Mechanical Engineering

What it means to be a Mechanical Engineer!

Gajendra Circle Initiative (GCI) from IIT Madras Alumni Association and The Hindu Group

May 15, 2010

Compiled by: Adayana Learning Solutions Pvt Ltd (www.adayana.com)

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Introduction

Mechanical engineering is an engineering discipline that applies the principles of physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems. It is the branch of engineering that involves the production and usage of heat and mechanical power for the design, production, and operation of machines and tools. It is one of the oldest and broadest engineering disciplines.

The field requires a good understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, and structural analysis. Mechanical engineers use these core principles along with tools like computer-aided engineering and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, motor vehicles, aircraft, watercraft, robotics, medical devices and more.

Mechanical engineering emerged as a field during the industrial revolution in Europe in the 19th century; however, its development can be traced back several thousand years around the world. The field has continually evolved to incorporate advancements in technology, and mechanical engineers today are pursuing developments in such fields as composites, mechatronics, and nanotechnology.

Mechanical Engineering finds application in all fields of technology. It is one of the primitive branches of Engineering which have remained always in demand and continue to be in the future. This is why Mechanical trade is called as an Evergreen trade (branch). Mechanical engineers have always been needed as essential staff personnel in various industries of both public and private sector. Their work criteria changes according to the type and domain of the company they are working with. As the Industrial sector has drastically risen in pace, the need for more mechanical engineers has increased exponentially. Every manufacturing and production industry needs mechanical engineers to carry out jobs efficiently and flawlessly for their companies.

As the working criteria of a Mechanical Engineer changes according to the type and domain of the company they are working with and field of specialization. We can broadly say that a Mechanical Engineer works how to design and control a system that goes into the process of manufacturing the machinery and product. He tests new systems for feasibility and efficiency and carries out quality management and improvement process.

What You Learn in Mechanical Engineering?

The main areas of study in Mechanical Engineering are:

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.

Kinematics – Kinematics is the study of the motion of bodies (objects) and systems (groups of objects), while ignoring the forces that cause the motion. The movement of a crane and the oscillations of a piston in an engine are both simple kinematic systems. The crane is a type of open kinematic chain, while the piston is part of a closed four-bar linkage.

Mechanical Engineers typically use kinematics in the design and analysis of mechanisms. Kinematics can be used to find the possible range of motion for a given mechanism, or, working in reverse, it can be used to design a mechanism that has a desired range of motion.

Mechatronics – Mechatronics 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.

Robotics – 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 can interact physically with the world.

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 analysis may be used in the office when designing parts, in the field to analyze failed parts, or in laboratories where parts might undergo controlled failure tests.

Thermo-dynamics – Thermo-dynamics is an applied science used in several branches of engineering, including mechanical and chemical engineering. At its simplest, thermo-dynamics is the study of energy, its use and transformation through a system. Typically, engineering thermo-dynamics 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.

Drafting – Drafting or technical drawing is the means by which mechanical engineers 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.

Mechanical Engineers have to study a whole lot of physics, Engineering drawing, machine drawing and many more concepts such as:

- Statics
- Dynamics
- Kinematics
- Strength of Materials
- Materials Science
- Theory of Machines
- Thermodynamics
- Fluid Mechanics
- Heat Transfer
- Manufacturing
- Machine Design
- Electrical Circuits
- Mechanical Drawing
- Mechanical Vibrations
- Metallurgy
- Manufacturing Process
- Production Management
- Computer Aided Design/ Drafting (CAD)
- Automobile Engineering
- Industrial Automation and Robotics

Opportunities

Mechanical engineering has a tremendous scope in industries such as:

- Automobile Industry
- Cement Industry
- Steel Industry
- Power Sector
- Hydraulics
- Manufacturing Plants
- Drilling and Mining Industry
- Oil and Gas Industry
- Aeronautical Industry
- Biotechnology
- Nanotechnology and many more.

