the largest and one of the oldest disciplines; broadest of all engineering disciplines.
- Mechanical engineers apply the principles of mechanics and energy to the design of machines and devices.

ENERGY and MOTION

Mechanical Engineering is

- The branch of engineering that encompasses the generation and application of heat and mechanical power and the design, production and use of machines and tools.

- A branch of engineering concerned with the design, construction and operation of machines and machinery.

- The branch of engineering that specializes in the design, production and uses of **machines**.

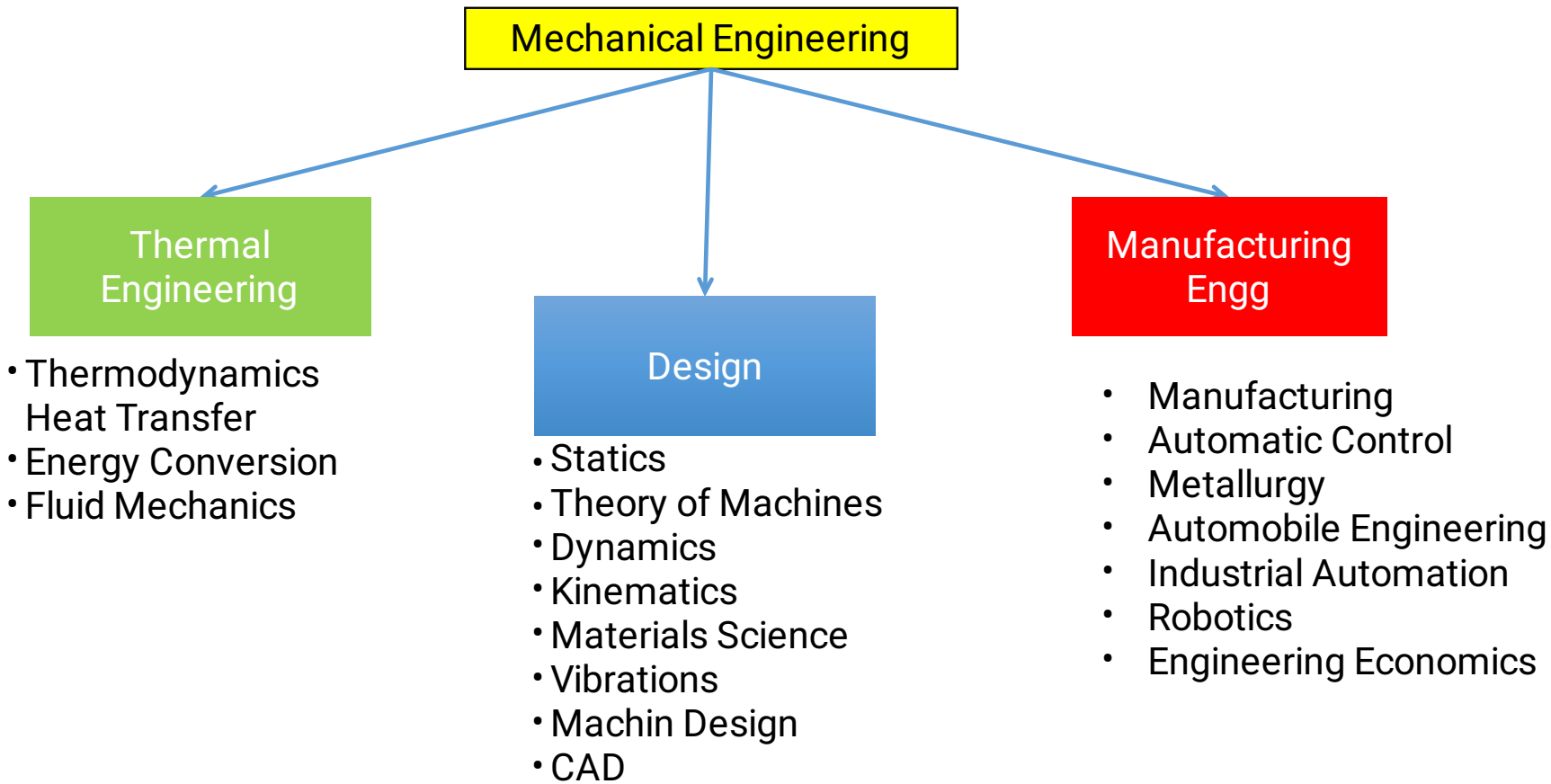
- **Mechanical Engineering is probably the forerunner of many branches of Engineering and has persistently been their companion up to the present.**

Multi-faceted Nature of Mechanical Engineering

Mechanical Engineering is a broad spectrum of Occupations and Challenges.

- Research
- Design
- Development
- Testing
- Manufacturing And Production
- Operations And Maintenance
- Marketing And Sales

➤ Subdivisions of Mechanical Engineering.



