MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

Estd. 2000

IQAC

LECTURE HANDOUTS

L-01

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Types of Automobiles

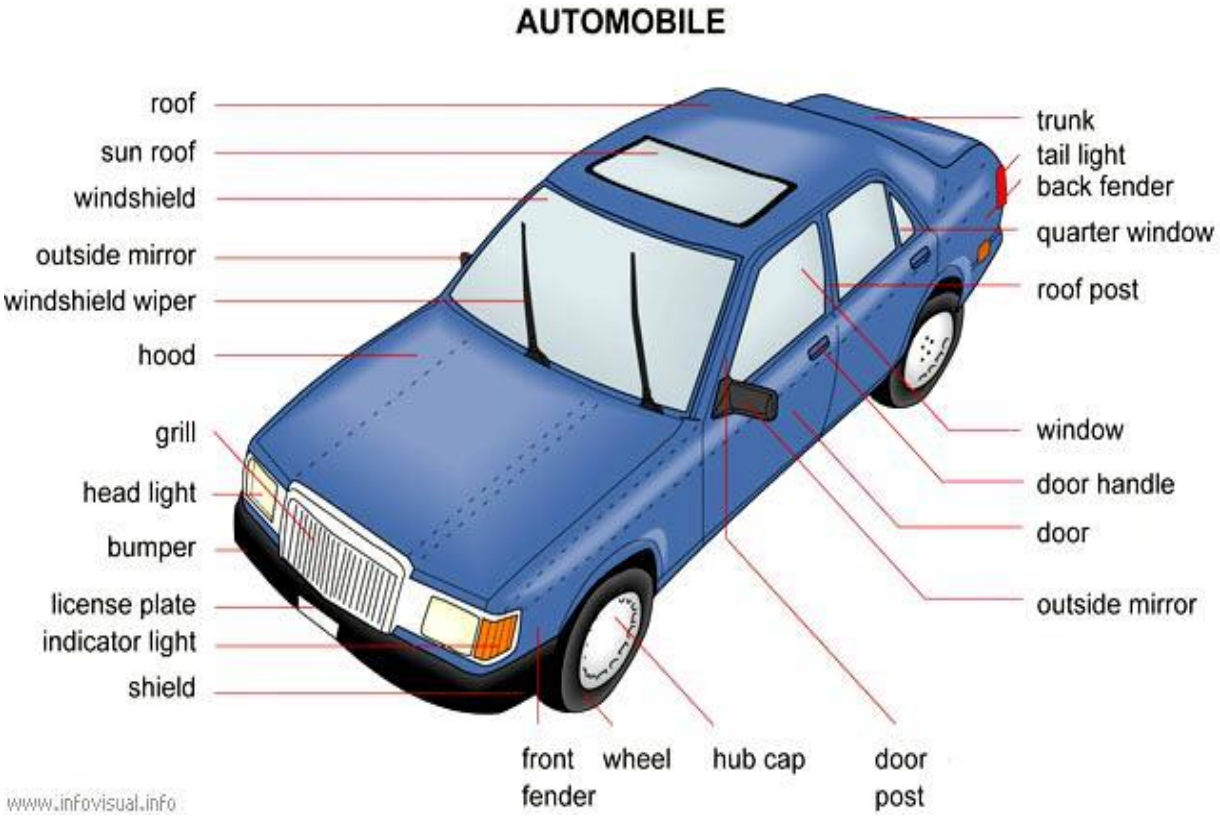
Introduction : (Maximum 5 sentences)

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks

Prerequisite knowledge for Complete understanding and learning of Topic:

Automobile basics

Detailed content of the Lecture:



Introduction of Automobile or Vehicle:

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks, etc.,,

The automobiles are classified by the following ways, milk

1. **On the Basis of Load:**
   - Heavy transport vehicle (HTV) or heavy motor vehicle (HMV),
   - Light transport vehicle (LTV), Light motor vehicle (LMV),
2. **On the Basis of Wheels :**
   - Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.
   - Three wheeler vehicle, for example : Autorickshaw,
   - Three wheeler scooter for handicaps and tempo, etc.
   - Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.
   - Six wheeler vehicle, for example : Big trucks with two gear axles.
3. **On the basis of Fuel Used:**
   - Petrol vehicle, e.g. motorcycle, scooter, cars, etc.
   - Diesel vehicle, e.g. trucks, buses, etc.
   - Electric vehicle which use battery to drive.
   - Steam vehicle, e.g. an engine which uses steam engine.
   - Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied
4. **On the basis of body style:**
   - Sedan Hatchback car.
   - Coupe car Station wagon Convertible.
   - Van Special purpose vehicle, e.g. ambulance, milk van, etc.

.5 On the basis of Transmission:

   - Conventional vehicles with manual transmission, e.g. car with 5 gears.
   - Semi-automatic
   - Automatic : In automatic transmission, gears are not required to be changed manually.

6. **On the basis of Drive:**
   - Left hand drive
   - Right hand drive
7. **On the basis of Driving Axle**

   Front wheel drive
   - Rear wheel drive
   - All wheel drive
8. **Position of Engine:**
   - Engine in Front - Most of the vehicles have engine in the front. Example : most of the cars,
   - Engine in the Rear Side Very few vehicles have engine located in the rear. Example : Nano car.

Video Content / Details of website for further learning (if any):

https://www.howstuffworks.com/typesofautomobiles

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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IQAC

LECTURE HANDOUTS

L-02

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Vehicle Construction

Introduction : (Maximum 5 sentences)

If the frame contains the base components its called as chassis. The components are like Engine, radiator, clutch, gearbox, silencer, road wheels, fuel tank, wirings, differential units, etc..,

Prerequisite knowledge for Complete understanding and learning of Topic:

- Horizontal Membrane
- Vertical Membrane
- Side Membrane

Detailed content of the Lecture:

Chassis Construction:

The chassis of an automobile consists of following components suitably mounted:
Engines and the radiator, Transmission system consisting of the clutch, gear box, propeller shaft and the rear axle, suspension system, road wheels, steering system, brakes and fuel tank.

Classification of Chassis:

Conventional control chassis: The engine is mounted in front of the driver's cabin.

Semi-forward control chassis: The engine is so mounted that half of it is in the drivers cabin, whereas the other half is in front, outside the drivers cabin.

Full forward control Chassis: The engine is mounted completely inside the driver's cabin.

Frame:

It is the basic unit to which various components are attached and body is bolted onto the frame later on. The frame is designed to support the weight of the body and absorb all of the loads imposed by the terrain, suspension system, engine, drive train, and steering system.

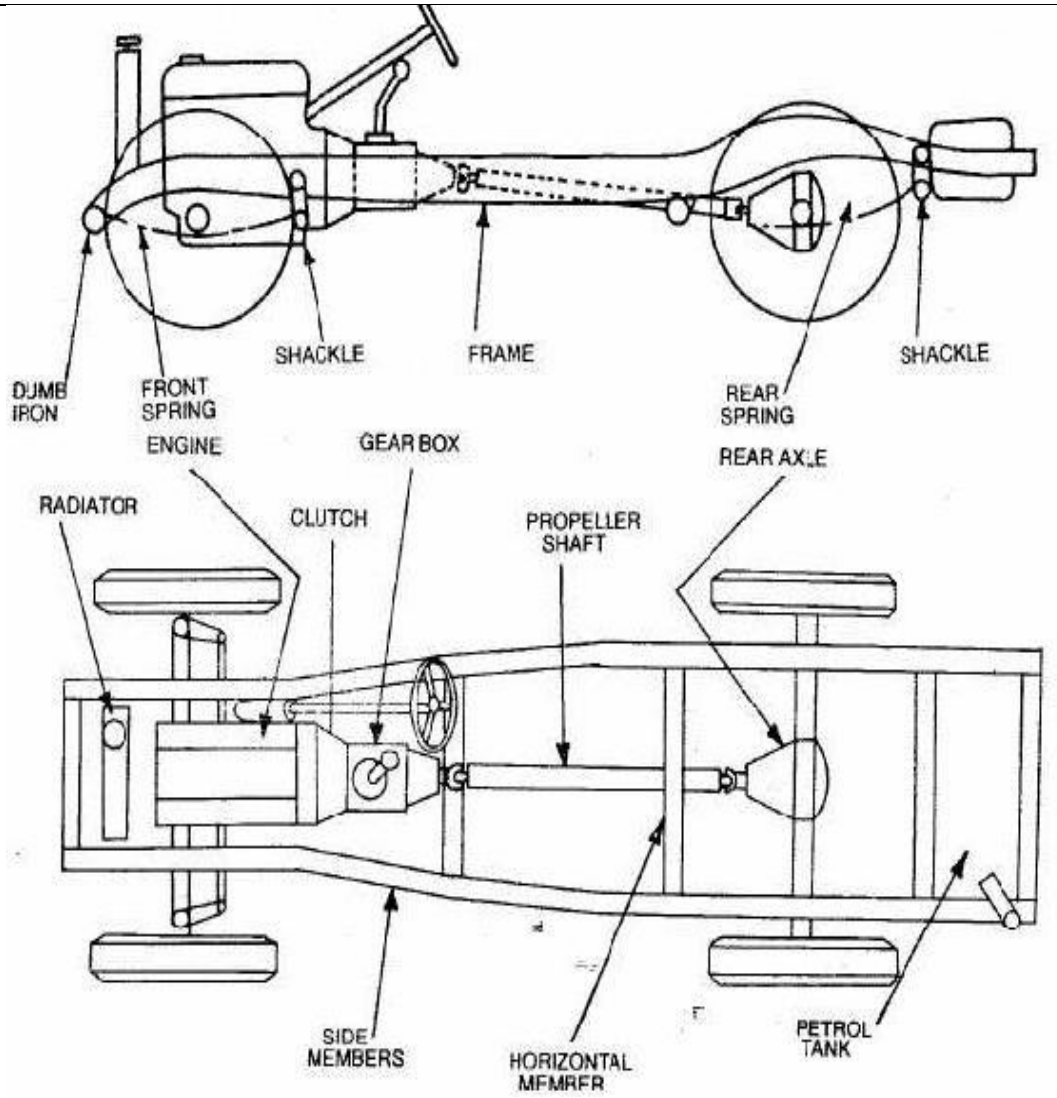
Functions of Frame:

To Support the chassis components and the body.
To withstand static and dynamic loads without undue deflection or distortion.

An automobile is made up of mainly two units, these are Chassis and Body.

"Frame" + "Base components" = "Chassis"

"Chassis" + "Body" = "Vehicle"



Frame :

The frame is the skeleton of the vehicle. It servers as a main foundation and base for alignment for the chassis.

Types;

- Conventional frame,
- Semi integral frame;
- Integral or untidiest frame.

Chassis;

If the frame contains the base components its called as chassis. The components are like Engine, radiator, clutch, gearbox, silencer, road wheels, fuel tank, wirings, differential units, etc..,

Video Content / Details of website for further learning (if any):

https://www.dsm.com/engineering-materials/en_US/industry/automotive/chassis.html

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L-03

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Different Layouts

Introduction : (Maximum 5 sentences)

If the frame contains the base components its called as chassis. The components are like Engine, radiator, clutch, gearbox, silencer, road wheels, fuel tank, wirings, differential units, etc..,

Prerequisite knowledge for Complete understanding and learning of Topic:

- Horizontal Membrane
- Vertical Membrane
- Side Membrane

Detailed content of the Lecture:

Chassis Construction:

The chassis of an automobile consists of following components suitably mounted:
Engines and the radiator, Transmission system consisting of the clutch, gear box, propeller shaft and the rear axle, suspension system, road wheels, steering system, brakes and fuel tank.

Classification of Chassis:

Conventional control chassis: The engine is mounted in front of the driver's cabin.

Semi-forward control chassis: The engine is so mounted that half of it is in the drivers cabin, whereas the other half is in front, outside the drivers cabin.

Full forward control Chassis: The engine is mounted completely inside the driver's cabin.

Frame:

It is the basic unit to which various components are attached and body is bolted onto the frame later on. The frame is designed to support the weight of the body and absorb all of the loads imposed by the terrain, suspension system, engine, drive train, and steering system.

Functions of Frame:

To Support the chassis components and the body.
To withstand static and dynamic loads without undue deflection or distortion.

An automobile is made up of mainly two units, these are Chassis and Body.

"Frame" + "Base components" = "Chassis"

"Chassis" + "Body" = "Vehicle"

Frame :

The frame is the skeleton of the vehicle. It servers as a main foundation and base for alignment for the chassis.

Types;

- Conventional frame,

- Semi integral frame;
- Integral or untidiest frame.

Chassis;

If the frame contains the base components its called as chassis. The components are like Engine, radiator, clutch, gearbox, silencer, road wheels, fuel tank, wirings, differential units, etc..,

Video Content / Details of website for further learning (if any):

https://www.dsm.com/engineering-materials/en_US/industry/automotive/chassis.html

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L-04

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Chassis and its classification

Introduction : (Maximum 5 sentences)

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks

Prerequisite knowledge for Complete understanding and learning of Topic:

Automobile basics

Detailed content of the Lecture:

Introduction of Automobile or Vehicle:

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks, etc.,,

The automobiles are classified by the following ways, milk

1. **On the Basis of Load:**
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   - Light transport vehicle (LTV), Light motor vehicle (LMV),
2. **On the Basis of Wheels :**
   - Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.
   - Three wheeler vehicle, for example : Autorickshaw,
   - Three wheeler scooter for handicaps and tempo, etc.
   - Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.
   - Six wheeler vehicle, for example : Big trucks with two gear axles.
3. **On the basis of Fuel Used:**
   - Petrol vehicle, e.g. motorcycle, scooter, cars, etc.
   - Diesel vehicle, e.g. trucks, buses, etc.
   - Electric vehicle which use battery to drive.
   - Steam vehicle, e.g. an engine which uses steam engine.
   - Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied
4. **On the basis of body style:**
   - Sedan Hatchback car.
   - Coupe car Station wagon Convertible.

- Conventional vehicles with manual transmission, e.g. car with 5 gears.
- Semi-automatic
- Automatic : In automatic transmission, gears are not required to be changed manually.

6. **On the basis of Drive:**
   - Left hand drive
   - Right hand drive
7. **On the basis of Driving Axle**

   Front wheel drive
   - Rear wheel drive
   - All wheel drive
8. **Position of Engine:**
   - Engine in Front - Most of the vehicles have engine in the front. Example : most of the cars,
   - Engine in the Rear Side Very few vehicles have engine located in the rear. Example : Nano car.

