Rohini College Of Engineering And Technology

BE3255 BASIC CIVIL AND MECHANICAL ENGINEERING

DIGITAL NOTE

UNIT I OVERVIEW OF MECHANICAL ENGINEERING

UNIT I OVERVIEW OF MECHANICAL ENGINEERING

Overview of Mechanical Engineering – Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering – Production, Automobile, Energy Engineering – Interdisciplinary concepts in Civil and Mechanical Engineering.

SCOPE OF MECHANICAL ENGINEERING

contribution of mechanical engineering to the welfare of the society. Mechanical engineering is the discipline that applies engineering physics and material sciences principles to design, analyses, manufacture and maintain mechanical system.

Various disciplines of Mechanical engineering

1. Applied mechanics
2. Dynamics
3. Fluid Mechanics
4. Thermodynamics
5. Heat transfer
6. Production Technology

Fields of employment:

1.Technology 2.Science 3.Exploration 4.Military

contribution of mechanical engineering to the welfare of the society.

The energy solution. Society of today badly needs more power. We have huge shortage of electricity, especially in underdeveloped countries. Prices of fuel oil are going up. As a Mechanical engineer you need to find a green way to generate power. The transportation solution. Millions of people die every year while traveling. Safety has to be priority while designing new vehicles. Cost effective products. There are many who can't afford to buy basic things that are required for day to day living. You need find better machines and processes that will reduce prices. and above all society wants you to be the leader. You shall bring the change society needs. Society doesn't know what she wants. She knows how to choose. It's your duty to give her better options.

Mechanical engineering covers development and implementation of solutions to energy and water needs of the society with minimal environmental impact. Mechanical engineers contribute to the society by designing, manufacturing and maintaining mechanical devices for broad range of applications in all forms of industry. Mechanical engineers also develop materials and measurements that contributes to research, economic and management dimensions that support the industrial activities. Mechanical engineering principles are employed in wide range of industries such as power generation, manufacturing, energy repair and maintenance, automation and control robotics, electronics, Nano technology, food industries, petroleum, aerospace, etc.,.

Specialized sub divisions in mechanical engineering

1. Production engg. 2.Automobile engg. 3.Energy engg.

Goals of production engineering are to accomplish the production process in the smoothest, most effective and economic way. It comprises of the application of casting, machining process, joining process, metal cutting, tool design, automation jigs, die and mold design, design of machine tools, automation.

Production engineering:

It is the combination of manufacturing technology, engineering sciences with material sciences. It has a wide range of engineering practices and it is aware of management challenges related to production.

Scope of Mechanical Engineering

Mechanical Engineering is one of the most perennial branches of engineering which has always been the choice of innovative minds since its inception. Mechanical engineering deals with the notions of machines, thermodynamics, fluids, mechanics, and structural scrutiny. Applications of Mechanical Engineering are omnipresent and inseparable from society. Even in today's digital world, this stream has its charm and fascination, the theories of Mechanical Engineering are used in scheming some of the best and most proficient state-of-the-art motor vehicles, developed units, airplanes as well as other industrial machinery. Apart from the machinery and vehicles, mechanical engineers contribute to the expansion of power equipment, engines, and complex machinery systems. Not only the strategy and manufacturing but also the maintenance and testing of such machinery and equipment are written in the errands of mechanical engineers. However, this classic branch of engineering is fronting an alarming question – whether it is still the right stream for students who love machines or not? The Answer is a 'BIG YES'. So here, we are going to elaborate on the scope of mechanical engineering and its forthcoming prospects.

Manufacturing or Production Engineering

Manufacturing or Production Engineering is the subset / specialization of a Mechanical Engineering. Mechanical Engineering with the focus only on Machine Tools, Materials Science, Tribology, and Quality Control is known as Manufacturing Engineering. Professional manufacturing engineers are responsible for all aspect of the design, development, implementation, operation and management of manufacturing system. Manufacturing is the most important element in any engineering process & Manufacturing Engineers are key personnel in many organization. The manufactured products range from aero planes, turbines, engines and pumps - to integrated circuits and robotic equipment.