➤ The Engineering Design Process: (Core of Engineering)

- Problem Identification: Get with Customer.
- Conceptual Design: Ideas, Sketches and Solution Lists.
- Refinement: Computer Modeling, Data Base Development.
- Testing: Analysis and Simulation of All Design Aspects.
- Prototyping: Visualizing and Improving the Design.
- Communication: Engineering Drawings, Specifications.
- Production: Final Design, Manufacturing, Distribution.

Thermal or Thermal Sciences

Branches of Mechanical Engineering.

Thermal

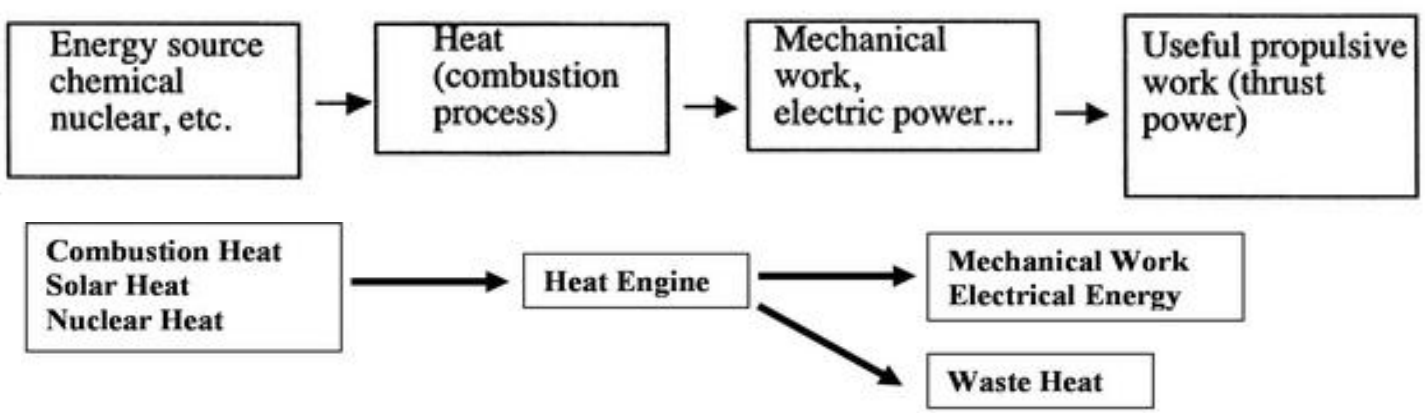
Thermodynamics

The science of thermodynamics deals with the amount of heat transfer as a system undergoes a process from one equilibrium state to another

Thermodynamics is concerned with the transition of a system from one equilibrium state to another.

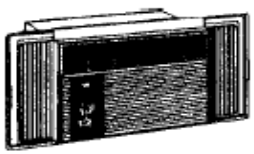
Introduction to Thermodynamics

- **Thermodynamics**: The science of *energy.*
- The name *thermodynamics* stems from the Greek words *Therme* (heat) and *dynamis* (power).
- Thermodynamics is a science and, more importantly, an engineering tool used to describe processes that involve changes in temperature, transformation of energy, and the relationships between heat and work