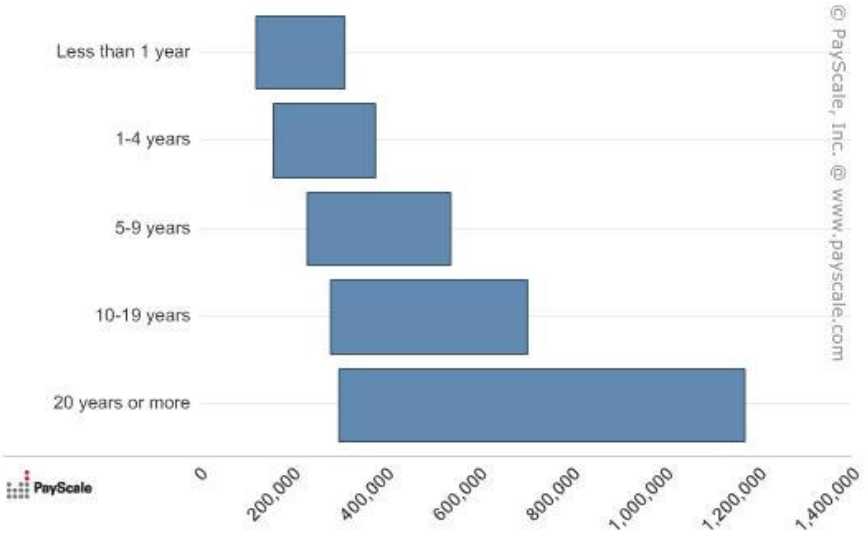
A mechanical engineer is commonly involved with projects such as:

- Development and design of various mechanical design projects
- Product design and development
- Manufacturing and production engineering
- Installation of thermal fluid and mechanical systems
- Design and analysis of energy
- Working on mechanical engineering projects overseas
- Collaborating with a mechanical engineering team
- Overseeing a staff of other mechanical engineers

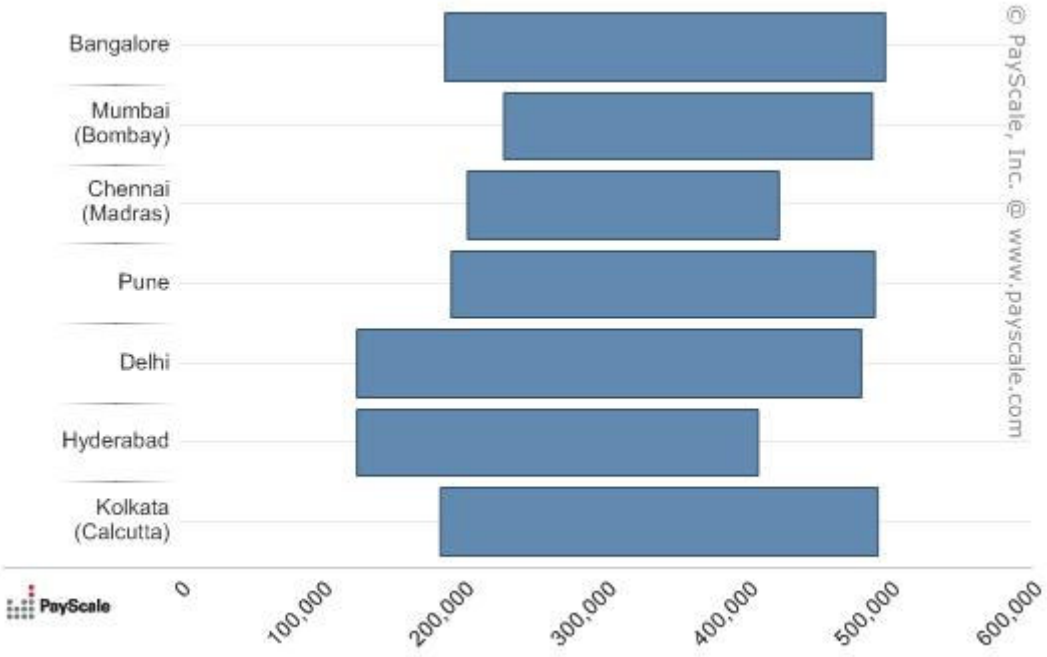
Salary Profile

This section provides salary profile of mechanical engineers in India based on years of experience, city of employment, type of employer.