What does a Production Engineer do?

Production Engineers work towards Choosing machinery and equipment's for the particular manufacturing process

- Production Engineers will be planning & scheduling the production in any manufacturing industry. [e.g. Automobile Manufacturing industry].
- Production Engineers will be programming the CNC machines to produce engineering components such as gears, screws, bolts, etc
- They are responsible for quality control, distribution and inventory control.

Production Engineer Responsibilities and Duties

- Plan and coordinate production engineering processes on daily basis to produce high quality products.
- Develop process improvements to effectively utilize equipment and materials to maximize production.
- Develop operational strategies to achieve production and financial objectives.
- Identify unsafe operations and practices and report the same to Manager immediately.
- Establish safety procedures and environmental regulations for employees.

- Provide engineering support for production and maintenance activities to ensure maximum production.
- Perform engineering analysis to reduce downtime and outages.
- Evaluate current production activities and make recommendations for improvements.
- Implement cost reduction initiatives while maintaining high quality standards.
- Develop operating instructions and equipment specifications for production activities.
- Provides training and guidance to team members to accomplish production goals.

Stay current with product specifications, engineering technology and production processes.

- Develop best practices to improve production capacity, quality and reliability.
- Investigate problems, analyze root causes and derive resolutions.
- Aid in budget preparation and monitor expenses and profitability.

Energy Engineering:

It is the field of engineering dealing with energy efficiency services, facility management, plant engineering, environmental compliance and alternative energy technology.

It is the most recent engineering discipline.

Combines the knowledge from the field of physics, chemistry, mathematics with economic and environmental engineering practices. Energy engineers apply their skills to increase efficiency and further develop renewable sources of energy.

Main job is to find the most efficient and sustainable way to operate buildings and manufacturing processes. Energy engineers audits the use of energy in those processes and suggests ways to improve the systems.

Advanced lighting, Better insulation, efficient heating and cooling properties of buildings.

1. Hydro 2.Solar 3.Bio-mass 4.Geo thermal 5.ONGE

Responsibilities:

1. You will be need to Design, develop and built renewable energy technologies.
2. Combine renewable energy pattern with existing power systems.
3. Arrange new supplies and negotiate traffic with fuel provider
4. Carry out site inspection and energy surveys
5. Design and select equipments.
6. Use mathematical and computer model to complete design and specification calculations
7. Carry out lab experiments and adapt them to the large scale
8. Prepare detail schedule of work, feasibility studies and cost estimates
9. Check site and ground conditions for the installation of renewable technologies such as wind turbines.

10. Keep up dates with legislation and environmental standards

11. Develop technical expertise in all matters.

Skills for mechanical engineers:

1. Responsible for the safe and efficient operation of internal combustion engines, steam and gas turbines.

2. Investigate equipment failures and difficulties to diagnose faulty operation and make recommendation to maintenance crew.

3. Assist drafters: CADD or drafting equipment and software.

4. Provide feedback to design engineer on customer problems and needs.

5. Oversee the installation,operation,maintanence and repair of machines and equipments to ensure they are installed and functioning according to specification.

APPLICATION:

1. Modern electric, wireless, Nuclear technology and tesla coil which has seen widely used in radio, television sets and other electronic equipment.

2. GPS, dynamic, flight simulations.

3. Steam engine, rotary engine and copying system

4. Heat pump, steam & gas turbines

5. Aerodynamics.

ENERGY ENGG:

Energy engineering or energy systems engineering is a broad field of engineering dealing with energy efficiency, energy services, facility management, plant engineering, environmental compliance and alternative energy technologies. Energy engineers are also employed by the fields of oil and natural gas extraction.

We divide our energy use among four economic sectors: residential, commercial, transportation, and industrial. Heating and cooling our homes, lighting office buildings, driving cars and moving freight, and manufacturing the products we rely on in our daily lives are all functions that require energy.

Energy systems engineers oversee complex energy conversion and distributionsystems, work to improve energy storage systems, and manage the efficient use of energy in building, manufacturing, and processing systems Assess the environmental impact of alternative energy systems.