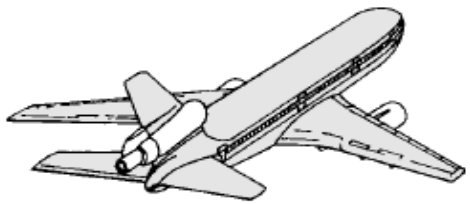


Some Applications of Thermodynamics

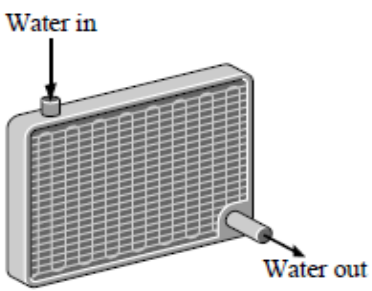
The human body



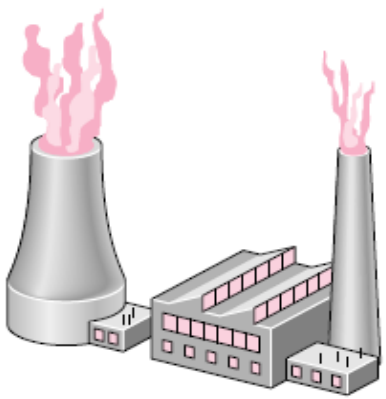
Air-conditioning systems



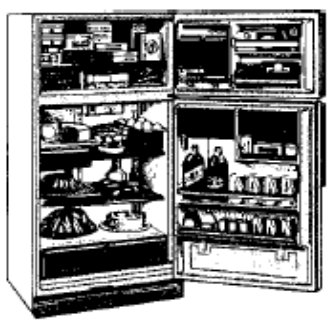
Airplanes



Car radiators



Power plants

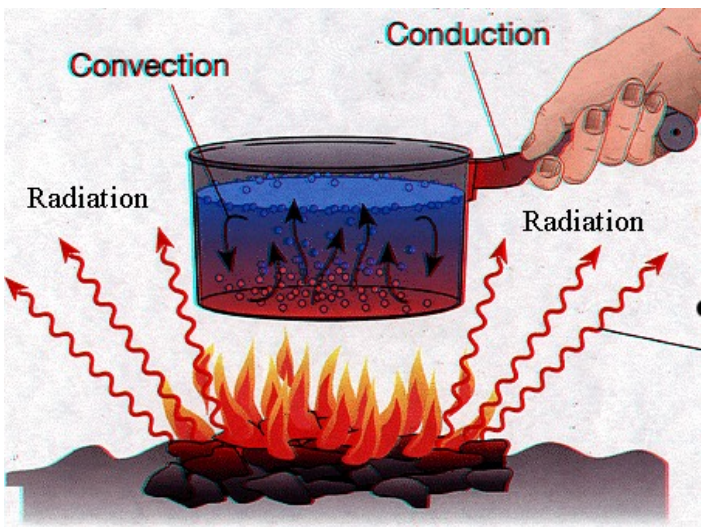


Refrigeration systems

Branches of Mechanical Engineering.

Thermal

Heat Transfer



Heat transfer is the passage of thermal energy from a hot to a cold body.

Transfer of thermal energy occurs mainly through conduction, convection or radiation. Heat transfer can never be stopped; it can only be slowed down.

Branches of Mechanical Engineering.

Thermal

Energy Conversion

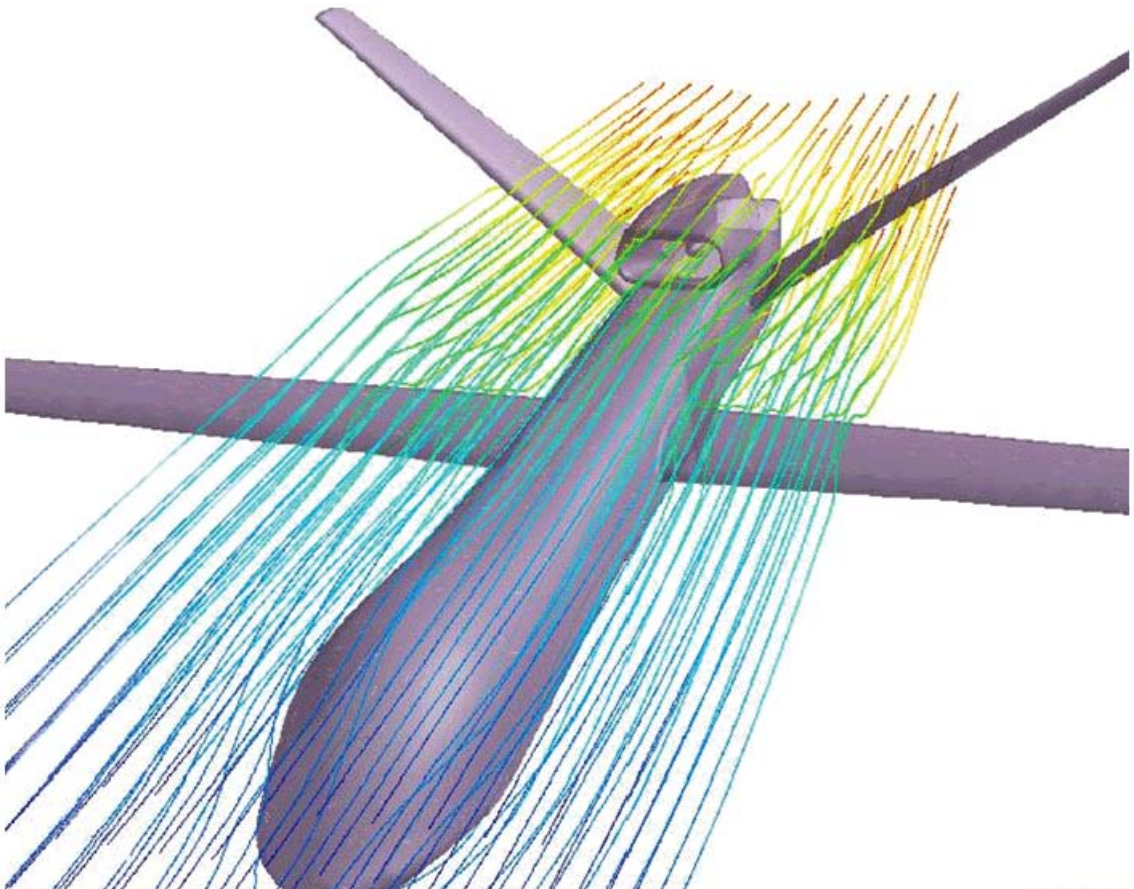
Energy Conversion is concerned with the transformation of energy from sources such as fossil and nuclear fuels and the sun into conveniently used forms such as electrical energy, rotational and propulsive energy, and heating and cooling.