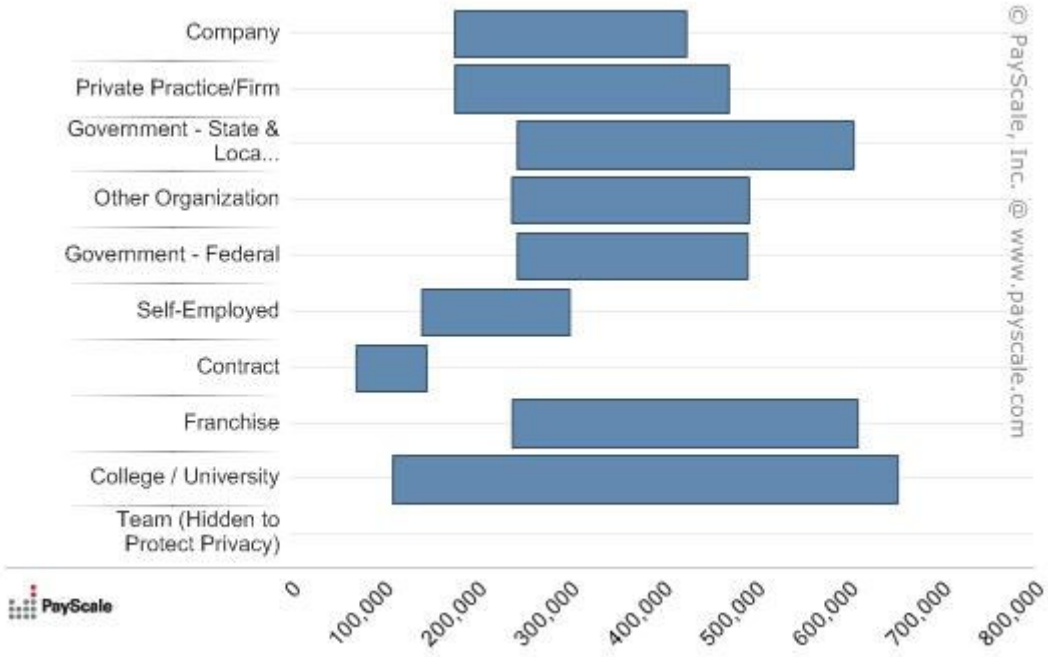
Typical Salary Data for Mechanical Engineers (Years of experience)



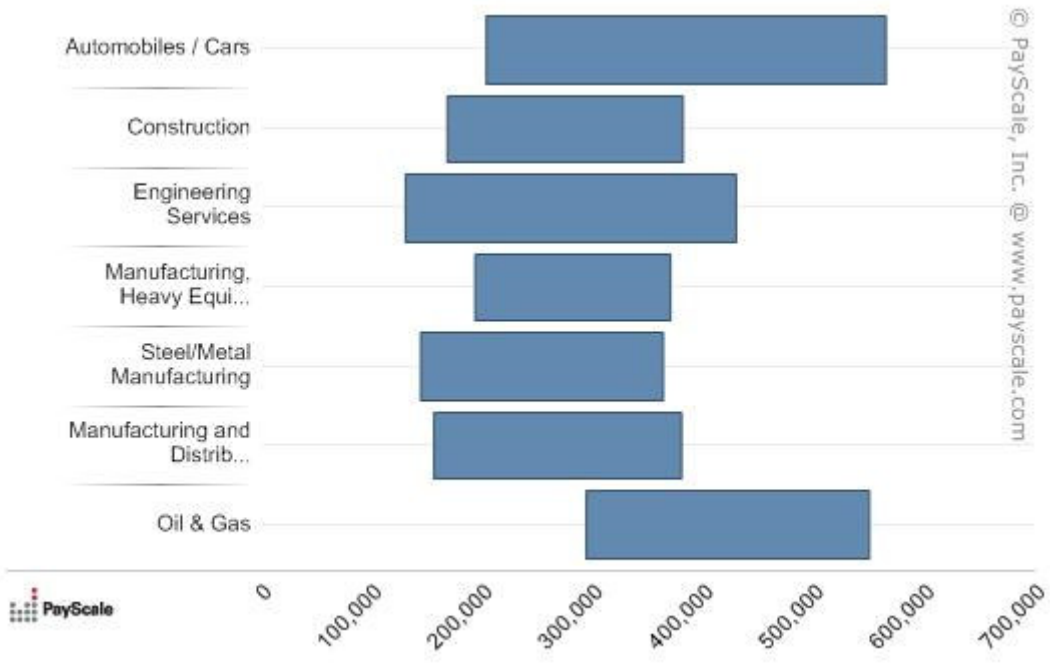
Typical Salary Data for Mechanical Engineers (by City)