As an energy engineer, you'll be involved with the production of energy through natural resources, such as the extraction of oil and gas, as well as from renewable or sustainable sources of energy, including biofuels, hydro, wind and solar power.

Thermal Engineering is controlling heating or cooling processes in an enclosed environment or an open environment using various equipments. It involves the science of thermodynamics, fluid mechanics, heat and mass transfer.

Applications:

The most common example is air conditioning(Home & car). You need extensive knowledge of thermal engineering for designing a compressor/condenser/evaporator coil/insulation used in any air conditioning unit. Refrigerators too use the same principles. Well to be frank it can be used in 'n' number of ways like we utilize thermal energy for generation of electricity, for heating purposes (it can be water heating, space heating, etc.), refrigeration system (vapour absorption types), etc.

The most important application & perhaps one of the greatest machines which ushered the industrial revolution is a BOILER. This my friend is used in every coal, gas, oil & nuclear power plant on the planet. Basically a boiler generates a lot of heat by burning coal/gas/oil which is absorbed by water & steam is formed, which is later expanded through a steam turbine to generate electricity. The nuclear powered submarine or aircraft carrier use these boilers too!

Another important application is COMBUSTION ENGINES. Look at the image below to see the wonder of thermal engineering - A V8 ENGINE!! I don't need to tell you how important this piece of machinery is to mankind.

The thermal systems engineering refers to how energy is used in every areas of our lives and those systems always include the transfer, storage and conversion of energy. Some examples are:

Engines (For cars, ships, boats, airplanes, rockets, helicopters, trains, motorcycles and so on) Freezers Microwaves Power generating plants

AUTOMOBILE ENGINEERING

It is a part of mechanics through the application of automotive technology, the course offers specialization in vehicle designing, repairing, testing & assembling. Also learn safety engg, Quality management & automotive analysis as well as assembling & installation of various automobile, aerospace & machine.

INTRODUCTION:

Automobile engineering is the one of the stream of mechanical engineering. It deals with the various types of automobiles, their mechanism of transmission systems and its applications. Automobiles are the different types of vehicles used for transportation of passengers, goods, etc. Basically all the types of vehicles work on the principle of internal combustion processes or sometimes the engines are called as internal combustion engines.

Different types of fuels are burnt inside the cylinder at higher temperature to get the transmission motion in the vehicles. Most of the automobiles are internal combustion engines vehicles only. Therefore, every mechanical and automobile engineer should have the knowledge of automobile engineering its mechanism and its various applications.

DEFINITION: Automobile engineering is a branch of engineering which deals with everything about automobiles and practices to propel them. Automobile is a vehicle driven by an internal combustion engine and it is used for transportation of passengers and goods on the ground. Automobile can also be defined as a vehicle which can move by itself.

Examples : Car, jeep, bus, truck, scooter, etc.

CLASSIFICATION OF VEHICLES:

Automobiles or vehicles can be classified on different bases as given below :

On the Basis of Load :

(a) Heavy transport vehicle (HTV) or heavy motor vehicle (HMV), e.g. trucks, buses, etc.

(b) Light transport vehicle (LTV) e.g. pickup, station wagon, etc.

(c) Light motor vehicle (LMV), e.g. cars, jeeps, etc.

On the Basis of Wheels :

(a) Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.

(b) Three wheeler vehicle, for example : Auto rickshaw, three wheeler scooter and tempo, etc.

(c) Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.

(d) Six wheeler vehicle, for example : Big trucks with two gear axles each having four wheels.

On the Basis of Fuel Used

(a) Petrol vehicle, e.g. motorcycle, scooter, cars, etc.

(b) Diesel vehicle, e.g. trucks, buses, etc.

(c) Electric vehicle, e.g. battery drive

(d) Steam vehicle, e.g. an engine which uses steam.

(e) Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied petroleum gas and CNG is compressed natural gas.

On the Basis of Body On the basis of body, the vehicles are classified as :

(a) Sedan with two doors

(b) Sedan with four doors

(c) Station wagon

(d) Convertible, e.g. jeep, etc.