Branches of Mechanical Engineering.

Thermal

Fluid Mechanics

Fluid mechanics is the study of fluids - liquids and gases. It involves study of various properties of the fluid, such as velocity, pressure, density and temperature as functions of space and time.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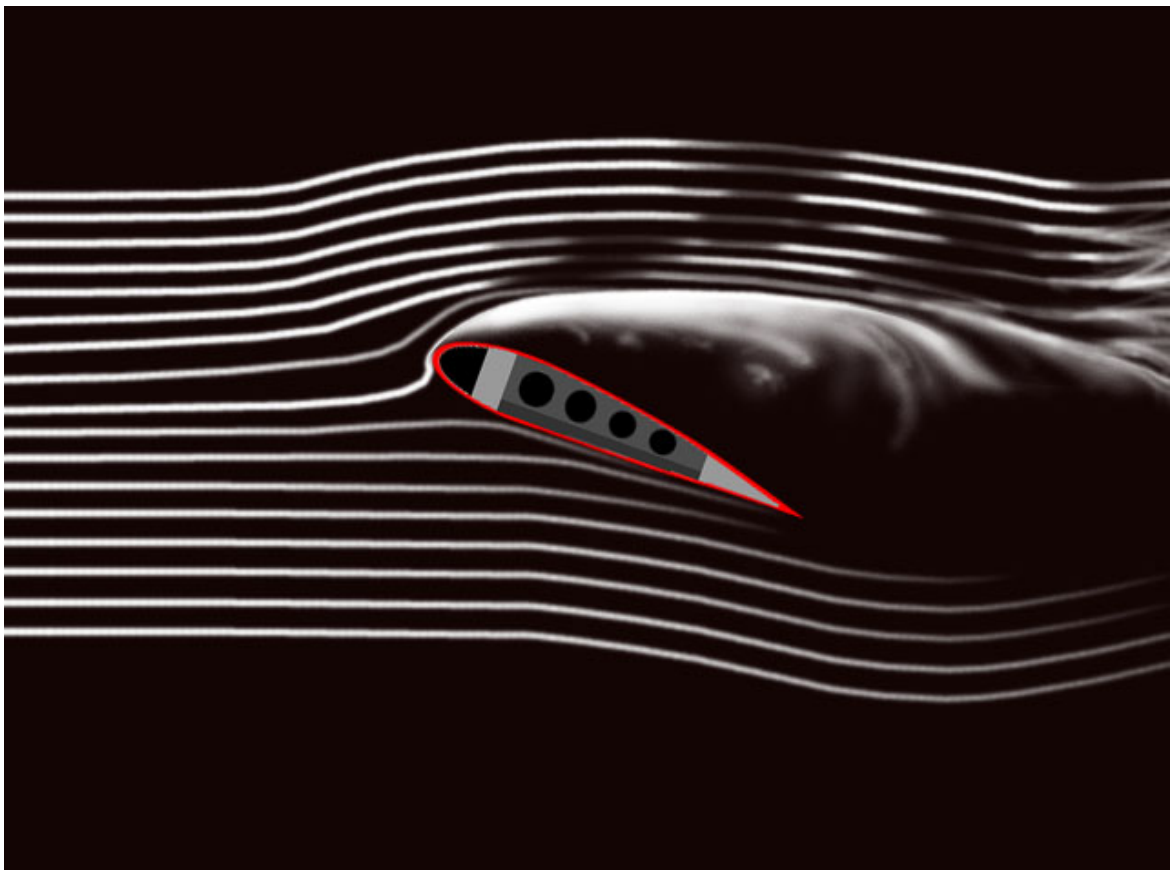


Design or Mechanical Design

Branches of Mechanical Engineering.

Design

Statics

Statics is the branch of mechanics concerned with the analysis of loads (force, torque/moment) on physical systems in static equilibrium, that is, in a state where the relative positions of subsystems do not vary over time, or where components and structures are at a constant velocity.

Branches of Mechanical Engineering.

Theory Of Machines

Design

Theory of machines is that branch of science which deals with the study of relative motion between the various parts of a machine and forces which act on them.

Branches of Mechanical Engineering.

Design

Kinematics

Kinematics is that branch of Theory of Machines which deals with the study of relative motion between the various parts of the machines. Here the various forces involved in the motion are not considered. Thus kinematics is the study to know the displacement, velocity and acceleration of a part of the machine.

Branches of Mechanical Engineering.

Design

Dynamics

Dynamics is that branch of theory of machines which deals with the study of various forces involved in various parts of the machine. The forces may be either static or dynamic

Branches of Mechanical Engineering.