Video Content / Details of website for further learning (if any):

https://www.howstuffworks.com/typesofautomobiles

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LECTURE HANDOUTS

L-05

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Frame and body Construction

Introduction : (Maximum 5 sentences)

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks

Prerequisite knowledge for Complete understanding and learning of Topic:

Automobile basics

Detailed content of the Lecture:

Introduction of Automobile or Vehicle:

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks, etc.,,

The automobiles are classified by the following ways, milk

- Heavy transport vehicle (HTV) or heavy motor vehicle (HMV),
- Light transport vehicle (LTV), Light motor vehicle (LMV),
- Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.
- Three wheeler vehicle, for example : Autorickshaw,
- Three wheeler scooter for handicaps and tempo, etc.
- Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.
- Six wheeler vehicle, for example : Big trucks with two gear axles.
- Petrol vehicle, e.g. motorcycle, scooter, cars, etc.
- Diesel vehicle, e.g. trucks, buses, etc.
- Electric vehicle which use battery to drive.
- Steam vehicle, e.g. an engine which uses steam engine.
- Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied
- Sedan Hatchback car.
- Coupe car Station wagon Convertible.
- Van Special purpose vehicle, e.g. ambulance, milk van, etc.
- Conventional vehicles with manual transmission, e.g. car with 5 gears.
- Semi-automatic

- Left hand drive
- Right hand drive

Front wheel drive

- Rear wheel drive
- All wheel drive
- Engine in Front - Most of the vehicles have engine in the front. Example : most of the cars,
- Engine in the Rear Side Very few vehicles have engine located in the rear. Example : Nano car.

Video Content / Details of website for further learning (if any):

https://www.howstuffworks.com

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L-06

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Vehicle Aerodynamics

Introduction : (Maximum 5 sentences)

Aerodynamics, from Greek ἀήρ aer (air) + δυναμική (dynamics), is a branch of dynamics concerned with studying the motion of air, particularly when it interacts with a solid object, such as an airplane wing.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)
Dynamics, air flow

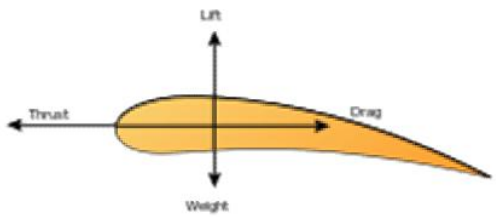
Detailed content of the Lecture:

Aerodynamics

Aerodynamics, from Greek ἀήρ aer (air) + δυναμική (dynamics), is a branch of dynamics concerned with studying the motion of air, particularly when it interacts with a solid object, such as an airplane wing.

Aerodynamics is a sub-field of fluid dynamics and gas dynamics, and many aspects of aerodynamics theory are common to these fields. The term aerodynamics is often used synonymously with gas dynamics, with the difference being that "gas dynamics" applies to the study of the motion of all gases, not limited to air.

Modern aerodynamics only dates back to the seventeenth century, but aerodynamic forces have been harnessed by humans for thousands of years in sailboats and windmills, and images and stories of flight appear throughout recorded history, such as the Ancient Greek legend of Icarus and Daedalus. Fundamental concepts of continuum, drag, and pressure gradients, appear in the work of Aristotle and Archimedes.



Forces of flight on an airfoil

Fundamental Concept

Understanding the motion of air around an object (often called a flow field) enables the calculation of forces and moments acting on the object. In many

over a solid body.

Calculation of these quantities is often founded upon the assumption that the flow field behaves as a continuum. Continuum flow fields are characterized by properties such as velocity, pressure, density and temperature, which may be functions of spatial position and time.

These properties may be directly or indirectly measured in aerodynamics experiments, or calculated from equations for the conservation of mass, momentum, and energy in air flows. Density, velocity, and an additional property, viscosity, are used to classify flow fields.

Video Content / Details of website for further learning (if any):

https://www.dynamics.com/automobiles

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L-07

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: IC Engine Components

Introduction : (Maximum 5 sentences)

An engine is a device that converts thermal energy into mechanical work. The thermal energy is produced by the combustion of air fuel mixture inside the cylinder by means of a spark produced by the spark plug. Since it uses thermal energy it is called as thermal engines. It is a source of power for many applications.

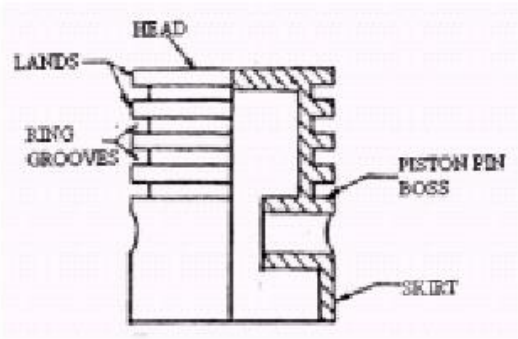
Prerequisite knowledge for Complete understanding and learning of Topic:

Cylinder, head, piston, crank shaft

Detailed content of the Lecture:

COMPONENTS OF AN I.C ENGINES

An engine is a device that converts thermal energy into mechanical work. The thermal energy is produced by the combustion of air fuel mixture inside the cylinder by means of a spark produced by the spark plug. Since it uses thermal energy it is called as thermal engines. It is a source of power for many applications.

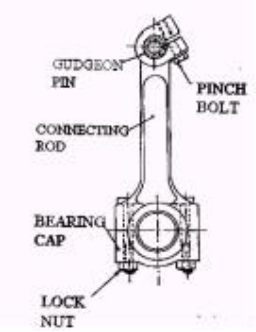


Cylinder: · v It is the part of the engine in which the conversion of thermal energy to · v mechanical work takes place. The piston reciprocates inside the cylinder. · v Since energy conversion takes place inside the cylinder it must withstand high pressure and temperature. · v It must be able to resist wear and tear and must dissipate heat. So material selection is an import ant consideration. Ordinary cast iron is used in light duty engines but in heavy duty engines alloy steels are used. · v The cylinders are provided with liners so that they can be replaced when worn out. Liners are made of nickel chrome iron.

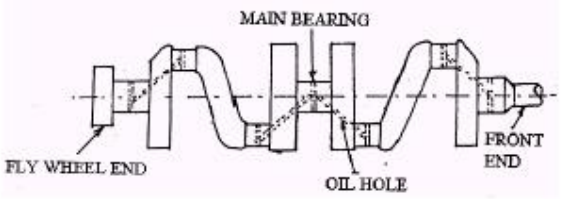
Cylinder head: · v The cylinder head closes one side of the cylinder. They are usually cast as a single piece and are bolted to the top of the cylinder. ·

Piston and piston rings: · v Piston is the main part of the engine. The main function of the piston is to compress the charge and to transmit the gas force to the connecting rod during the power stroke. · v Piston

v The upper rings are the compression rings. · v They help in sealing and preventing the gas from leaking past the piston into the casing. · v The lower rings are the oil scraper rings. · v They are provided to remove the oil film from the cylinder walls

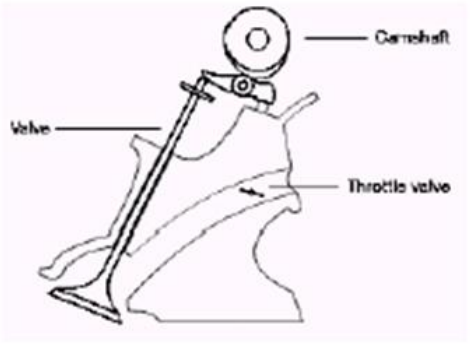


Connecting rod: · v The connecting rod connects the piston and the crankshaft. · v The piston is connected to the connecting rod by means of gudgeon pin. · v It converts the reciprocating motion into rotary motion.



Crankshaft: · v It is steel forged and smooth finished. Both the ends of the crankshaft are supported in the bearings.

Cam and camshaft: · v The main function of the camshaft is to open and close the valves at the appropriate time. The cam is operated by means of gear arrangement driven by the flywheel. ·



Valves: · v Valves play a major role in allowing the air fuel mixture into the cylinder (inlet valve) for combustion and also releasing the exhaust gases from the cylinder after combustion (outlet valve). Manifolds: ·

Video Content / Details of website for further learning (if any):

http://www.idc-online.com/technical_references/pdfs/mechanical_engineering/Components_Of_an_IC_Engines.pdf

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L-08

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: IC Engine Functions and Materials

Introduction : (Maximum 5 sentences)

An engine is a device that converts thermal energy into mechanical work. The thermal energy is produced by the combustion of air fuel mixture inside the cylinder by means of a spark produced by the spark plug. Since it uses thermal energy it is called as thermal engines. It is a source of power for many applications.

Prerequisite knowledge for Complete understanding and learning of Topic:

Cylinder, head, piston, crank shaft

Detailed content of the Lecture:

COMPONENTS OF AN I.C ENGINES

An engine is a device that converts thermal energy into mechanical work. The thermal energy is produced by the combustion of air fuel mixture inside the cylinder by means of a spark produced by the spark plug. Since it uses thermal energy it is called as thermal engines. It is a source of power for many applications.

Cylinder: · v It is the part of the engine in which the conversion of thermal energy to · v mechanical work takes place. The piston reciprocates inside the cylinder. · v Since energy conversion takes place inside the cylinder it must withstand high pressure and temperature. · v It must be able to resist wear and tear and must dissipate heat. So material selection is an import ant consideration. Ordinary cast iron is used in light duty engines but in heavy duty engines alloy steels are used. · v The cylinders are provided with liners so that they can be replaced when worn out. Liners are made of nickel chrome iron.

Cylinder head: · v The cylinder head closes one side of the cylinder. They are usually cast as a single piece and are bolted to the top of the cylinder. ·

Piston and piston rings: · v Piston is the main part of the engine. The main function of the piston is to compress the charge and to transmit the gas force to the connecting rod during the power stroke. · v Piston rings are circumferential rings that are provided in the piston grooves. ·

There are two types of piston rings ·

v The upper rings are the compression rings. · v They help in sealing and preventing the gas from leaking past the piston into the casing. · v The lower rings are the oil scraper rings. · v They are provided to remove the oil film from the cylinder walls

Connecting rod: · v The connecting rod connects the piston and the crankshaft. · v The piston is connected to the connecting rod by means of gudgeon pin. · v It converts the reciprocating motion into rotary motion.

Cam and camshaft: · v The main function of the camshaft is to open and close the valves at the appropriate time. The cam is operated by means of gear arrangement driven by the flywheel. ·

Valves: · v Valves play a major role in allowing the air fuel mixture into the cylinder (inlet valve) for combustion and also releasing the exhaust gases from the cylinder after combustion (outlet valve). Manifolds: ·

Video Content / Details of website for further learning (if any):

http://www.idc-online.com/technical_references/pdfs/mechanical_engineering/Components_Of_an_IC_Engines.pdf

Important Books/Journals for further learning including the page nos.:

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LECTURE HANDOUTS

L-09

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **I**

Topic of Lecture: Variable Valve Timing (VVT)

Introduction : (Maximum 5 sentences)

An engine is a device that converts thermal energy into mechanical work. The thermal energy is produced by the combustion of air fuel mixture inside the cylinder by means of a spark produced by the spark plug. Since it uses thermal energy it is called as thermal engines. It is a source of power for many applications.

Prerequisite knowledge for Complete understanding and learning of Topic

valve

Detailed content of the Lecture:

·

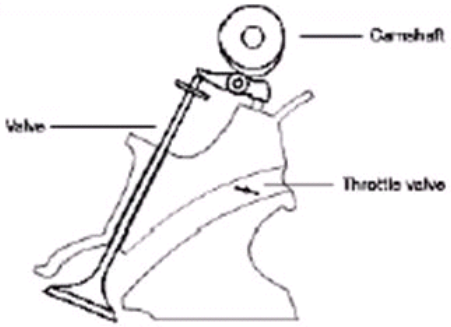
There are two types of piston rings ·

v The upper rings are the compression rings. · v They help in sealing and preventing the gas from leaking past the piston into the casing. · v The lower rings are the oil scraper rings. · v They are provided to remove the oil film from the cylinder walls

Connecting rod: · v The connecting rod connects the piston and the crankshaft. · v The piston is connected to the connecting rod by means of gudgeon pin. · v It converts the reciprocating motion into rotary motion.

Crankshaft: · v It is steel forged and smooth finished. Both the ends of the crankshaft are supported in the bearings.

Cam and camshaft: · v The main function of the camshaft is to open and close the valves at the appropriate time. The cam is operated by means of gear arrangement driven by the flywheel. ·



Valves: · v Valves play a major role in allowing the air fuel mixture into the cylinder (inlet valve) for combustion and also releasing the exhaust gases from the cylinder after combustion (outlet valve).

Video Content / Details of website for further learning (if any):

http://www.idc-online.com/technical_references/pdfs/mechanical_engineering/Components_Of_an_IC_Engines.pdf

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L - 10

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Electronically controlled gasoline injection system for SI engines

Introduction : (Maximum 5 sentences)

Spark-ignition engines normally use volatile liquid fuels. Preparation of fuel-air mixture is done outside the engine cylinder and formation of a homogeneous mixture is normally not completed in the inlet manifo

Prerequisite knowledge for Complete understanding and learning of Topic:

Throttle, Idle, Chamber

Detailed content of the Lecture:

The process of formation of a combustible fuel-air mixture by mixing the proper amount of fuel with air before admission to engine cylinder is called carburetion and the device which does this job is called a carburetor.

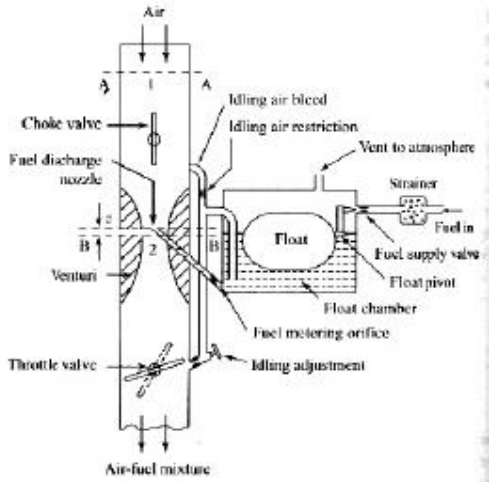
The carburetor is a device used for atomizing and vaporizing the fuel and mixing it with the air in varying proportions to suit the changing operating conditions of vehicle engines Both air and gasoline are drawn through the carburetor and into the engine cylinders by the suction created by the downward movement of the piston. This suction is due to an increase in the volume of the cylinder and a consequent decrease in the gas pressure in this chamber.

It is the difference in pressure between the atmosphere and cylinder that causes the air to flow into the chamber. In the carburetor, air passing into the combustion chamber picks up discharged from a tube. This tube has a fine orifice called carburetor jet that is exposed to the air path.

The rate at which fuel is discharged into the air depends on the pressure difference or pressure head between the float chamber and the throat of the venturi and on the area of the outlet of the tube. In order that the fuel drawn from the nozzle may be thoroughly atomized, the suction effect must be strong and the nozzle outlet comparatively small. In order to produce a strong suction, the pipe in the carburetor carrying air to the engine is made to have a restriction. At this restriction called throat due to increase in velocity of flow, a suction effect is created. The restriction is made in the form of a venturi to minimize throttling losses.