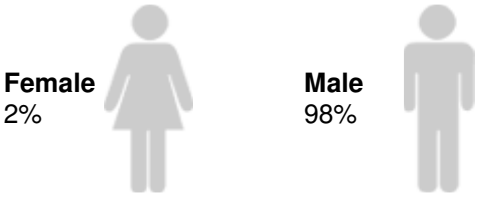
Typical Salary Data for Electrical Engineers (by Type of Employer)



Popular Industry & Salary Range



Gender Profile



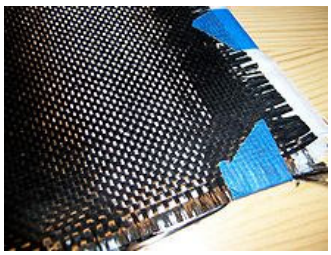
Areas of Research in Mechanical Engineering

This section provides guidance to some of the technological advancements and areas of research in mechanical engineering - giving glimpse of what a Mechanical Engineer may work on in future.

Mechanical engineers are constantly pushing the boundaries of what is physically possible in order to produce safer, cheaper, and more efficient machines and mechanical systems. Some technologies at the cutting edge of mechanical engineering are listed.

Micro Electro-Mechanical Systems (MEMS) – Micron-scale mechanical components such as springs, gears, fluidic and heat transfer devices are fabricated from a variety of substrate materials such as silicon, glass and polymers like SU8. Examples of MEMS components will be the accelerometers that are used as car airbag sensors, gyroscopes for precise positioning and micro fluidic devices used in biomedical applications.

Composites – Composites or composite materials are a combination of materials which provide different physical characteristics than either material separately. Composite material research within mechanical engineering typically focuses on designing (and, subsequently, finding applications for) stronger or more rigid materials while attempting to reduce weight, susceptibility to corrosion, and other undesirable factors. Carbon fiber reinforced composites, for instance, have been used in such diverse applications as spacecraft and fishing rods.



Mechatronics – Mechatronics is the synergistic combination of mechanical engineering, electronic engineering, and software engineering. The purpose of this interdisciplinary engineering field is the study of automata from an engineering perspective and serves the purposes of controlling advanced hybrid systems.

Nanotechnology – At the smallest scales, mechanical engineering becomes nanotechnology and molecular engineering—one speculative goal of which is to create a molecular assembler to build molecules and materials via mechanosynthesis. For now that goal remains within exploratory engineering.

Finite element analysis – Finite Element Analysis (FEA) or Finite Element Method (FEM) is used for analysis of structural problems. Many commercial codes such as ANSYS, Nastran and ABAQUS are widely used in industry for research and design of components. Similar other techniques such as finite difference method (FDM) and finite-volume method (FVM) are employed to solve problems relating heat and mass transfer, fluid flows, fluid surface interaction etc.

Reference

This report has been compiled based on the following publications.

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About Gajendra Circle

Gajendra Circle (GC) Initiative is a subset of IITM alumni association, and is aimed at building the IIT Madras brand and strengthening the Institute resources. It has been structured as a collection of city

specific cells. GC Hyderabad was constituted in April 2010 with the aim to take up activities which strengthen IIT Madras and have a good resonance with the core team.

About Adayana

Adayana is a leading Human Capital Development organization with its headquarters in Indianapolis, IN, USA and offices across Americas, EMEA, Asia. Adayana provides comprehensive learning services that leverage best-of-class and proprietary technologies and processes.

For four subsequent years, from 2006 to 2009, TrainingOutsourcing.com recognized us as one of the "Top 20 Companies in the Training Outsourcing Industry" for it's unique and diverse capabilities. In 2007, 2008 and 2009 Adayana has been named to the Inc. 500 list of America's 500 fastest growing companies. Adayana offers e-Learning, instructor-led training, mobile learning, gameware and performance support tools to its customers for improving human capital performance.

Adayana India (based in Hyderabad) focuses on India and Asia markets - serving large multinationals in the Automotive, IT/ITES, Healthcare, Agriculture & Food and other verticals. Adayana is a leading player in skill development and capacity building and has partnered with leading universities and colleges to provide finishing school content to improve employability of students.

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