Design

Materials Science

Materials science deals with fundamental properties and characteristics of materials. **Materials science** is an interdisciplinary field applying the properties of matter to various areas of science and engineering. This scientific field investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. It incorporates elements of applied physics and chemistry.

Branches of Mechanical Engineering.

Design

Vibrations

Mechanical vibration is the study of measurement of a periodic process of oscillations with respect to an equilibrium point.

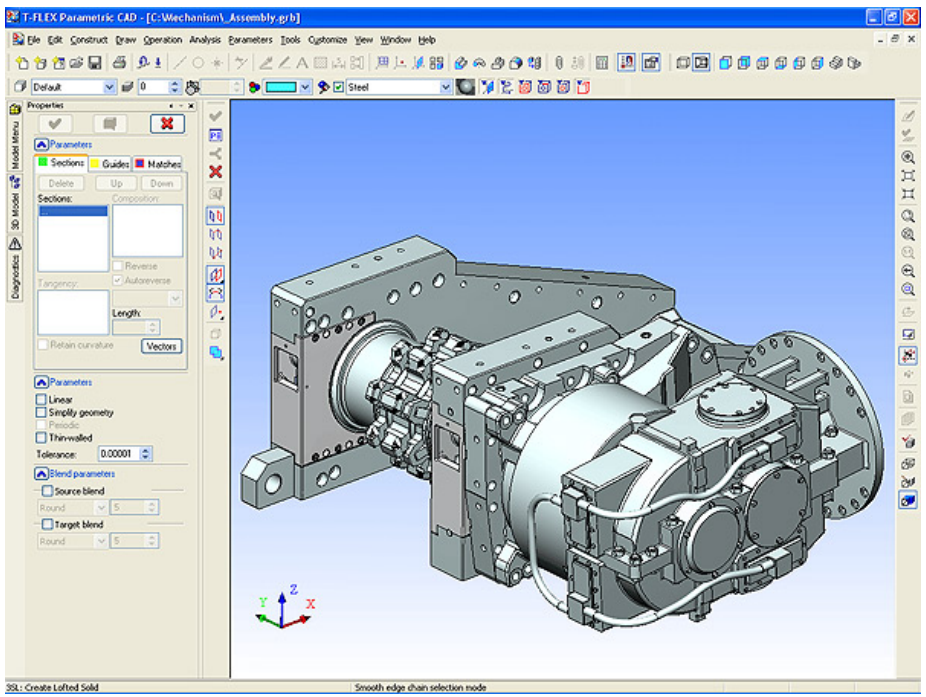
Attention will be given to vibrating systems such as beams, strings, springs, plates and membranes, vibration isolation, critical speeds, the balancing of rotating and reciprocating machinery.

Basic principles of control theory will be studied from feedback control systems.

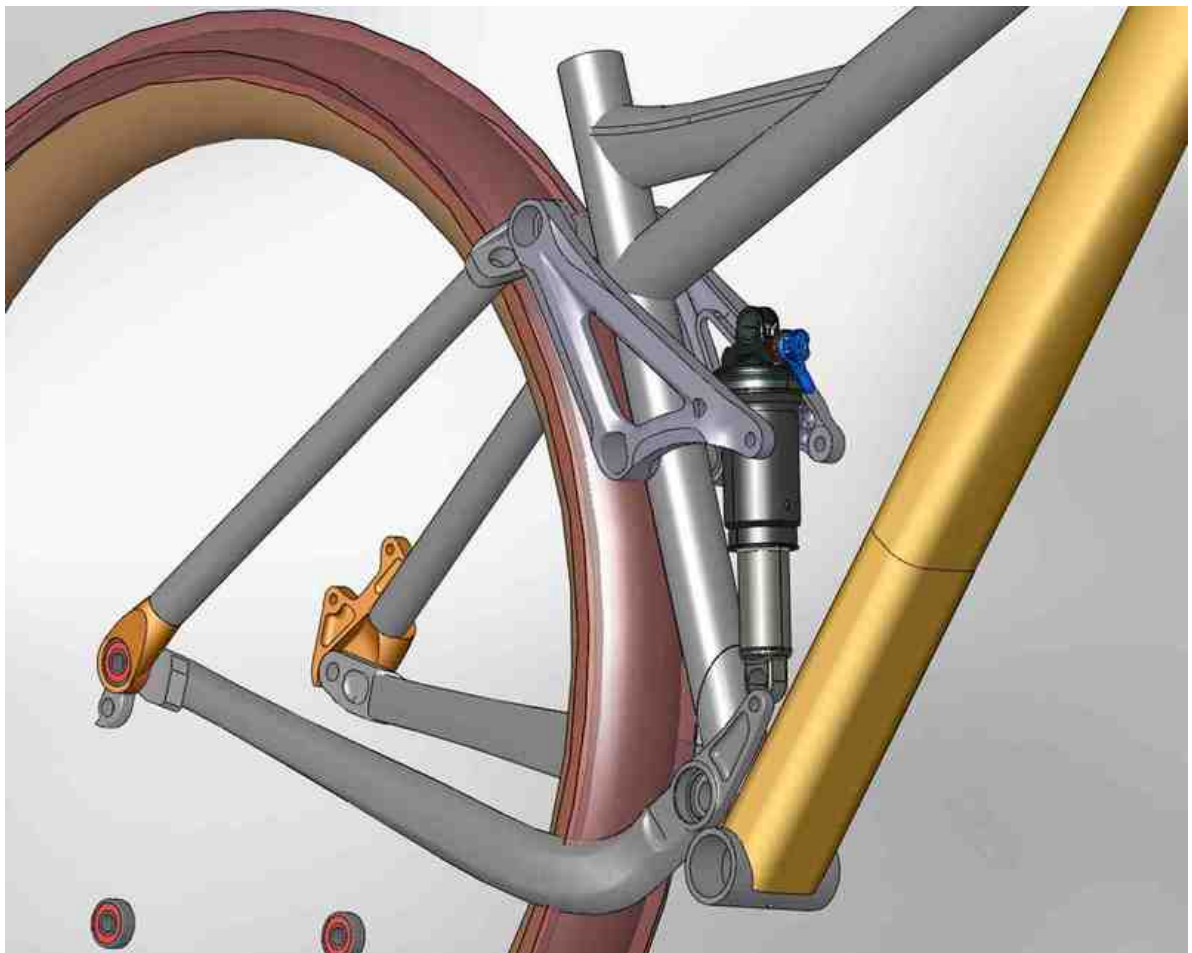
Branches of Mechanical Engineering.