The end of the fuel jet is located at the venturi or throat of the carburetor. The geometry of venturi tube is as shown in Fig.16.6. It has a narrower path at the center so that the flow area through which the air must pass is considerably reduced. As the same amount of air must pass through every point in the tube, its velocity will be greatest at the narrowest point. The smaller the area, the greater will be the velocity of the air, and thereby the suction is proportionately increased As mentioned earlier, the opening of the fuel discharge jet is usually loped where the suction is maximum. Normally, this is just below the narrowest section of the venturi tube. The spray of gasoline from the nozzle and the air

simultaneously a small part will be vaporized. Increased air velocity at the throat of the venturi helps he rate of evaporation of fuel. The difficulty of obtaining a mixture of sufficiently high fuel vapour-air ratio for efficient starting of the engine and for uniform fuel-air ratio indifferent cylinders (in case of multi cylinder engine) cannot be fully met by the increased air velocity alone at the venturi throat.



Carburetors are highly complex. Let us first understand the working principle bf a simple or elementary carburetor that provides an air fuel mixture for cruising or normal range at a single speed. Later, other mechanisms to provide for the various special requirements like starting, idling, variable load and speed operation and acceleration will be included. Figure 3. shows the details of a simple carburetor.

The simple carburetor mainly consists of a float chamber, fuel discharge nozzle and a metering orifice, a venturi, a throttle valve and a choke. The float and a needle valve system maintain a constant level of gasoline in the float chamber. If the amount of fuel in the float chamber falls below the designed level, the float goes down, thereby opening the fuel supply valve and admitting fuel. When the designed level has been reached, the float closes the fuel supply valve thus stopping additional fuel flow from the supply system. Float chamber is vented either to the atmosphere or to the" upstream side of the venturi.During suction stroke air is drawn through the venturi. As already described, venturi is a tube of decreasing cross-section with a minimum area at the throat, Venturi tube is also known as the choke tube and is so shaped that it offers minimum resistance to the air flow. As the air passes through the venturi the velocity increases reaching a maximum at the venturi throat. Correspondingly, the pressure decreases reaching a minimum. From the float chamber, the fuel is fed to a discharge jet, the tip of which is located in the throat of the venturi. Because of the differential pressure between the float chamber and the throat of the venturi, known as carburetor depression, fuel is discharged into the air stream.

Video Content / Details of website for further learning (if any):

http://www.obrum.gliwice.pl/upload/downloads/15.-electronic-control-systems-of-internal-combustion-engines-with-respect-to-the-implementation-of-special-functions-in-military-vehicle-piotr-stryjek-tomasz-nikisz-krzysztof-sykulski-michal-sowa-1465551105.pdf

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L - 11

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Electronically controlled diesel injection system

Introduction : (Maximum 5 sentences)

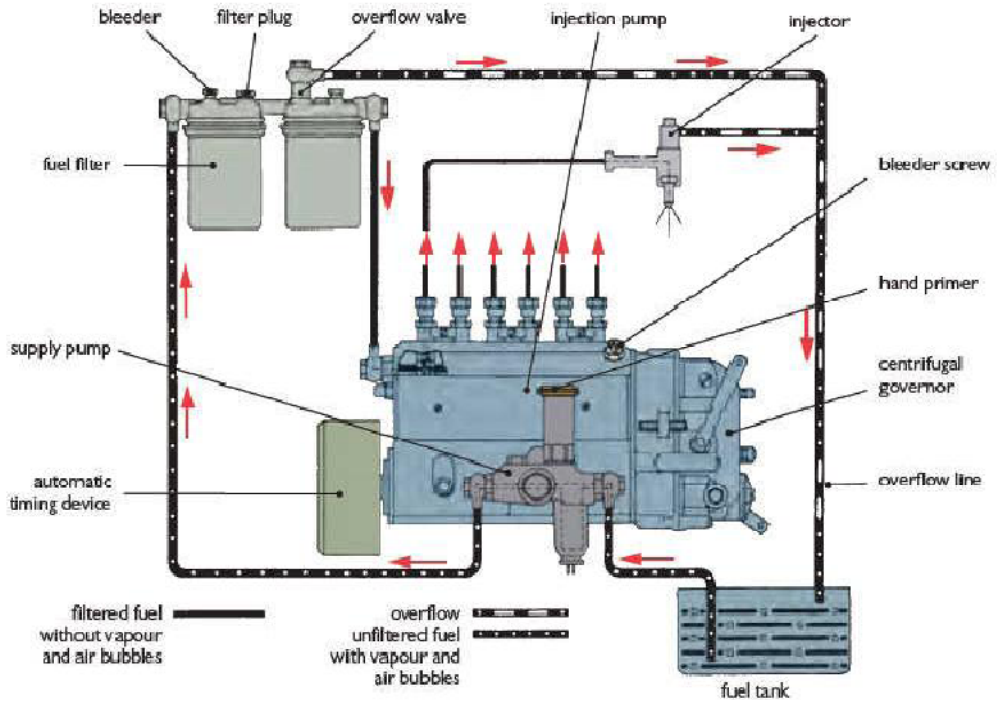
Injection system In the C.I. engine the fuel is injected into the combustion chamber, it the has to mix thoroughly with the air, ignite and burn all at the same time. To insure this happens, two types of combustion chamber have been developed. Direct Injection Indirect Injection.

Prerequisite knowledge for Complete understanding and learning of Topic:

Governor, pump, filter

Detailed content of the Lecture:

Electronic Diesel Control is a diesel engine fuel injection control system for the precise metering and delivery of fuel into the combustion chamber of modern diesel engines used in trucks and cars



control fuel delivery under a variety of engine loads and conditions could no longer deal with the ever increasing demands for efficiency, emission control, power and fuel consumption.
These demands are now primarily fulfilled by the Electronic Control, the system which provides greater ability for precise measuring, data processing, operating environment flexibility and analysis to ensure efficient diesel engine operation. The EDC replaces the mechanical control governor with an electro-magnetic control device.

Components in Electronically controlled Diesel Supply;
The EDC is divided into these main groups of components.
- Electronic sensors for registering operating conditions and changes. A wide array of physical inputs is converted into electrical signal outputs.
- Actuators or solenoids which convert the control unit's electrical output signal into mechanical control movement.
- ECM (Electronic Control Module) or Engine ECU (Electronic Control Unit) with microprocessors which process information from various sensors in accordance with programmed software and outputs required electrical signals into actuators and solenoids.

The ECU collects and processes signals from various on-board sensors. AnECU electronic module contains microprocessors, memory units, analog to digital converters and output interface units. Depending upon the parameters, a number of different maps can be stored in the onboard memory.
This allows the ECU to be tailored to the specific engine and vehicle requirements, depending on the application. The operating software of the ECU can be adapted for a wide variety of engines and vehicles without the necessity of hardware modification.
The ECU is usually located in the cab or in certain cases, in a suitable position in the engine bay where additional environmental conditions might require cooling of the ECU as well as a requirement for better dust, heatand vibrations insulation .

The injection of fuel or the quantity of injected fuel has a decisive influence on engine starting, idling, power and emissions. The engine ECU is programmed ("mapped") with relevant data to where the fuel rack position has an equivalent signal for the amount of fuel being injected. The driver requests the torque or engine speed requirements via accelerator pedal potentiometer thereby sending a signal to the engine ECU which then, depending on its *mapping* and data collected from various sensors, calculates in real time the quantity of injected fuel required, thus altering the fuel rack to the required position. The driver can also input additional commands such as idle speed increase to compensate e.g. for PTO operation which can be either variably set or has a preset speed which can be recalled.

Video Content / Details of website for further learning (if any):
http://www.obrum.gliwice.pl/upload/downloads/15.-electronic-control-systems-of-internal-combustion-engines-with-respect-to-the-implementation-of-special-functions-in-military-vehicle-piotr-stryjek-tomasz-nikisz-krzysztof-sykulski-michal-sowa-1465551105.pdf

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LECTURE HANDOUTS

L - 12

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Unit injector system, Rotary distributor type, Common Rail Direct Injection System

Introduction : (Maximum 5 sentences)

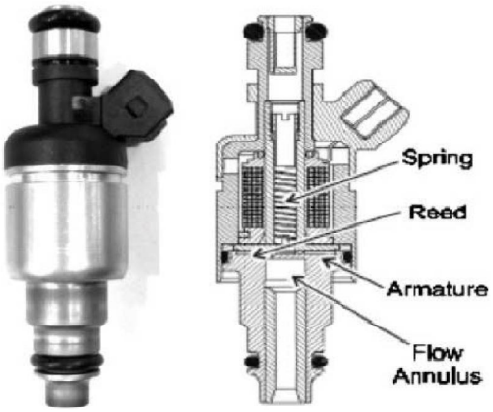
Fuel injection is a system for admitting fuel into an internal combustion engine. It has become the primary fuel delivery system used in automotive engines, having replaced carburetors during the 1980s and 1990s. A variety of injection systems have existed since the earliest usage of the internal combustion engine.

Prerequisite knowledge for Complete understanding and learning of Topic:

Ignition, distributor, tank

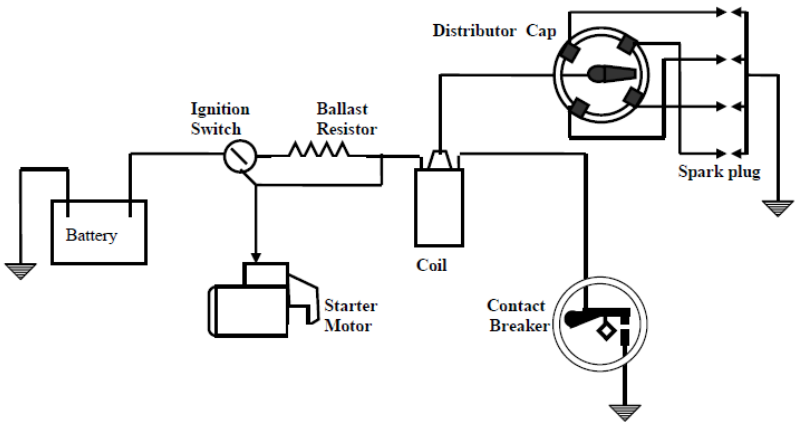
Detailed content of the Lecture:

The primary difference between carburetors and fuel injection is that fuel injection atomizes the fuel by forcibly pumping it through a small nozzle under high pressure, while a carburetor relies on suction created by intake air accelerated through a Venturi tube to draw the fuel into the airstream.

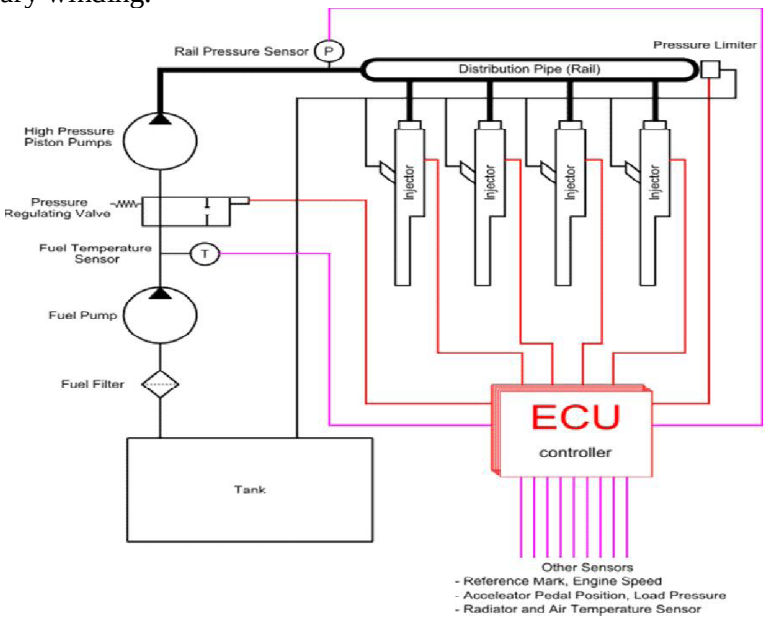


A simple circuit shown above can illustrate the position of the major components of an ignition system. **With the ignition switch 'on'**: when the breaker contacts initially close, a current commences to flow in the primary circuit and the magnetic field builds up relatively slowly, due to the self induced voltage that is developed at this time

It takes a certain number of degrees of distributor shaft rotation and therefore a measurable



Electromagnetic induction is the effect of creating the voltage in a conductor by means of relative movement between the conductor and a magnetic field. In the ignition coil the conductors remain stationary and the magnetic field is moved across them. To develop these necessary conditions, the first requirement in the ignition oil is the production of a magnetic field. This is the function of the primary winding.



In common rail systems, a high-pressure pump stores a reservoir of fuel at high pressure — up to and above 2,000 bars (200 MPa; 29,000 psi). The term "common rail" refers to the fact that all of the fuel injectors are supplied by a common fuel rail which is nothing more than a pressure accumulator where the fuel is stored at high pressure.

Video Content / Details of website for further learning (if any):

http://www.obrum.gliwice.pl/upload/downloads/electronic-control-systems-of-internal-combustion-engines-

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L - 13

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Electronic Ignition System

Introduction : (Maximum 5 sentences)

On diesel engines, it features a high-pressure (over 1,000 baror 100 MPa or 15,000 psi) fuel rail feeding individual solenoid valves, as opposed to low-pressure fuel pump feeding unit injectors (or pump nozzles). Third-generation common rail diesels now feature piezoelectric injectors for increased precision, with fuel pressures up to 3,000 bar (300 MPa; 44,000 psi). In gasoline engines, it is used in gasoline direct injection engine technology.