(e) Van (f) Special purpose vehicle, e.g. ambulance, milk van, etc.

Transmission

(a) Conventional vehicles with manual transmission, e.g. car with 5 gears.

(b) Semi-automatic

(c) Automatic: In automatic transmission, gears are not required to be changed manually. It is automatically changes as per speed of the automobile.

Position of Engine in Front : Most of the vehicles have engine in the front. Example: most of the cars, buses, trucks in India.

Engine in the Rear Side: Very few vehicles have engine located in the rear. Example: Nano car.

COMPONENTS OF THE AUTOMOBILE

The automobile can be considered to consist of five basic components:

(a) The Engine or Power Plant : It is source of power.

(b) The Frame and Chassis: It supports the engine, wheels, body, braking system, steering, etc.

(c) The transmission which transmits power from the engine to the car wheels. It consists of clutch, transmission, shaft, axles and differential.

(d) The body fitted on chassis.

(e) Accessories including light, air conditioner/hearer, stereo, wiper, etc.

FUNCTIONS OF MAJOR COMPONENTS OF AN AUTOMOBILE Chassis and Frame:

The chassis is formed by the frame with the frame side members and cross members. The frame is usually made of box, tubular and channel members that are welded or riveted together. In addition to this, it comprises of the springs with the axles and wheels, the steering system and the brakes, the fuel tank, the exhaust system, the radiator, the battery and other accessories. Along with this the frame supports the body. Engine or Power Plant : The engine is the power plant of the vehicle. In general, internal combustion engine with petrol or diesel fuel is used to run a vehicle.

An engine may be either a two-stroke engine or a four-stroke engine. An engine consists of a cylinder, piston, valves, valve operating mechanism, carburetor (or MPFI in modern cars), fan, fuel feed pump and oil pump, etc. Besides this, an engine requires ignition system for burning fuel in the engine cylinder.

Transmission System (Clutch and Gear Box): The power developed by the engine is transferred to the wheels by transmission system. Transmission system must do three jobs : (a) It must provide varying gear ratios. Number of gear ratio are equal to number of gears in a vehicle. (b) It must provide a reverse gear for moving vehicle in reverse direction. (c) It must provide a neutral or disconnecting arrangement so that the engine can be uncoupled from the wheels of the vehicle. In a conventional transmission system, there is a clutch, a manually operated transmission (gear box), a propeller shaft and a differential or final drive.

Clutch : The purpose of the clutch is to allow the driver to couple or decouple the engine and transmission. When clutch is in engaged position, the engine power flows to the transmission through it (clutch). When gears are to be changed while vehicle is running, the clutch permits temporary decoupling of engine and wheels so that gears can be shifted. In a scooter, the clutch is operated by hand where as in a car the clutch is operated by foot. It is necessary to interrupt the flow of power before gears are changed. Without a clutch, it will by very difficult. Final Drive Final drive is the last stage in transferring power from engine to wheels. It reduces the speed of the propeller shaft (drive shaft) to that of wheels. It also turns the drive of the propeller shaft by an angle of 90 degree to drive the wheels.

The propeller shaft has a small bevel pinion which meshes with crown wheel. The crown wheel gives rotary motion to rear axles. The size of crown wheel in bigger than that of bevel pinion, therefore, the speed of rear

axles (or crown wheel) in lower than the speed of pinion. Final drive is of two types, i.e. chain type and gear type. Braking System Brakes are used to slow down or stop the vehicle

Hydraulic brakes are generally used in automobiles, where brakes are applied by pressure on a fluid. Mechanical brakes are also used in some vehicles. These brakes are operated by means of leavers, linkages, pedals, cams, etc. Hand brake or parking brake is known usually mechanical brake. These are used for parking the vehicles on sloppy surfaces and also in case of emergency.