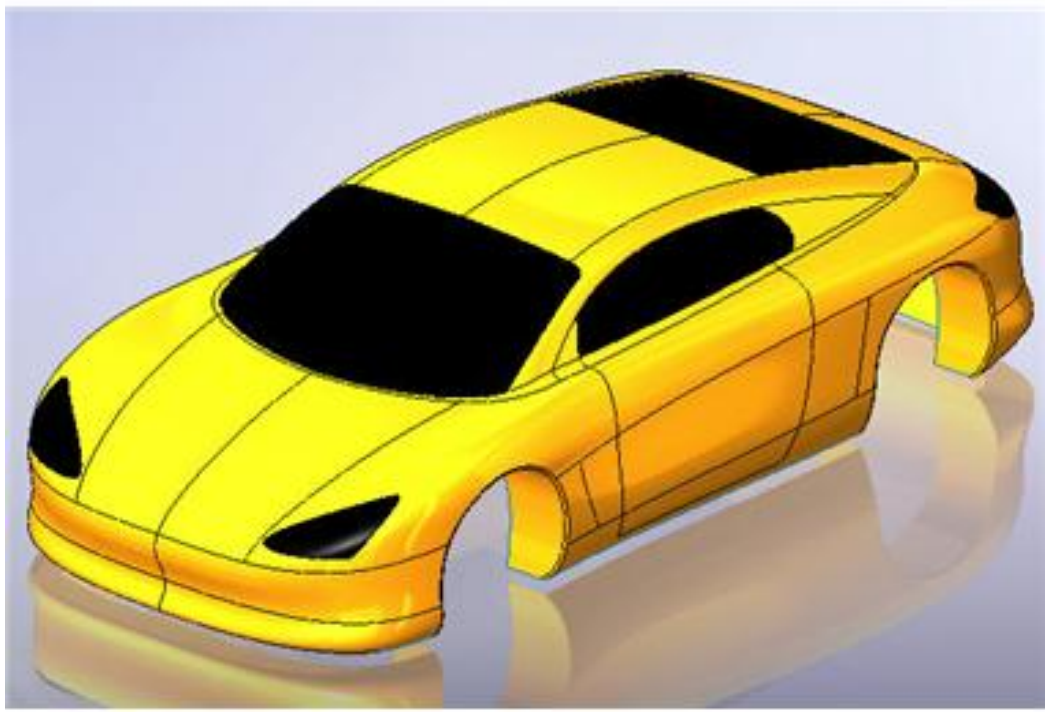
Design

CAD – Computer Aided Design



Computer-aided design (CAD), also known as **computer-aided design and drafting** (CADD) , is the use of computer technology for the process of design and design-documentation.





Branches of Mechanical Engineering

Design

Machine Design

Machine design is creation of plans for machine to perform desired functions.

The machine may be entirely new in concept performing new type of work or it may perform more economically the work that can be done by existing machine.

It may be an improvement or enlargement of an existing machine for better economy & capability.

Production or Manufacturing Engineering.

Branches of Mechanical Engineering.