Prerequisite knowledge for Complete understanding and learning of Topic:

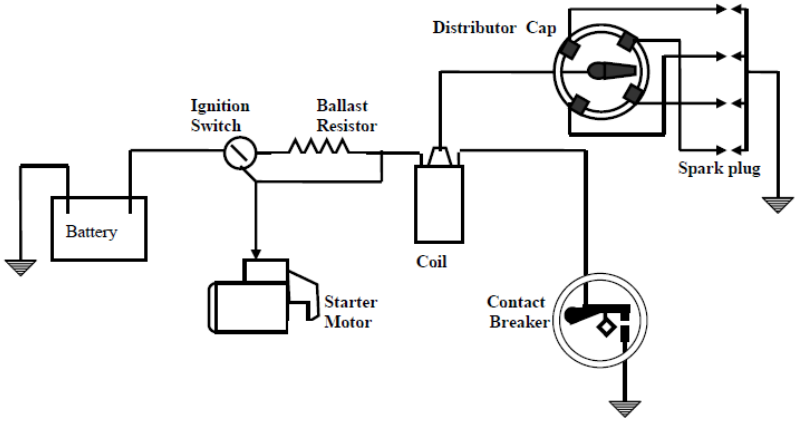
Contact breaker

Detailed content of the Lecture:

Solenoid or piezoelectric valves make possible fine electronic control over the fuel injection time and quantity, and the higher pressure that the common rail technology makes available provides better fuel atomisation. To lower engine noise, the engine's electronic control unit can inject a small amount of diesel just before the main injection event ("pilot" injection), thus reducing its explosiveness and vibration, as well as optimising injection timing and quantity for variations in fuel quality, cold starting and so on. Some advanced common rail fuel systems perform as many as five injections per stroke. Common rail engines require a very short (< 10 seconds) to no heating-up time[depending on ambient temperature, and produce lower engine noise and emissions than older systemsDiesel engines have historically used various forms of fuel injection. Two common types include the unit injection system and the distributor/inline pump systems (See diesel engine andunit injector for more information). While these older systems provided accurate fuel quantity and injection timing control, they were limited by several factors:

- They were cam driven, and injection pressure was proportional to engine speed. This typically meant that the highest injection pressure could only be achieved at the highest engine speed and the maximum achievable injection pressure decreased as engine speed decreased. This relationship is true with all pumps, even those used on common rail systems. With unit or distributor systems, the injection pressure is tied to the instantaneous pressure of a single pumping event with no accumulator, and thus the relationship is more prominent and troublesome.
- They were limited in the number and timing of injection events that could be commanded during a single combustion event. While multiple injection events are possible with these older systems, it is much more difficult and costly to achieve.
- For the typical distributor/inline system, the start of injection occurred at a pre-determined pressure (often referred to as: pop pressure) and ended at a pre-determined pressure. This

pressure in the injector reached a pre-determined level, the plunger would lift and injection would start.



In common rail systems, a high-pressure pump stores a reservoir of fuel at high pressure — up to and above 2,000 bars (200 MPa; 29,000 psi). The term "common rail" refers to the fact that all of the fuel injectors are supplied by a common fuel rail which is nothing more than a pressure accumulator where the fuel is stored at high pressure.

This accumulator supplies multiple fuel injectors with high-pressure fuel. This simplifies the purpose of the high-pressure pump in that it only needs to maintain a commanded pressure at a target (either mechanically or electronically controlled). The fuel injectors are typically ECUcontrolled. When the fuel injectors are electrically activated, a hydraulic valve (consisting of a nozzle and plunger) is mechanically or hydraulically opened and fuel is sprayed into the cylinders at the desired pressure.

Since the fuel pressure energy is stored remotely and the injectors are electrically actuated, the injection pressure at the start and end of injection is very near the pressure in the accumulator (rail), thus producing a square injection rate. If the accumulator, pump and plumbing are sized properly, the injection pressure and rate will be the same for each of the multiple injection events.

Video Content / Details of website for further learning (if any):
https://learnmechanical.com/electronic-ignition-system/

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L - 14

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Transistorized coil ignition system

Introduction : (Maximum 5 sentences)

On diesel engines, it features a high-pressure (over 1,000 baror 100 MPa or 15,000 psi) fuel rail feeding individual solenoid valves, as opposed to low-pressure fuel pump feeding unit injectors (or pump nozzles). Third-generation common rail diesels now feature piezoelectric injectors for increased precision, with fuel pressures up to 3,000 bar (300 MPa; 44,000 psi). In gasoline engines, it is used in gasoline direct injection engine technology.

Prerequisite knowledge for Complete understanding and learning of Topic:

Contact breaker

Detailed content of the Lecture:

Two common types include the unit injection system and the distributor/inline pump systems (See diesel engine andunit injector for more information). While these older systems provided accurate fuel quantity and injection timing control, they were limited by several factors:

- They were cam driven, and injection pressure was proportional to engine speed. This typically meant that the highest injection pressure could only be achieved at the highest engine speed and the maximum achievable injection pressure decreased as engine speed decreased. This relationship is true with all pumps, even those used on common rail systems. With unit or distributor systems, the injection pressure is tied to the instantaneous pressure of a single pumping event with no accumulator, and thus the relationship is more prominent and troublesome.
- They were limited in the number and timing of injection events that could be commanded during a single combustion event. While multiple injection events are possible with these older systems, it is much more difficult and costly to achieve.
- For the typical distributor/inline system, the start of injection occurred at a pre-determined pressure (often referred to as: pop pressure) and ended at a pre-determined pressure. This characteristic resulted from "dummy" injectors in the cylinder head which opened and closed at pressures determined by the spring preload applied to the plunger in the injector. Once the pressure in the injector reached a pre-determined level, the plunger would lift and injection would start.

In common rail systems, a high-pressure pump stores a reservoir of fuel at high pressure — up to and above 2,000 bars (200 MPa; 29,000 psi). The term "common rail" refers to the fact that all of the fuel injectors are supplied by a common fuel rail which is nothing more than a pressure

purpose of the high-pressure pump in that it only needs to maintain a commanded pressure at a target (either mechanically or electronically controlled).

Video Content / Details of website for further learning (if any):
https://learnmechanical.com/electronic-ignition-system/

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LECTURE HANDOUTS

L - 15

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: capacitive discharge ignition system

Introduction : (Maximum 5 sentences)

On diesel engines, it features a high-pressure (over 1,000 baror 100 MPa or 15,000 psi) fuel rail feeding individual solenoid valves, as opposed to low-pressure fuel pump feeding unit injectors (or pump nozzles). Third-generation common rail diesels now feature piezoelectric injectors for increased precision, with fuel pressures up to 3,000 bar (300 MPa; 44,000 psi). In gasoline engines, it is used in gasoline direct injection engine technology.

Prerequisite knowledge for Complete understanding and learning of Topic:

Contact breaker

Detailed content of the Lecture:

Solenoid or piezoelectric valves make possible fine electronic control over the fuel injection time and quantity, and the higher pressure that the common rail technology makes available provides better fuel atomisation. To lower engine noise, the engine's electronic control unit can inject a small amount of diesel just before the main injection event ("pilot" injection), thus reducing its explosiveness and vibration, as well as optimising injection timing and quantity for variations in fuel quality, cold starting and so on. Some advanced common rail fuel systems perform as many as five injections per stroke. Common rail engines require a very short (< 10 seconds) to no heating-up time[depending on ambient temperature, and produce lower engine noise and emissions than older systemsDiesel engines have historically used various forms of fuel injection. Two common types include the unit injection system and the distributor/inline pump systems (See diesel engine andunit injector for more information). While these older systems provided accurate fuel quantity and injection timing control, they were limited by several factors:

- They were cam driven, and injection pressure was proportional to engine speed. This typically meant that the highest injection pressure could only be achieved at the highest engine speed and the maximum achievable injection pressure decreased as engine speed decreased. This relationship is true with all pumps, even those used on common rail systems. With unit or distributor systems, the injection pressure is tied to the instantaneous pressure of a single pumping event with no accumulator, and thus the relationship is more prominent and troublesome.
- They were limited in the number and timing of injection events that could be commanded during a single combustion event. While multiple injection events are possible with these older systems, it is much more difficult and costly to achieve.
- For the typical distributor/inline system, the start of injection occurred at a pre-determined

pressures determined by the spring preload applied to the plunger in the injector. Once the pressure in the injector reached a pre-determined level, the plunger would lift and injection would start.
In common rail systems, a high-pressure pump stores a reservoir of fuel at high pressure — up to and above 2,000 bars (200 MPa; 29,000 psi).

Video Content / Details of website for further learning (if any):
https://learnmechanical.com/electronic-ignition-system/

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LECTURE HANDOUTS

L - 16

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: TurboChargers

Introduction : (Maximum 5 sentences)

Catalytic converter is a vehicle emissions control device that converts toxic pollutants in exhaust gas to less toxic pollutants by catalyzing a redox reaction(oxidation or reduction). Catalytic converters are used in internal combustion engines fueled by either petrol (gasoline) or diesel—including lean burn engines.

Prerequisite knowledge for Complete understanding and learning of Topic:

Recycle, waste heat

Detailed content of the Lecture:

Although catalytic converters are most commonly applied to exhaust systems in automobiles, they are also used on electrical generators, forklifts, mining equipment, trucks, buses, locomotives, motorcycles, and airplanes. They are also used on some wood stoves to control emissions. This is usually in response to government regulation, either through direct environmental regulation or through health and safety regulations.

The catalyst support or substrate. For automotive catalytic converters, the core is usually a ceramic monolith with a honeycomb structure. Metallic foil monoliths made of Kanthal (FeCrAl) are used in applications where particularly high heat resistance is required Either material is designed to provide a large surface area. The cordierite ceramic substrate used in most catalytic converters was invented by Rodney Bagley, Irwin Lachman andRonald Lewis at Corning Glass, for which they were inducted into the National Inventors Hall of Fame in 2002.

The washcoat. A washcoat is a carrier for the catalytic materials and is used to disperse the materials over a large surface area. Aluminum oxide, titanium dioxide, silicon dioxide, or a mixture of silica and alumina can be used. The catalytic materials are suspended in the washcoat prior to applying to the core. Washcoat materials are selected to form a rough, irregular surface, which greatly increases the surface area compared to the smooth surface of the bare substrate. This in turn maximizes the catalytically active surface available to react with the engine exhaust. The coat must retain its surface area and prevent sintering of the catalytic metal particles even at high temperatures

The catalyst itself is most often a mix of precious metals. Platinum is the most active catalyst and is widely used, but is not suitable for all applications because of unwanted additional reactions and high cost. Palladium and rhodium are two other precious metals used. Rhodium is used as a reduction catalyst, palladium is used as an oxidation catalyst, and platinum is used both for reduction and oxidation. Cerium, iron, manganese and nickel are also used, although each has limitations. Nickel is not legal for use in the European Union because of its reaction with carbon monoxide into toxic nickel tetracarbonyl.[citation needed] Copper can be used everywhere

Video Content / Details of website for further learning (if any): https://www.turochargers.com
Important Books/Journals for further learning including the page nos.: Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L - 17

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Three way catalytic converter system

Introduction : (Maximum 5 sentences)

Catalytic converter is a vehicle emissions control device that converts toxicpollutants in exhaust gas to less toxic pollutants by catalyzing a redox reaction(oxidation or reduction). Catalytic converters are used in internal combustion engines fueled by either petrol (gasoline) or diesel—including lean burn engines.

Prerequisite knowledge for Complete understanding and learning of Topic:

Inlet, outlet, harm

Detailed content of the Lecture:

Although catalytic converters are most commonly applied to exhaust systems in automobiles, they are also used on electrical generators, forklifts, mining equipment, trucks, buses, locomotives, motorcycles, and airplanes. They are also used on some wood stoves to control emissions. This is usually in response to government regulation, either through direct environmental regulation or through health and safety regulations.

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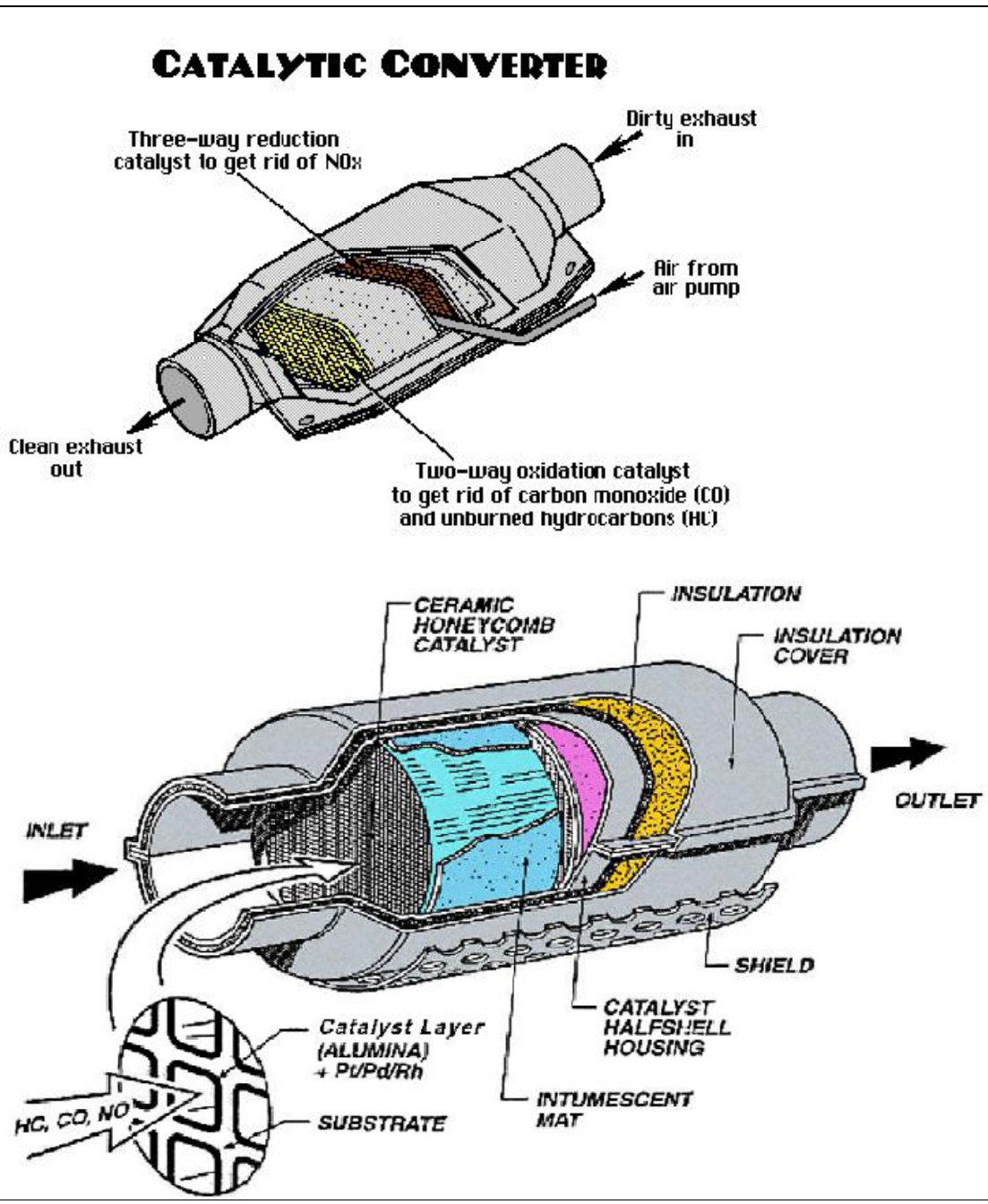

Video Content / Details of website for further learning (if any):
https://www.howstuffworks.com/three_way_catalytic_converter

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L - 18

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **II**

Topic of Lecture: Emission norms (Euro and BS)

Introduction : (Maximum 5 sentences)

Vehicle emissions control device that converts toxic pollutants in exhaust gas to less toxic pollutants by catalyzing a redox reaction(oxidation or reduction). Catalytic converters are used in internal combustion engines fueled by either petrol (gasoline) or diesel—including lean burn engines.