Gear Box : Gear box contain gearing arrangement to get different speeds. Gears are used to get more than one speed ratios. When both mating gears have same number of teeth, both will rotate at same number speed. But when one gear has less teeth than other, the gear with less number of teeth will rotate faster than larger gear. In a typical car, there may be six gears including one reverse gear. First gear gives low speed but high torque. Higher gears give progressively increasing speeds. Gears are engaged and disengaged by a shift lever.

Steering System : In front wheels can be turned to left and right by steering system so that the vehicle can be steered. The steering wheel is placed in front of driver. It is mechanically linked to the wheels to provide the steering control. The primary function of the steering system is to provide angular motion to front wheels so that vehicle can negotiate a turn. It also provides directional stability to vehicle when the vehicle moves ahead in straight line. Now-a-days, many vehicles are equipped with power steering which uses pressure of a fluid to reduce steering effort. When driver turns the steering wheel, a hydraulic mechanism comes into play to provide most of the effort needed to turn the wheel. Front Axle A part of the weight of vehicle is transmitted to the wheels through this axle. The front axle performs several functions. It carries the weight of the front of the vehicle and also takes horizontal and vertical loads when vehicle moves on bumpy roads. When brakes are provided on front wheels, it endures bending stresses and tensional stresses. It is generally made from steel drop forging. It is robust in construction. Suspension System Suspension system of an automobile separates the wheel and axle assembly of the automobile from its body. Main function of the suspension system is to isolate the body of the vehicle from shocks and vibrations generated due to irregularities on the surface of roads. Shock absorbers are provided in the vehicles for this purpose. It is in the form of spring and damper. The suspension system is provided both on front end and rear end of the vehicle motion.

A suspension system also maintains the stability of the vehicle in pitching or rolling when vehicle is in

APPLICATION OF IC ENGINE

Road vehicles * Aircraft * Locomotive * Construction Equipment Pumping set * several Industries

Small Two Stroke Petrol Engine : Used when operation is simple and requirement of low cost of prime mover (scooters, pumping sets etc.) Small Four Stroke Petrol Engine : Used in automobiles, generators, pumping set. Two Stroke Diesel Engine : High power, generally used in ship propulsion. Four Stroke Diesel Engine : Mostly used engine, have diameter 50 to 600 mm, speed ranges from 100 to 4400 rpm, power developed is 1 to 1000 kW. Used in pumping sets, construction machinery, drilling rigs, tractors, diesel electric locomotive, mobile & stationary electric generation plants.

Engineering design

Why is the engineering design process important?

The engineering design process is a series of steps that engineers follow when they are trying to solve a problem and design a solution for something; it is a methodical approach to problem solving. This is similar to the “Scientific Method” which is taught to young scientists.

Job Duties

It is important that product design engineers be familiar with, and adhere to, their company's product standards and specifications, so that they may design quality products that represent the company brand. They must also keep trends and the needs of consumers in mind when designing products. Product design engineers may also be responsible for making improvements or updates to existing design and development standards. Professionals may also need to understand how their decisions affect product cost, performance, and quality.

“Scientists discover the world that exists; engineers create the world that never was.”

Theodore von Karman, co-founder of NASA’s Jet Propulsion Laboratory

INDUSTRIAL ENGINEERING

Industrial engineering is a branch of engineering which deals with the optimization of complex processes, systems, or organizations. Industrial engineers work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value.

Industrial designers develop concepts and designs for manufactured products. They typically specialize in one product category, such as automobiles, furniture or housewares. They must be imaginative and persistent to communicate their ideas about new product design.

Industrial engineering is a branch of engineering which deals with the optimization of complex processes, systems, or organizations. Industrial engineers work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value.

CAD/CAM/CIM:

computer manufacturing aided design. CAD is particularly valuable in space programs, where many unknown design variables are involved. ... CIM is a programmable manufacturing method designed to link CAD, CAM, industrial robotics, and machine manufacturing using unattended processing workstations.

CAM is now a system used in schools and lower educational purposes. CAM is a subsequent computer-aided process after computer-aided design (CAD) and sometimes computer-aided engineering (CAE), as the model generated in CAD and verified in CAE can be input into CAM software, which then controls the machine tool.