Manufacturing

Production

Engineering activities involved in the creation and operation of the technical and economic processes that convert raw materials, energy and purchased items into

a) components for sale to other manufacturers

Or

b) end products for sale to the public.

Branches of Mechanical Engineering.

Production

Metallurgy

Metallurgical Engineering is a broad field that deals with all sorts of metal-related areas. The three main branches are physical metallurgy, extractive metallurgy, and mineral processing.

Physical metallurgy deals with problem solving: developing the sorts of metallic alloys needed for different types of manufacturing and construction.

Extractive metallurgy involves extracting metal from ore.

Mineral processing involves gathering mineral products from the earth’s crust.

Production

Branches of Mechanical Engineering.

Automatic Control

Automatic control is also a methodology or philosophy of analyzing and designing a system that can self-regulate a plant (such as a machine or an industrial process) operating condition or parameters by the controller with minimal human intervention.

Branches of Mechanical Engineering.
Industrial Automation & Robotics

Production

Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services.

Robotics is the branch of technology that deals with the design, construction, operation, structural disposition, manufacture and application of robots.

Branches of Mechanical Engineering.
Automobile Engineering

Production

Automotive Engineering is a field closely related to Mechanical Engineering. With the specialist expertise in power plant (engine and transmission) design, vehicle dynamics, vehicle aerodynamics, CAD/CAM, advanced manufacturing and quality systems and project management.

One will be able to work on the design, construction, production and maintenance of automotive components and assemblies in a thriving engineering sector.

Branches of Mechanical Engineering.

Production

Engineering Economics

An engineering economy study involves technical considerations and it is a comparison between technical alternatives in which the differences between the alternatives are expressed so far as practicable in financial terms.

Associations:

- Indian Society of Mechanical Engineers (ISME).
- Society for Automotive Engineers (SAE) International.
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- American Society of Mechanical Engineers (ASME).
- The Institution of Mechanical Engineers (IMechE).

Indian Society of Mechanical Engineers (ISME).

"Indian Society of Mechanical Engineers" is a non-profit Technical Society in India updating vital information in field of Engineering and Technology.

ISME was established in Madras in 1990 and is being sponsored and supported by various professional membership organizations, Societies, Institutions, Industries & others.

ISME seeks to bring together individuals, and institutions and Govt. agencies & industries and Education to evolve and develop Engineering practices in India.

Society for Automotive Engineers (SAE) International.

SAE is an organization for engineering professionals in the aerospace, automotive, and commercial vehicle industries. The Society is a standards development organization for the engineering of powered vehicles of all kinds, including cars, trucks, boats, aircraft, and others.

SAE International has 120,000 members around the world. The mission of SAE International is to enable voluntary consensus on standards development. The *SAE Foundation* raises funds to support science and technology education in students from elementary school through to college.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

The **American Society of Heating, Refrigerating and Air Conditioning Engineers** (**ASHRAE**, is an international technical society for all individuals and organizations interested in heating, ventilation, air-conditioning, and refrigeration (**HVAC&R**).

The Society, organized into Regions, Chapters, and Student Branches, allows exchange of HVAC&R knowledge and experiences for the benefit of the field's practitioners and the public. ASHRAE provides many opportunities to participate in the development of new knowledge via, for example, research and its many Technical Committees.

These committees meet typically twice per year at the ASHRAE Annual and Winter Conferences. A popular product show, the AHR Expo, is held in conjunction with each Winter Meeting. The Society has approximately 50,000 members and has headquarters at Atlanta, Georgia, USA.

American Society of Mechanical Engineers (ASME)

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The **American Society of Mechanical Engineers** (**ASME**) is a professional body, specifically an engineering society, focused on mechanical engineering.

The ASME was founded in 1880. The organization is known for setting codes and standards for mechanical devices. The ASME conducts one of the world's largest technical publishing operations through its ASME Press,

As of 2006, the ASME has 120,000 members.

Tubular Exchanger Manufacturers Association (TEMA)

- The Tubular Exchanger Manufacturers Association (also known as TEMA) is an association of fabricators of shell and tube type heat exchangers.
- TEMA has established and maintains a set of construction standards for heat exchangers, known as the TEMA Standard.
- TEMA also produces software for evaluation of flow induced vibrations and of flexible shell elements .
- TEMA was founded in 1939, and is based in Tarrytown, New York.
- The association meets regularly to revise and update the standards, respond to inquiries, and discuss topics related to the industry.
- The TEMA® standards and software have achieved worldwide acceptance as the authority on shell and tube heat exchanger mechanical design.
- Members are market-aware and actively involved, meeting several times a year to discuss current trends in design and manufacturing.
- This cooperative technical effort creates an extensive network for problem-solving, adding value from design to fabrication.