Prerequisite knowledge for Complete understanding and learning of Topic:

Emission, Norms, Code

Detailed content of the Lecture:

Although catalytic converters are most commonly applied to exhaust systems in automobiles, they are also used on electrical generators, forklifts, mining equipment, trucks, buses, locomotives, motorcycles, and airplanes. They are also used on some wood stoves to control emissions. This is usually in response to government regulation, either through direct environmental regulation or through health and safety regulations.

The catalyst support or substrate. For automotive catalytic converters, the core is usually a ceramic monolith with a honeycomb structure. Metallic foil monoliths made of Kanthal (FeCrAl) are used in applications where particularly high heat resistance is required Either material is designed to provide a large surface area. The cordierite ceramic substrate used in most catalytic converters was invented by Rodney Bagley, Irwin Lachman andRonald Lewis at Corning Glass, for which they were inducted into the National Inventors Hall of Fame in 2002.

The washcoat. A washcoat is a carrier for the catalytic materials and is used to disperse the materials over a large surface area. Aluminum oxide, titanium dioxide, silicon dioxide, or a mixture of silica and alumina can be used. The catalytic materials are suspended in the washcoat prior to applying to the core. Washcoat materials are selected to form a rough, irregular surface, which greatly increases the surface area compared to the smooth surface of the bare substrate. This in turn maximizes the catalytically active surface available to react with the engine exhaust. The coat must retain its surface area and prevent sintering of the catalytic metal particles even at high temperatures

The catalyst itself is most often a mix of precious metals. Platinum is the most active catalyst and is widely used, but is not suitable for all applications because of unwanted additional reactions and high cost. Palladium and rhodium are two other precious metals used. Rhodium is used as a reduction catalyst, palladium is used as an oxidation catalyst, and platinum is used both for reduction and oxidation. Cerium, iron, manganese and nickel are also used, although each has limitations. Nickel is not legal for use in the European Union because of its reaction with carbon monoxide into toxic nickel tetracarbonyl [citation needed] Copper can be used everywhere

Video Content / Details of website for further learning (if any):
https://www.wikihow.com/emissin-norms

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384

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LECTURE HANDOUTS

L-19

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Clutch-types and construction

Introduction : (Maximum 5 sentences)

- Clutch is a device which is used in the transmission system of automobile to engage and disengage the engine to the transmission or gear box.
- It is located between the transmission and the engine.
- When the clutch is engaged, the power flows from the engine to the rear wheels in a rear-wheel-drive transmission and the vehicle moves.
- When the clutch is disengaged, the power is not transmitted from the engine to the rear wheels and vehicle stops even if engine is running.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Transmission system
- Components of Transmission system

Detailed content of the Lecture:

- Clutch works on the principle of friction. When two friction surfaces are brought in contact with each other and they are united due to the friction between them. If one is revolved the other will also revolve.
- The friction depends upon the surface area contact. The friction surfaces are so designed that the driven member initially slips on driving member when initially pressure is applied. As pressure increases the driven member is brought gradually to speed the driving member.
- The three main parts of clutch are:
  - Driving member
  - Driven member

- The driving member consists of a flywheel mounted on the engine crank shaft. The flywheel is bolted to cover which carries a pressure plate or driving disc, pressure springs and releasing levers. Thus the entire assembly of flywheel and cover rotates all the times. The clutch housing and the cover provided with openings dissipate the heat generated by friction during the clutch operation.
- The driving member consists of a disc or plate called clutch plate. It is free to slide length wise on the splines of the clutch shaft. It carries friction materials on both of its surfaces when it is gripped between the flywheel and the pressure plate; it rotates the clutch shaft through splines.
- The operating members consists of a foot pedal, linkage, release or throw-out bearing, release levers and springs necessary to ensure the proper operation of the clutch.
- Now the driving member in an automobile is flywheel mounted on crank shaft, the driven member is the pressure plate mounted on transmission or gear box input shaft. Friction surfaces or clutch plates is placed between two members.

Single Clutch Plate

- It is the most common type of clutch plate used in motor vehicles. Basically it consists of only one clutch plate, mounted on the splines of the clutch plate. The flywheel is mounted on engine crankshaft and rotates with it.
- The pressure plate is bolted to the flywheel through clutch springs, and is free to slide on the clutch shaft when the clutch pedal is operated. When the clutch is engaged the clutch plate is gripped between the flywheel and pressure plate.
- The friction linings are on both the sides of the clutch plate. Due to the friction between the flywheel, clutch plate and the pressure plate the clutch plate revolves the flywheel. As the clutch plate revolves the clutch shaft also revolves. Clutch shaft is connected to the transmission gear box. Thus the engine power is transmitted to the crankshaft and then to the clutch shaft.

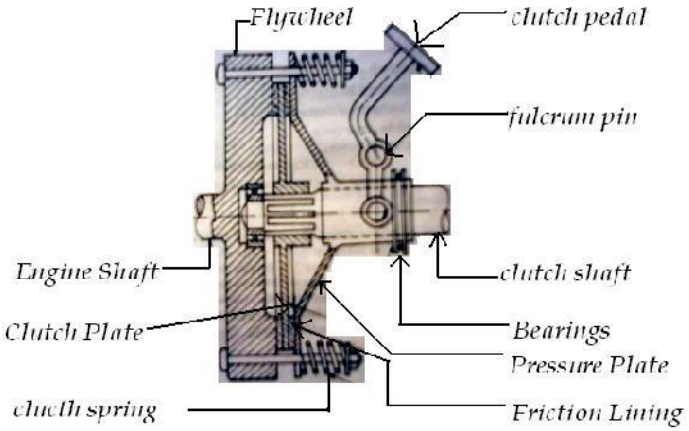

Fig: Single Plate Clutch

Multi-plate Clutch

- Multi-plate clutch consists of a number of clutch plates instead of only one clutch plate as in case of single plate clutch.
- As The number of clutch plates are increased, the friction surfaces also increases. The increased number of friction surfaces obliviously increases the capacity of the clutch to transmit torque.

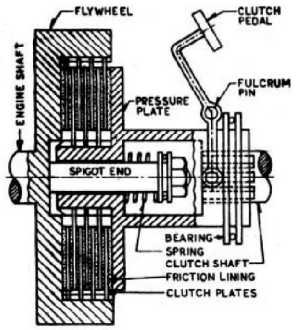

Fig : Multi-Plate Clutch

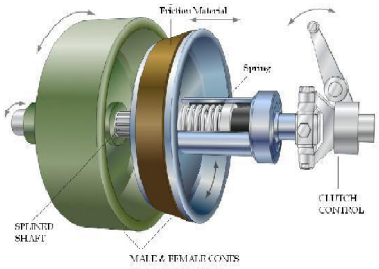

Fig: CONE CLUTCH

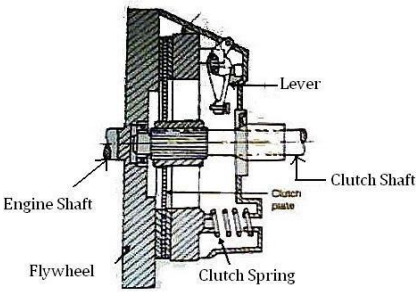

Fig: Semicentrifugal Clutch

- Multi-plate clutch consists of a number of clutch plates instead of only one clutch plate as in case of single plate clutch. As The number of clutch plates are increased, the friction surfaces also increases. The increased number of friction surfaces obliviously increases the capacity of the clutch to transmit torque.
- Cone clutch consists of friction surfaces in the form of cone. The engine shaft consists of female cone. The male cone is mounted on the splined clutch shaft. It has friction surfaces on the conical portion. The male cone can slide on the clutch shaft. Hen the clutch is engaged the friction surfaces of the male cone are in contact with that of the female cone due to force of the spring. When the clutch pedal is pressed, the male cone slides against the spring force and the clutch is disengaged.
- A semi centrifugal clutch is used to transmit power from high powered engines and racing car engines where clutch disengagements requires appreciable and tiresome drivers effort. The transmission of power in such clutches is partly by clutch springs and rest by centrifugal action of an extra weight provided in system. The clutch springs serve to transmit the torque up to normal speeds, while the centrifugal force assists at speeds higher than normal

Video Content / Details of website for further learning (if any):
https://www.youtube.com/jnehw_86njkf

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-20

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Gear boxes- Manual and Automatic

Introduction : (Maximum 5 sentences)

- A gearbox is a mechanical method of transferring energy from one device to another and is used to increase torque while reducing speed.
- Torque is the power generated through the bending or twisting of a solid material. This term is often used interchangeably with transmission Located at the junction point of a power shaft.
- The gearbox is often used to create a right angle change in direction, as is seen in a rotary mower or a helicopter.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Gears
- Types of Gears
- Meshing of Gears

Detailed content of the Lecture:

Principle Of Gearing

- Consider a simple 4-gear train. It consists of a driving gear A on input shaft and a driven gear D on the output shaft. In between the two gears there are two intermediate gears B, C. Each of these gears are mounted on separate shaft.

Types of Gear Boxes: The following types of gear box are used in automobiles

- Sliding Mesh
- Constant Mesh
- Synchromesh.

Sliding Mesh Gear Box

- It is the simplest gear box. The following figure shows 4-speed gear box in neutral position. 4 gears are connected to the lay shaft/counter shaft.
- A reverse idler gear is mounted on another shaft and always remains connected to the reverse gear of countershaft. This "H" shift pattern enables the driver to select four different gear ratios and a reverse gear.

Gears in Neutral:

- When the engine is running and clutch is engaged the clutch shaft gear drives the countershaft gear. The countershaft rotates opposite in direction of the clutch shaft.
- In neutral position only the clutch shaft gear is connected to the countershaft gear. Other gears are free and hence the transmission main shaft is not turning. The vehicle is stationary.

First or low shaft gear:

- By operating the gear shift lever the larger gear on the main shaft is moved along the shaft to mesh with the first gear of the counter shaft. The main shaft turns in the same direction as that of the clutch shaft.
- Since the smaller countershaft is engaged with larger shaft gear a gear reduction of approximately 4:1 is obtained i.e. the clutch shaft turns 4 times for each revolution of main shaft.

Second speed gear

- By operating the gear shift lever the third gear on the main shaft is moved along the shaft to mesh with the third gear of the counter shaft.
- The main shaft turns in same direction as clutch shaft. A gear reduction of approximately 3:1is obtained.

Third speed gear:

- By operating the gear shift lever, the second gear of the main shaft and countershaft are demeshed and then the third gear of the main shaft are forced axially against the clutch shaft gear.
- External Teeth on the clutch shaft gear mesh with the internal teeth in the third and top gear. The main shaft turns in same direction as clutch shaft.

Fourth speed gear/ Top or High-Speed Gear

- By operating the gear shaft lever the third gears of the main and countershaft is demeshed and the gears present on the main shaft along with the shaft is forced axially against the clutch shaft gear.
- External teeth present on the main shaft engage with the internal teeth present on the main shaft. The main shaft turns along with the clutch shaft and a gear ratio of approximately

1:1 is obtained.

Reverse gear:

- By operating the gear shift lever, the last gear present on the main shaft is engaged with the reverse idler gear.
- The reverse idler gear is always in mesh with the counters haft gear. Interposing the idler gear between the counter-shaft reverse gear and main shaft gear, the main shaft turns in the direction opposite to the clutch shaft.
- This reverses the rotation of the wheels so that the wheel backs.

Constant Mesh Gear Box:

- In this type of gear box, all gears of the main shaft are in constant mesh with the corresponding gears of the countershaft (Lay shaft). Two dog clutches are provided on the main shaft- one between the clutch gear and the second gear, and the other between the first gear and reverse gear.
- The main shaft is splined and all the gears are free on it. Dog clutch can slide on the shaft and rotates with it. All the gears on the countershaft are rigidly fixed with it.

Syncromesh Gear Box:

- In sliding Mesh Gear box the two meshing gears need to be revolve at equal peripheral speeds to achieve a jerk less engagement and it is true for constant mesh gear box in which the peripheral speeds of sliding dog and the corresponding gear on the output shaft must be equal.

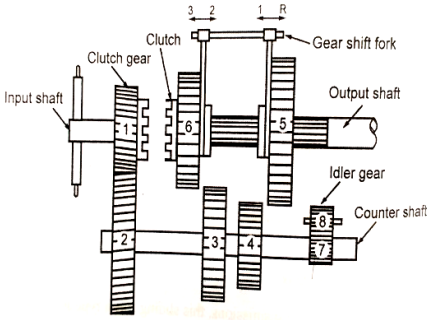

Figure 3.16 Sliding mesh gearbox

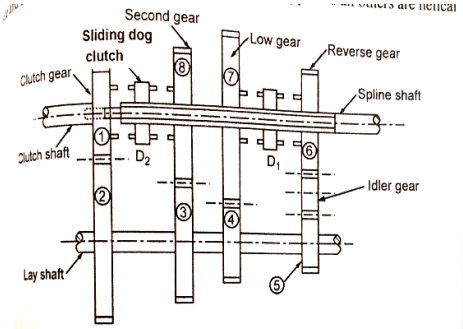

Figure 3.21 Constant mesh gearbox

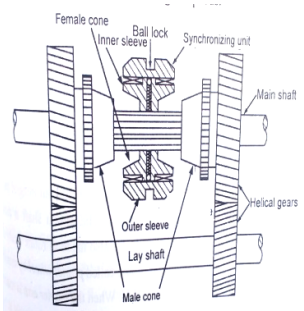

Figure 3.26 Synchromesh unit

Video Content / Details of website for further learning (if any):
www.idn.com/hjgthelfajghjagh?_hylcgsgdfj=search

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-21

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Gear shift Mechanisms, Over drive

Introduction : (Maximum 5 sentences)

- Overdrive is the operation of an automobile cruising at sustained speed with reduced engine revolutions per minute (RPM), leading to better fuel consumption, lower noise, and lower wear.
- Use of the term is confused, as it is applied to several different, but related, meanings.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Automatic Transmission
- Drive Ratio
- Shifting Mechanism

Detailed content of the Lecture:

Gear shift Mechanisms

- The automatic transmission automatically shifts from OD to direct drive when more load is present.
- When less load is present, it shifts back to OD. Under certain conditions, for example driving uphill, or towing a trailer, the transmission may "hunt" between OD and the next highest gear, shifting back and forth.
- In this case, switching it off can help the transmission to "decide". It may also be advantageous to switch it off if engine braking is desired, for example when driving downhill.
- The vehicle's owner's manual will often contain information and suitable procedures regarding such situations, for each given vehicle.
- Virtually all vehicles (cars and trucks) have overdrive today whether manual transmission

or automatic.