CAD/CAM applications are used to both design a product and program manufacturing processes, specifically, CNC machining. CAM software uses the models and assemblies created in CAD software to generate toolpaths that drive machine tools to turn designs into physical parts.

Computer integrated manufacturing (CIM), a term popularized by Joseph Harrington in 1975, is also known as autofacturing. CIM is a programmable manufacturing method designed to link CAD, CAM, industrial robotics, and machine manufacturing using unattended processing workstations. CIM offers uninterrupted operation from raw materials to finished product, with the added benefits of quality assurance and automated assembly.

What is Mechanical Engineering?

Mechanical engineering is the subdivision of engineering that deals with the proposal, manufacturing, maintenance, and testing of machines. It is also deliberated as one of the most miscellaneous and multipurpose disciplines of engineering. Mechanical engineering also comprises the presentation of mechanics, material science, applied mathematics, and physics.

With the upsurge of modern technology, mechanical engineering has gained a newfound prominence with more and more students opting to learn less explored domains of robotics, mechatronics, Industry 4.0, smart manufacturing, digital manufacturing, nanotechnology, smart materials, etc.

New trends and future scope

The opportunities in mechanical engineering are no longer limited to just the manufacturing and testing of massive machinery and equipment. With technology making new-fangled advancements, there are numerous new domains in mechanical engineering which are being taken up by fanatical engineers. These domains comprise robotics, smart materials, nanotechnology, computer-aided design, smart machines, Industry 4.0 geomechanics, etc. The most decidedly pursued domains are robotics, digital manufacturing, smart manufacturing, Automobile Engineering, and mechatronics.

Applications of Mechatronics and Robotics in manufacturing

Mechatronics is an approaching field of engineering which embraces applications of mechanical, electronics, control, and computer engineering to develop products, processes, and systems with superior flexibility, ease in a redesign, and ability of reprogramming. Mechatronics applications are there in every invention of daily usage such as automobiles, autofocusing digital cameras, Automatic washing machines, industrial robotics, hard disks, electro-pneumatic valves, etc.

An industrial robot is a robot system used for industrialization. Typical solicitations of robots include welding, painting, assembly line, picking and placing for printed circuit boards, packaging and labeling, palletizing, product inspection, and testing; all proficient with high fortitude, speed, and precision. The robot is everywhere in manufacturing but there is an enormous scope of manufacturing robots in India and multi-skilled mechanical Engineers are always in demand for this purpose.

Job prospects in industries for mechanical engineers

When we talk about the diverse job roles for mechanical engineers, their similarities can be broadly categorized into the subsequent few segments –

1.Design – In this role, the mechanical engineers would be accountable for drafting technical sketches either with tools or computers. Any mechanical engineer virtuous with sketches or computer-aided drawing is idyllic for such a position.

2.Production – The production job role generally encompasses consultation and regulation in manufacturing machines and their mechanisms. If you are an individual who wants to experience manufacturing procedures and production processes, this would be the accurate job role for you.

3.Analysis and Testing – In this job role, you would be answerable for the scrutiny and testing of machine parts, systems, and paraphernalia. Your errands would embrace checking for culpabilities that could have come up in the manufacturing or design procedures.

4.Installation & Maintenance – The job role comprises acquaintance with the installation of machine parts in the industrialized location, along with their proper upkeep as per the provided stipulations. The installation and maintenance are only suggested for those who are robust in practical acquaintance instead of academic knowledge.

5.Automation– To embed accuracy, speed, repeatability, and flexibility of machines, automation is the utmost need of the industrial world. It unfolds vast scope for the mechanical engineers, who better understand the working of machines.

6.Industry 4.0, Smart manufacturing and digital Manufacturing- this is a very new domain, where machines are being provided with eyes, ears, and decision-making capability. Machines can interact with each other to provide better quality, service, accuracy, and flexibility. Skilled Mechanical Engineers are the need of the hour to implement such systems.

7.Research – Research is one of the most exhilarating job roles in mechanical engineering. Your job tasks would embrace researching and executing findings for the development of new products using cutting-edge technologies.