Recent Trends in Mechanical Engineering

1. 3D Printing (Additive Manufacturing)
2. 4D Printing Technology
3. Digital Manufacturing
4. Green Manufacturing
5. Agile Manufacturing
6. High Speed Machining
7. Interconnected machines
8. Manufacturing Optimization
9. Nano Technology
10. Nano Electro-Mechanical Systems
11. Mechatronics
12. Robotics
13. Automation and intelligent system
14. Agricultural Technology
15. Textile Industry
16. Internet of Things
17. Hyperloop Technology
18. Advances in Heating, ventilation and Air conditioning
19. Cryogenics
20. Fuel-efficient Engine Technologies
21. Autonomous Vehicles
22. Self Driving Cars and New Automated Transport solutions
23. Advances in Gas Turbine Technology
24. A scramjet (Supersonic Combustion Ramjet)
25. Energy Solutions
26. Alternative Energy (Solar energy and other renewable energy)
27. Computational Fluid Dynamics
28. Beamed Energy Propulsion
29. Laser Cooling
30. Biomedical Engineering

Additive Manufacturing

- As the name implies, additive manufacturing adds the material to create a 3D object. Additive Manufacturing is also called 3D Printing.
- Additive Manufacturing is a process in which the model of an object has to be created in any Modelling Software(CAD Software) and has to save in the format of.STL.
- This format essentially "slices" the object into ultra-thin layers. Each successive layer bonds to the preceding layer of partially melted or melted material.
- This file has to be sent to Additive Manufacturing machine or 3D Printing Machine to produce a 3D object in the form of fine layers.

Digital Manufacturing

- As there are more number of automated tools in the manufacturing industry, it is the duty of the industry to model, run the simulation and analyse the machines, input materials and tooling.
- The name indicates that the manufacturing is controlled by means of numbers or numerals in the digital form i.e. write the G codes and M codes in a program and that can be operated by means of a central computer.
- In order to meet the market demand, there will be a need of large amount of goods to the consumers. By making a few things or goods does not sustain the environment, therefore there is the need of Digital Manufacturing.
- With the rise in the quality and quantity of computer systems in manufacturing plants, the transition to digital manufacturing has become popular.

Green Manufacturing

- The “greening” of manufacturing in the sense reducing waste and pollution by minimizing natural resource use, reusing and recycling waste, and reducing emissions.

- Step by step procedure for Green Manufacturing:

1. Design
2. Procure
3. Manufacture
4. Packing and Distribution
5. Customer use to end of life
6. Remanufacture

And the cycle continues….

Interconnected Machines

- Machines Interconnected or Machine to Machine(**M2M**) in the sense there is a direct communication either in the form of wired or wireless between devices using a communication channel.

- Machines Interconnection includes industrial instrumentation that enables the sensors to communicate the information.

- While using less power, the expansion of IP networks has made machine to machine communication faster and easier around the world.

- **Applications of Interconnected Machines:**

1. Machine-to-machine communication is used for remote monitoring.
2. M2M is vital in warehouse management systems
3. Machine-to-machine communication also plays a vital role in supply chain management.

Nano Technology

- Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers.
- Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.
- Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules.
- Engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

Biomedical Engineering

- **Biomedical engineering** (**BME**) is also known as **medical engineering** is the application of design concepts and engineering principles to biology and medicine for healthcare purposes.

- This can solve advanced health care treatment which includes; Diagnosis, Monitoring and Therapy

- The contents which you can listen in Biomedical Engineering are; Biomedical optics, Biomaterial, Genetic engineering, Biomechanics, Tissue engineering, Bioinformatics, Pharmaceutical engineering, Neural engineering

- Some of the examples of medical devices are; Dialysis machines, Pacemakers, Artificial organs, Dental implants etc.

Internet of Things (IoT)

- In this system, there is no need of human intervention. Each and every system is under the control of devices connected around it.
- It is a system of mechanical and digital machines which are provided with UID's in order to transfer the data over a wide variety of networks.
- It actually involves Machine learning with real time analytics.
- Traditional fields of wireless sensor networks, embedded systems, automation, control systems and all other contribute for enabling the Internet of Things.
- **Examples** that can comes under **Internet of Things** include thermostats, security systems, cars, alarm clocks, electronic appliances, lights in commercial and household environments, vending machines, speaker systems and more.
- **Applications of IoT:**

- Commercial applications like medical and health care, building and home automation, transportation etc.
- Industrial applications like manufacture and agriculture.
- Infrastructure applications like environmental monitoring, energy management etc.
- Military applications like Ocean of things, Internet of battlefield things etc.

Hyperloop Technology

- A **Hyperloop** is a proposed high-speed mass transportation system for both passenger and freight transport.
- The term was invented to describe the modern open-source project.
- Hyperloop is described as a sealed tube or system of tubes with low air pressure through which a pod may travel substantially free of air resistance or friction.
- The Hyperloop could potentially move people or objects at airline speeds while being energy efficient compared with existing high-speed rail systems.
- This, if implemented, may reduce travel times compared to train and airplane travel over distances considerably.