- In the automotive aftermarket you can also retrofit overdrive to existing early transmissions. Overdrive was widely used in European automobiles with manual transmission in the 60s and 70s to improve mileage and sport driving as a bolt-on option but it became increasingly more common for later transmissions to have this gear built in.
- If a vehicle is equipped with a bolt-on overdrive (e.g.: GKN or Gear Vendors) as opposed to having an overdrive built in one will typically have the option to use the overdrive in more gears than just the top gear.

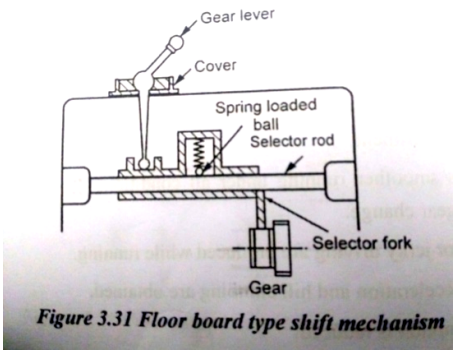

Figure 3.31 Floor board type shift mechanism

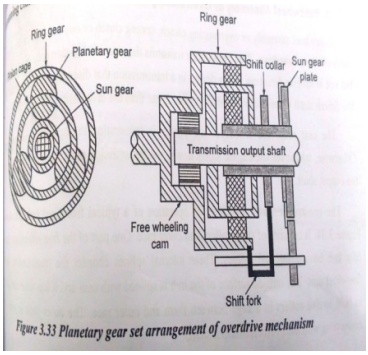

Figure 3.33 Planetary gear set arrangement of overdrive mechanism

Overdrive

- In an era when different models of car with different wheel sizes could be accommodated by simply changing the final drive ratio, it made sense for all transmissions to use direct drive as the highest gear.
- As noted earlier, however, this would cause the engine to operate at too high an RPM for efficient cruising. Although adding the cruising gear to the main gearbox was possible, it was generally simpler to add a separate two-gear overdrive system to the existing gearbox. This not only meant that it could be tuned for different vehicles, but had the additional advantage that it could be offered as an easily installed option.
- With the use of front-wheel drive layouts, the gearbox and final drive are combined into a single transaxle. There is no longer a drive shaft between them and so the notion of "direct drive" isn't applicable. Although "overdrive" is still referred to, this is now mostly a marketing term to refer to any extra-high ratio for efficient cruising, whether it is achieved through the gearbox ratios, or by an unusually high final drive

Video Content / Details of website for further learning (if any):
https://www.youtube.com/6njkf jnehw_8

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-22

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Transfer box, Fluid flywheel

Introduction : (Maximum 5 sentences)

- A transfer case is a part of a four-wheel-drive system found in four-wheel-drive and all-wheel-drive vehicles.
- The transfer case is connected to the transmission and also to the front and rear axles by means of drive shafts

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Four wheel drive system
- Crank shaft
- Gear Box

Detailed content of the Lecture:

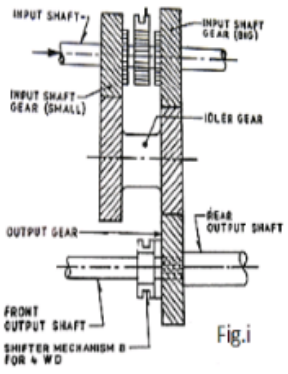


Fig.i

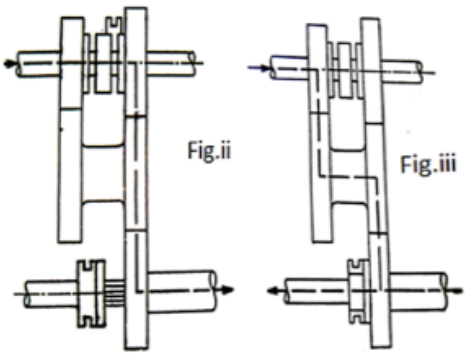
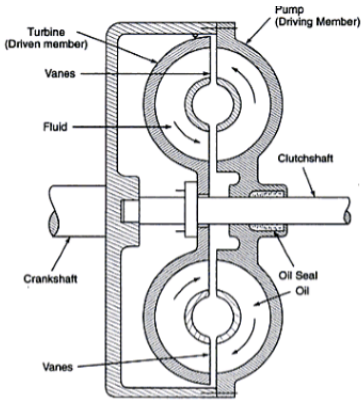


Fig.ii Fig.iii

Transfer Box



- The input shaft is connected to the gear box and carries on it a member having axial teeth.

side which have axial teeth of the same pitch as the central member on the input shaft.

- Depending upon the movement of the transfer box gear lever, the central member and thereby the input shaft may be connected either to the small gear or to the big gear.
- There are two output shafts, one going to the front axle and the second going to the rear axle.
- The front output shaft is smaller in diameter and is supported inside the rear output shaft which is directly connected to the output gear.
- The front output shaft has fitted on it a shifter mechanism and also has splines over a small length of it, which when engage with the corresponding internal splines on the rear output shaft, connect the two shafts rotationally with each other.
- When the shifter mechanism A is in the centre so that no gear is connected to the input shaft, the drive is in neutral as shown in Fig.i., Fig.ii shows when the shifter mechanism A connects the input shaft with the big input gear, but the shifter mechanism B disconnects the front output of shaft from the rear output shaft. In this position, two-wheel drive with the high gear is obtained.In the same way Fig.iii depicts the situation with four wheel drive in low.

Fluid Flywheel

- The fluid flywheel is used in cars with automatic transmission.
- It consists of two members; the driving member is attached to the engine flywheel and the driven member to the transmission shaft.
- There is no direct contact between the two members. The two rotors are always filled with fluid of suitable viscosity.
- A simplified diagram representing the fluid flywheel is shown. At start tube X is rotating say at N rpm and Y tube is stationary.
- With the movement of fluid in X and Y, Y also starts rotating but at a lower speed.
- The speed goes on increasing till the speed equals to N rpm, then the coupling is fully engaged.

Video Content / Details of website for further learning (if any):
www.fluiddynamics.com/fluid_fly_wheel.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-23

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Torque Converter, Propeller shaft

Introduction : (Maximum 5 sentences)

- Unlike a manual transmission system, automatic transmission does not use a clutch to disconnect power from the engine temporarily when shifting gears.
- Instead, a device called a torque converter was invented to prevent power from being temporarily disconnected from the engine and also to pre-vent the vehicle from stalling when the transmission is in gear.

Prerequisite Knowledge For Complete Understanding And Learning Of Topic:
(Max. Four Important Topics)

- Prime Mover
- centrifugal force
- torque

Detailed content of the Lecture:

- A fluid coupling/torque converter consists of a sealed chamber containing two toroidal-shaped, vaned components, the pump and turbine, immersed in fluid (usually oil).
- The pump or driving torus (the latter a General Motors automotive term) is rotated by the prime mover, which is typically an internal combustion engine or electric motor.
- The pump's motion imparts a relatively complex centripetal motion to the fluid. Simplified, this is a centrifugal force that throws the oil outwards against the coupling's housing, whose shape forces the flow in the direction of the turbine or driven torus (the latter also a General Motors term).
- Here, Corolis force reaction transfers the angular fluid momentum outward and across, applying torque to the turbine, thus causing it to rotate in the same direction as the pump.
- The fluid leaving the center of the turbine returns to the pump, where the cycle endlessly

repeats. The pump typically is connected to the flywheel of the engine—in fact, the coupling's enclosure may be part of the flywheel proper, and thus is turned by the engine's crankshaft.

- The turbine is connected to the input shaft of the transmission. As engine speed increases while the transmission is in gear, torque is transferred from the engine to the input shaft by the motion of the fluid, propelling the vehicle.
- In this regard, the behavior of the fluid coupling strongly resembles that of a mechanical clutch driving a manual transmission.

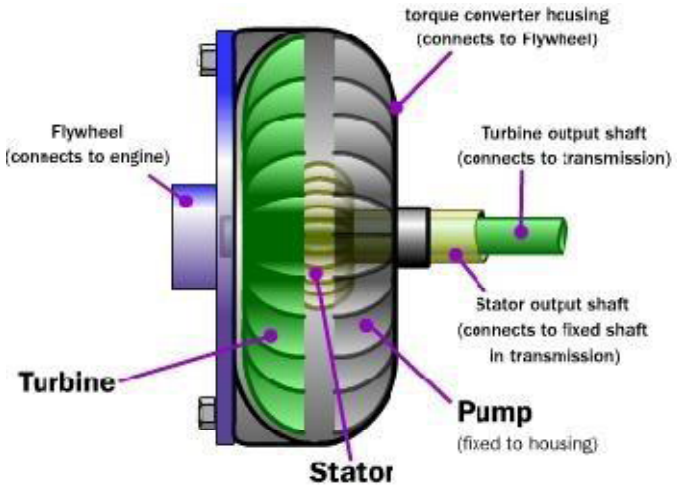


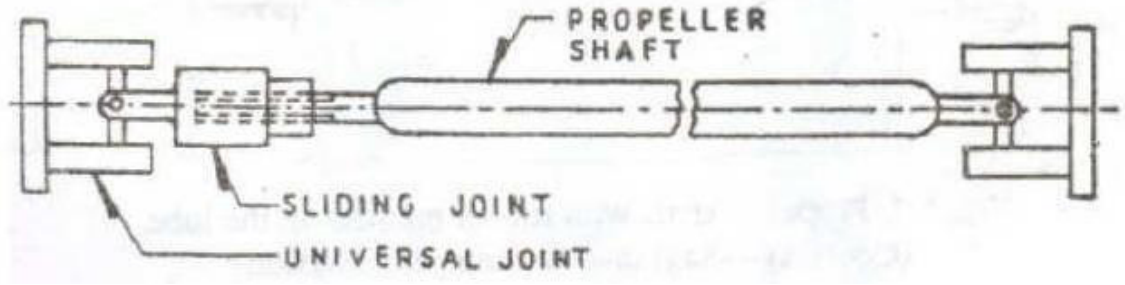
Fig: Cut section Model of Torque converter

- A torque converter differs from a fluid coupling in that it provides a variable amount of torque multiplication at low engine speeds, increasing "breakaway" acceleration.
- This is accomplished with a third member in the "coupling assembly" known as the stator, and by altering the shapes of the vanes inside the coupling in such a way as to curve the fluid's path into the stator.
- The stator captures the kinetic energy of the transmission fluid in effect using the left-over force of it to enhance torque multiplication.

Propeller shaft

- The drive shaft, or propeller shaft, connects the transmission output shaft to the differential pinion shaft.
- Since all roads are not perfectly smooth, and the transmission is fixed, the drive shaft has to be flexible to absorb the shock of bumps in the road. Universal, or "U-joints" allow the drive shaft to flex (and stop it from breaking) when the drive angle changes.
- Drive shafts are usually hollow in order to weigh less, but of a large diameter so that they are strong. High quality steel, and sometimes aluminum are used in the manufacture of the drive shaft.

- The shaft must be quite straight and balanced to avoid vibrating. Since it usually turns at engine speeds, a lot of damage can be caused if the shaft is unbalanced, or bent. Damage can also be caused if the U-joints are worn out.
- There are two types of drive shafts, the Hotchkiss drive and the Torque Tube Drive. The Hotchkiss drive is made up of a drive shaft connected to the transmission output shaft and the differential pinion gear shaft. U-joints are used in the front and rear.
- The Hotchkiss drive transfers the torque of the output shaft to the differential. No wheel drive thrust is sent to the drive shaft. Sometimes this drive comes in two pieces to reduce vibration and make it easier to install (in this case, three U-joints are needed).
- The two-piece types need ball bearings in a dustproof housing as center support for the shafts. Rubber is added into this arrangement for noise and vibration reduction.



- The torque tube drive shaft is used if the drive shaft has to carry the wheel drive thrust. It is a hollow steel tube that extends from the transmission to the rear axle housing. One end is fastened to the axle housing by bolts.
- The transmission end is fastened with a torque ball. The drive shaft fits into the torque tube. A U-joint is located in the torque ball, and the axle housing end is splined to the pinion gear shaft.
- Drive thrust is sent through the torque tube to the torque ball, to transmission, to engine and finally, to the frame through the engine mounts. That is, the car is pushed forward by the torque tube pressing on the engine.

Video Content / Details of website for further learning (if any):
https://autoparts.com/tranmission.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-24

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Slip joints, Universal joints

Introduction : (Maximum 5 sentences)

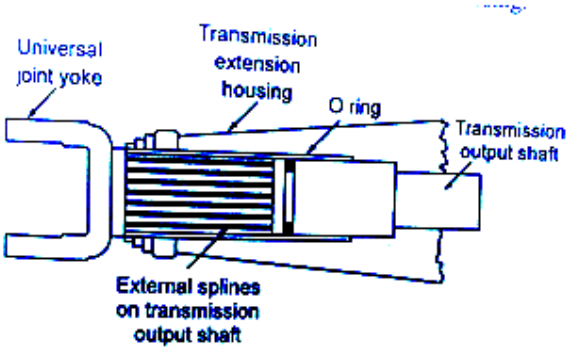
- Slip joint is attached to the driven yoke to increase or decrease the length of propeller shaft. It has outside splines on the shaft and matching internal splines in a mating hollow shaft or yoke.
- When assembled, the splines cause the shafts to rotate together while they can move back and forth

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

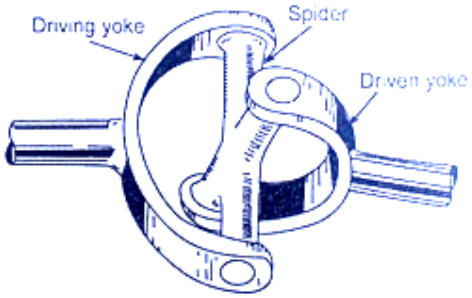
- Universal Joint
- Transmission
- Splines

Detailed content of the Lecture:

- Slip joints can be designed to allow continuous relative motion of two components or it can allow an adjustment, by unclamping from one fixed position, and re-clamping to another. Examples of the latter are tripods, hiking poles, or similar telescoping device.
- The clamping mechanism is based on a cam, a set screw or similar locking mechanism. Slip joints can also be non-telescoping, such as the joints on some older wooden surveyor's levelling rods.
- These use a joint that keeps the sections offset from each other but able to be slid together for transport**.**
- Slip joint is usually provided in propeller shaft close to the Universal joint that is situated near the Gear box.
- The Propeller shaft with a slip joint is called telescopic propeller shaft



Slip joint



Universal joints

- A universal joint, U-joint, Cardan joint, Hardy-Spicer joint, or Hooke's joint is a linkage that transmits rotation between two non parallel shafts whose axes are coplanar but not coinciding., and is commonly used in shafts that transmit rotary motion.
- It is used in automobiles where it is used to transmit power from the gear box of the engine to the rear axle. The driving shaft rotates at a uniform angular speed, where as the driven shaft rotates at a continuously varying angular speed.
- A complete revolution of either shaft will cause the other to rotate through a complete revolution at the same time. Each shaft has fork at its end. The four ends of the two fork are connected by a centre piece, the arms of which rest in bearings, provided in fork ends.
- The centre piece can be of any shape of a cross, square or sphere having four pins or arms. The four arms are at right angle to each other.
- When the two shafts are at an angle other than 180° (straight), the driven shaft does not rotate with constant angular speed in relation to the drive shaft; the more the angle goes toward 90° the jerkier the movement gets (clearly, when the angle $\beta = 90°$ the shafts would even lock).
- However, the overall average speed of the driven shaft remains the same as that of driving shaft, and so speed ratio of the driven to the driving shaft on average is 1:1 over multiple rotations.

Video Content / Details of website for further learning (if any):
https://autoparts.com/tranmission.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-25

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Differential and rear axle

Introduction : (Maximum 5 sentences)

- Differentials are a variety of gearbox, almost always used in one of two ways. In one of these, it receives one input and provides two outputs; this is found in every automobile.
- In automobile and other wheeled vehicles, the differential allows each of the driving wheels to rotate at different speeds, while supplying equal torque to each of them.
- In the other, less commonly encountered, it combines two inputs to create an output that is the sum (or difference) of the inputs.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Differential function
- Ring gear
- Planetary Gear

Detailed content of the Lecture:

- In automotive applications, the differential and its housing are sometimes collectively called a "pumpkin" (because the housing resembles a pumpkin).
- The differential gear box has following functions:
  - Avoid skidding of the rear wheels on a road turning.
  - Reduces the speed of inner wheels and increases the speed of outer wheels, while drawing a curve.
  - Keeps equal speeds of all the wheels while moving on a straight road.
  - Eliminates a single rigid rear axle, and provides a coupling between two rear axles.
- The following description of a differential applies to a "traditional" rear- or front-wheel-

- Power is supplied from the engine, via the transmission or gearbox, to a drive shaft termed as propeller shaft, which runs to the differential.
- A spiral bevel pinion gear at the end of the propeller shaft is encased within the differential itself, and it meshes with the large spiral bevel ring gear termed as crown wheel. The ring and pinion may mesh in hypoid orientation.
- The ring gear is attached to a carrier, which holds what is sometimes called a spider, a cluster of four bevel gears in a rectangle, so each bevel gear meshes with two neighbors and rotates counter to the third that it faces and does not mesh with.
- Two of these spider gears are aligned on the same axis as the ring gear and drive the half shafts connected to the vehicle's driven wheels.

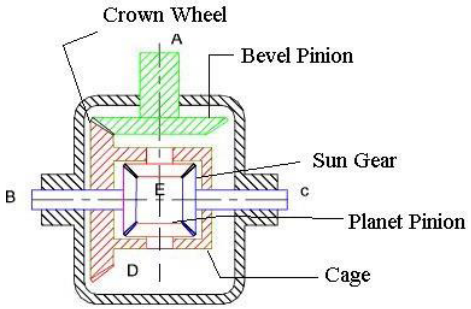

Fig: Differntial gear Assembly

- The following description of a differential applies to a "traditional" rear- or front-wheel-drive car or truck:Power is supplied from the engine, via the transmission or gearbox, to a drive shaft termed as propeller shaft, which runs to the differential.
- A spiral bevel pinion gear at the end of the propeller shaft is encased within the differential itself, and it meshes with the large spiral bevel ring gear termed as crown wheel. The ring and pinion may mesh in hypoid orientation.
- The ring gear is attached to a carrier, which holds what is sometimes called a spider, a cluster of four bevel gears in a rectangle, so each bevel gear meshes with two neighbors and rotates counter to the third that it faces and does not mesh with. Two of these spider gears are aligned on the same axis as the ring gear and drive the half shafts connected to the vehicle's driven wheels.
- These are called the side gears. The other two spider gears are aligned on a perpendicular axis which changes orientation with the ring gear's rotation.
- These two gears are just called pinion gears, not to be confused with the main pinion gear. (Other spider designs employ different numbers of pinion gears depending on durability requirements.)
- As the carrier rotates, the changing axis orientation of the pinion gears imparts the motion of the ring gear to the motion of the side gears by pushing on them rather than turning against them (that is, the same teeth stay in contact), but because the spider gears are not

restricted from turning against each other, within that motion the side gears can counter-rotate relative to the ring gear and to each other under the same force (in which case the same teeth do not stay in contact).

- Thus, for example, if the car is making a turn to the right, the main ring gear may make 10 full rotations. During that time, the left wheel will make more rotations because it has further to travel, and the right wheel will make fewer rotations as it has less distance to travel.
- The side gears will rotate in opposite directions relative to the ring gear by, say, 2 full turns each (4 full turns relative to each other), resulting in the left wheel making 12 rotations, and the right wheel making 8 rotations.

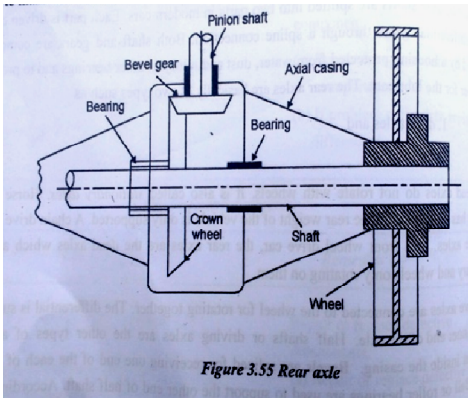

Figure 3.55 Rear axle

- The rotation of the ring gear is always the average of the rotations of the side gears. This is why if the wheels are lifted off the ground with the engine off, and the drive shaft is held (preventing the ring gear from turning inside the differential), manually rotating one wheel causes the other to rotate in the opposite direction by the same amount.
- When the vehicle is traveling in a straight line, there will be no differential movement of the planetary system of gears other than the minute movements necessary to compensate for slight differences in wheel diameter, undulations in the road (which make for a longer or shorter wheel path), etc.

Video Content / Details of website for further learning (if any):
https://autoparts.com/tranmission.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-26

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Hotchkiss Drive

Introduction : (Maximum 5 sentences)

- The Hotchkiss drive is a system of power transmission. It was the dominant form of power transmission for front-engine, rear-wheel drive layout cars in the 20th century.
- The name comes from the French automobile firm of Hotchkiss, although it is clear that other makers (such as Peerless) used similar systems before Hotchkiss.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Propeller Shaft
- Universal Joint
- Power Transmission

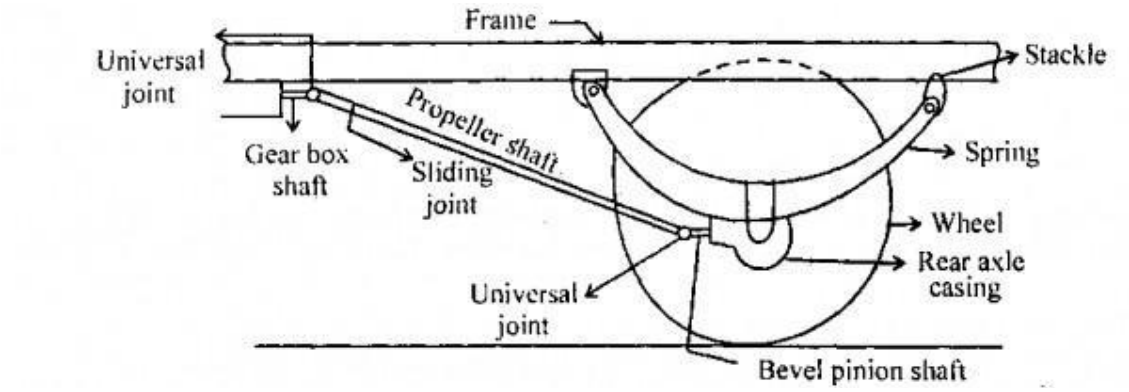
Detailed content of the Lecture:

Hotchkiss drive

- The Hotchkiss drive is a system of power transmission. It was the dominant form of power transmission for front-engine, rear-wheel drive layout cars in the 20th century. The name comes from the French automobile firm of Hotchkiss, although it is clear that other makers (such as Peerless) used similar systems before Hotchkiss.
- During the early part of the 20th century the two major competing systems of power transmission were the shaft-drive and chain-drive configurations. The Hotchkiss drive is a shaft- drive system (another type of direct-drive transmission system is the torque tube, which was also popular until the 1950s).
- All shaft-drive systems consist of a driveshaft (also called a "propeller shaft" or Cardan shaft) extending from the transmission in front to the differential in the rear. The differentiating characteristic of the Hotchkiss drive is the fact that it uses universal joints at

both ends of the driveshaft, which is not enclosed. The use of two universal joints, properly phased and with parallel alignment of the drive and driven shafts, allows the use of simple cross- type universals. (In a torque-tube arrangement only a single universal is used at the end of the transmission tail shaft, and this universal should be a constant velocity joint.)

- In the Hotchkiss drive, slip-splines or a plunge-type (ball and trunnion u-joint) eliminate thrust transmitted back up the driveshaft from the axle, allowing simple rear-axle positioning using parallel leaf springs. (In the torque-tube type this thrust is taken by the torque tube to the transmission and thence to the transmission and motor mounts to the frame. While the torque-tube type requires additional locating elements, such as a Panhard rod, this allows the use of coil springs.)



- Some Hotchkiss drive shafts are made in two pieces with another universal joint in the center for greater flexibility, typically in trucks and specialty vehicles built on truck frames. Some installations use rubber mounts to isolate noise and vibration. The 1984–1987 RWD Toyota Corolla (i.e., Corolla SR5 and GT-S) coupe is another example of a car that uses a 2-part Hotchkiss driveshaft with a rubber-mounted center bearing.
- This design was the main form of power transmission for most cars from the 1920s through the 1970s. Presently (circa 2012), it remains common in pick-up trucks, and sport utility vehicles.

Video Content / Details of website for further learning (if any):
https://autoparts.com/tranmission_drive.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997.

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LECTURE HANDOUTS

L-27

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **III**

Topic of Lecture: Torque Tube Drive

Introduction : (Maximum 5 sentences)

- A torque tube system is a driveshaft technology, often used in automobiles with a front engine and rear drive.
- It is not as widespread as the Hotchkiss drive, but is still occasionally used to this day. Drive shafts are sometimes also used for other vehicles and machinery

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Torque tube
- Hotchkiss drive

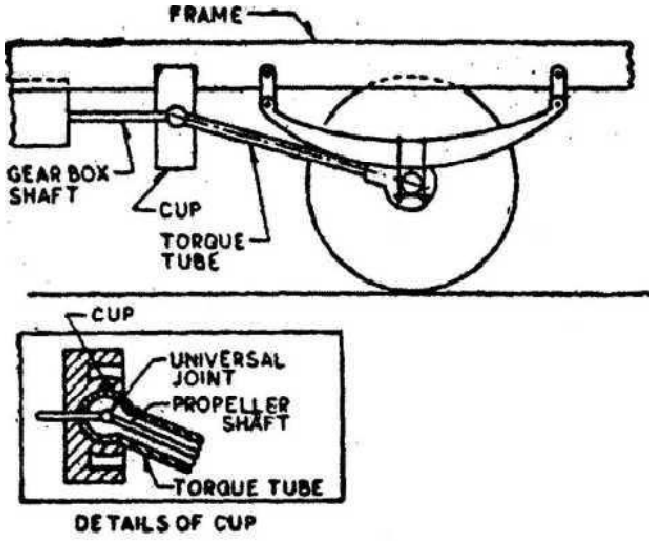
Detailed content of the Lecture:

Torque tube Drive

- A torque tube system is a driveshaft technology, often used in automobiles with a front engine and rear drive.
- It is not as widespread as the Hotchkiss drive, but is still occasionally used to this day. Drive shafts are sometimes also used for other vehicles and machinery.
- The "torque" that is referred to in the name is not that of the driveshaft, along the axis of the car, but that applied by the wheels.
- The design problem that the torque tube solves is how to get the traction forces generated by the wheels to the car frame.
- The "torque tube" transmits this force by directly coupling the axle differential to the transmission and therefore propels the car forward by pushing on the engine/transmission and then through the engine mounts to the car frame[citation needed].

using other suspension components such as leaf springs or trailing arms. A ball and socket type of joint called a "torque ball" is used at one end of the torque tube to allow relative motion between the axle and transmission due to suspension travel.

- Since the torque tube does not constrain the axle in the lateral (side-to-side) direction a pan hard rod is often used for this purpose.
- The combination of the pan hard rod and the torque tube allows the easy implementation of soft coil springs in the rear to give good ride quality.
- In addition to transmitting the traction forces, the torque tube is hollow and contains the rotating driveshaft.



- Inside the hollow torque ball is the universal joint of the driveshaft that allows relative motion between the two ends of the driveshaft.
- In most applications the drive shaft uses a single universal joint which has the disadvantage that it causes speed fluctuations in the driveshaft when the shaft is not straight.
- The Hotchkiss drive uses two universal joints which has the effect of canceling the speed fluctuations and gives a constant speed even when the shaft is no longer straight.

Video Content / Details of website for further learning (if any):
https://autoparts.com/tranmission_drive.html

Important Books/Journals for further learning including the page nos.:
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LECTURE HANDOUTS

L-28

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Steering Geometry and types

Introduction : (Maximum 5 sentences)

The steering arrangement is to turn the front wheels using a hand– operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints to allow it to deviate somewhat from a straight line.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Camber
- Toe in
- Toe out

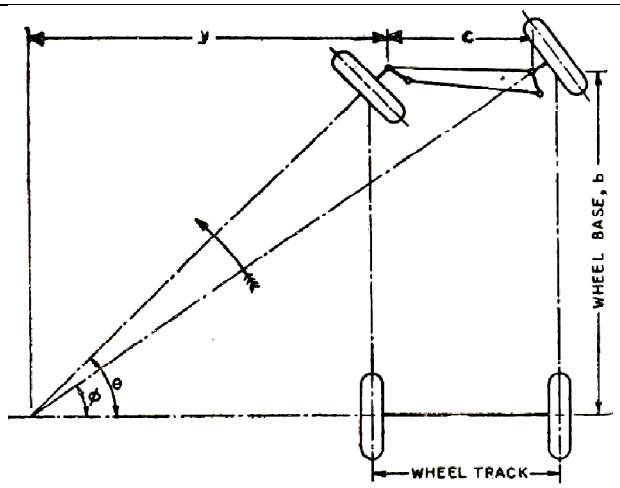
Detailed content of the Lecture:

- Steering is the collection of components, linkages, etc. which allow a vessel (ship, boat) or vehicle (car, motorcycle, and bicycle) to follow the desired course. An exception is the case of rail transport by which rail tracks combined together with railroad switches (and also known as 'points' in British English) provide the steering function.
- The most conventional steering arrangement is to turn the front wheels using a hand– operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints (which may also be part of the collapsible steering column design), to allow it to deviate somewhat from a straight line.
- Other arrangements are sometimes found on different types of vehicles, for example, a tiller or rear–wheel steering.

Steering Geometry:

Camber: Camber is the tilt of the car wheels from the vertical.

- Camber is positive if the tilt is outward at the top.



Correct steering angle.

Toe-in & Toe-out

- Toe in is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary
- Toe in = B – A.
- When the wheel may be set closer at the rear than at the front in which case the difference of the distances between the front wheels at the front and at the rear.

Two Stub axles pivoted to the axle beam at R and S known as kingpins.

- The stub axles are connected together by two short track arms and a track rod.
- The length between the kingpins is greater than the track rod length.
- This is to enable the inner wheels to displace through a greater angle than the outer.
- The Ackermann principle states that when a vehicle takes a bend, its wheels should make arcs round the same centre, i.e. the front wheels must move in relation to each other and the axes of front wheels should meet the axis of rear wheels at a point (Instantaneous Centre I).
- The fundamental condition for true steering is

$$\cot \phi - \cot \Theta = \text{Wheel Track / Wheel base}$$

- Ackermann steering mechanism gives correct steering for a) straight ahead position when $\Theta = \phi = 0^{o}$ and b) inside and outside 'Lock' angles.

Video Content / Details of website for further learning (if any):
https://www.edumech.co.uk/learn-about-steering

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 209-214.

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LECTURE HANDOUTS

L-29

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Power steering

Introduction : (Maximum 5 sentences)

The movement of the steering wheel turns the worm, which in turn drives the worm wheel. On wheel is further mounted the drop arm, which steers the road wheels through the link rod and the steering arms. The pinion is in mesh with a rack.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Worm
- Rack
- Pinion

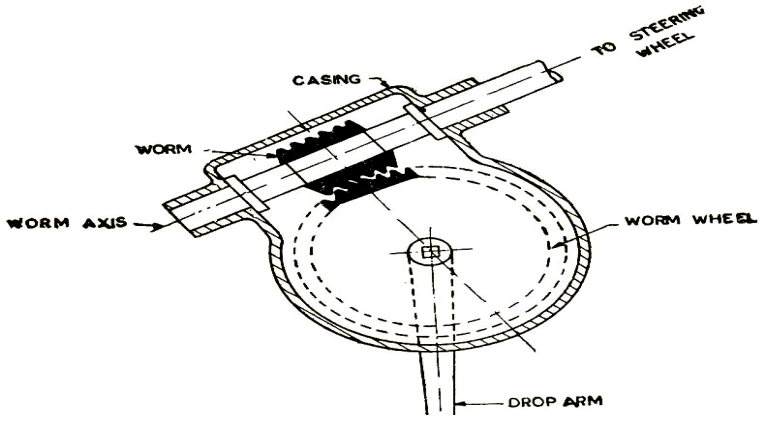
Detailed content of the Lecture:

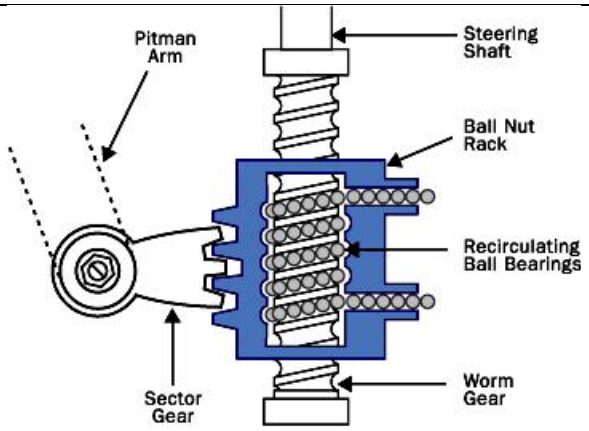
Worm and Wheel steering Gear:

• The movement of the steering wheel turns the worm, which in turn drives the worm wheel.

• Drop arm is rigidly attached to the wheel spindle.

• Therefore, a rotation of the steering wheel corresponds to a linear motion of the drop arm end, which is connected to the link rod





Recirculating Ball Type steering Gear:

• Consists of a worm at the end of steering rod.

• A nut is mounted on the worm with two sets of balls in the grooves of the worm in between nut and the worm.

• The balls reduce the friction during the movement of the nut on the worm.

• The nut has a number of teeth on the outside.

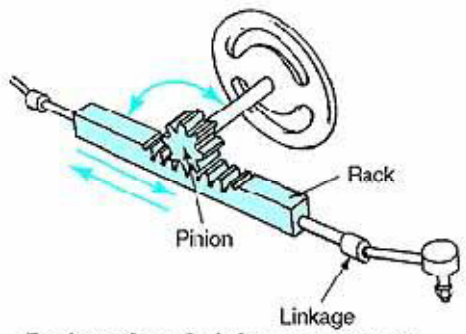
• The nut meshes with the teeth on a worm wheel sector.

• On wheel is further mounted the drop arm, which steers the road wheels through the link rod and the steering arms.

Rack and Pinion steering Gear:

• The rotary motion of the steering wheel is transmitted to the pinion on the steering gear through universal joints.

• The pinion is in mesh with a rack.



Basic rack and pinion components

Video Content / Details of website for further learning (if any):
https://dir.indiamart.com/impcat/steering-gearboxes.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 230-234.

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LECTURE HANDOUTS

L-30

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Front Axle - Types

Introduction : (Maximum 5 sentences)

In automobiles, power steering (also known as power assisted steering (PAS) or steering assist system) helps drivers steer by augmenting steering effort of the steering wheel.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Fluid Mechanics
- Rack and Pinion
- Control valve

Detailed content of the Lecture:

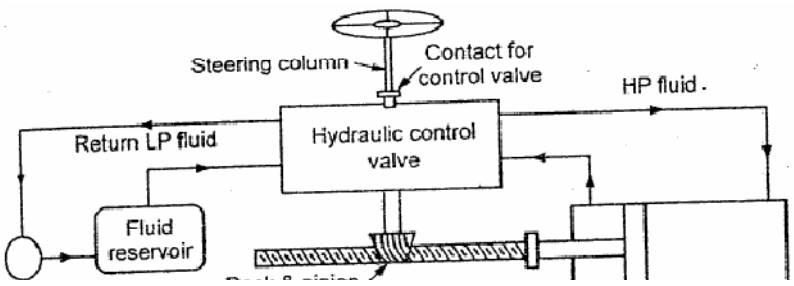
Large amount of torque is required to be applied by the driver for steering of medium and heavy vehicles.

• The power steering systems provides automatic hydraulic assistance to the turning effort applied to the manual steering system.

• The power system is designed to become operative when the effort at wheel exceeds a predetermined value.

• The system is always so designed that in the event of the failure of the power system, the driver is able to steer the vehicle manually although with increased effort.

• The power steering systems are operated by fluid under pressure. (7 MPa)



Principle of Working:

• The slight movement of the slight movement of the steering wheel actuates a valve so that the fluid under pressure from the reservoir enters on the appropriate side of a cylinder, thereby applying pressure on one side of a piston to operate the steering linkage, which steers the wheel in the appropriate direction.

• There are a couple of key components in power steering in addition to the rack and- pinion or recirculating-ball mechanism.

Pump:

• The hydraulic power for the steering is provided by a rotary-vane pump. This pump is driven by the car's engine via a belt and pulley. It contains a set of retractable vanes that spin inside an oval chamber.

Integral Power Steering:

- Power steering assembly is an integral part of the steering gear.
- Consists of a hydraulic pump assembly and a steering gear assembly connected by means of hoses.
- A rotary valve power steering gear for the integral system using recirculating ball type worm and wheel steering gear is normally used.
- The steering wheel is connected to the right end of the torsion bar through the steering shaft.
- The other end of the torsion bar is connected to the worm and also to the spool about which the rotary valve is centered.
- When the driver applies a force on the Steering wheel to steer, the far end of the torsion bar, being connected to the spool of the rotary valve and worm offers resistance.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=F6dFueN8EOI

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 239-244.

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LECTURE HANDOUTS

L-31

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Suspension System - Types

Introduction : (Maximum 5 sentences)

Conventionally front axle is a dead axle. For good steering, handling and vehicle stability, it is also necessary that rear wheels should follow the front wheels properly. This condition occurs if all the four wheels are parallel to the frame. This is called tracking.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Steering arm
- Steering pin
- beam

Detailed content of the Lecture:

Front Axle:

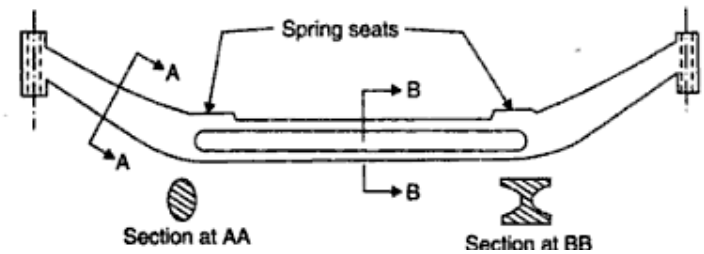
• Conventionally front axle is a dead axle

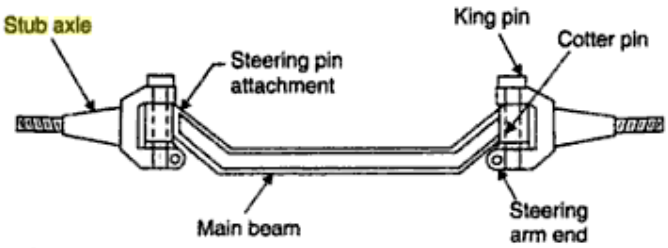
• For four wheel drive vehicles and most of the cars, it is a live axle.

• Drop forging steel is used to mfr. dead axle. (0.4% Carbon steel or 1.3% Ni Steel)

• The axle has to take bending loads due to weight of the vehicle and torque loads due to braking of the wheels.

• Made of 'I' section in mid portion, while the ends are made either circular or elliptical.





A downward sweep is given to the centre portion to keep a low chassis height.

• The main axle beam is connected to the stub axles by means of king pins.

• The front road wheels are mounted on these stub axles.

• Stub axles can have any of the four shapes

– Elliot type

– Reversed Elliot Type

– Lamoine Type

– Reversed Lamoine Type

• Stub axles are made of 3% Ni steel and alloy steel containing Cr and Mo.

Wheel Alignment

• Positioning of the steered wheels to achieve

– Directional stability during straight ahead position

– Perfect rolling condition on steering

– Recovery after completing the turn.

• Factors of Wheel Alignment:

– Factors pertaining to wheels: a) Balance of wheels, b) Inflation of tyres,

c) Brake adjustment.

– Steering Geometry

– Steering linkages

– Suspension System

• For good steering, handling and vehicle stability, it is also necessary that rear wheels should follow the front wheels properly.

• This condition occurs if all the four wheels are parallel to the frame This is called tracking.

Video Content / Details of website for further learning (if any):
https://siamagazin.com/man-hydrodrive-front-axle-drive-working-principles/

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 205-206.

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LECTURE HANDOUTS

L-32

MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Pneumatic Braking systems

Introduction : (Maximum 5 sentences)

Suspension system is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels. It is basically cushioned for passengers protect the luggage or any cargo and also itself from damage and wear.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Compression
- Tension
- Shear

Detailed content of the Lecture:

Objects of suspension:

- To prevent the road shocks from being transmitted to the vehicle components
- To safeguard the occupants from road shocks
- To preserve the stability of the vehicle in pitching or rolling, while in motion.

BASIC CONSIDERATIONS:

Vertical Loading: due to bump or pit on the road

Rolling: due to the centre of gravity of the vehicles is considerably above the ground, which causes the centrifugal force acts outwards on the C.G. of vehicle while taking the turns.

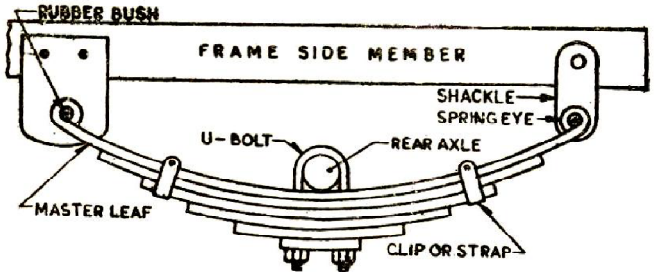
Brake Dip: on braking, the vehicle has a tendency to be lowered or to dip, which based on the C.G., wheel base and other suspension characteristics.

Side Thrust: Due to cornering, cross winds, cambering of the road etc.

Miscellaneous: Pitching, Yawing, etc.

Functions of Suspension Springs:

- Expending the energy by rebounding.



Rear Leaf Spring.

Types of Suspension springs:

1. Steel Springs:
   - Leaf spring
   - Tapered Leaf Spring
   - Coil Spring
   - Torsion bar
2. Rubber Springs:
   - Compression shear spring
   - Torsion shear spring
3. Plastic Spring
4. Air Spring
5. Hydraulic Spring

Types of Leaf Springs

- The quarter elliptic type was used earlier
- Most widely used type is semi-elliptic type

Tapered Leaf Springs:

- Another name is Taper lite springs
- No collection of moisture between the leaves and hence no fretting fatigue.

Coil Springs:

- Used in independent suspension
- A helper coil spring is also sometimes used to provide stiffness against increasing load.

Video Content / Details of website for further learning (if any):
https://gomechanic.in/blog/car-suspension-explained/

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 168-204.

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LECTURE HANDOUTS

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III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Hydraulic Braking Systems

Introduction : (Maximum 5 sentences)

Brakes are applied on the running wheels to stop the vehicle.

• A moving vehicle possesses kinetic energy which is converted into heat energy on the application of brakes.

• The heat is transferred to the surrounding air.

• When the driver applies force on the brake pedal which gets amplified and pushes the stationary shoe to make contact with the rotating brake drum and stops its rotation due to frictional resistance.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Drum
- Disk
- Shoe

Detailed content of the Lecture:

Requirements of Brakes:

– To bring the vehicle to a relatively quick stop on any type of road.

– Components should require minimum maintenance.

– Minimum effort should be required for braking

– Allows minimum time between application of brake pedal and braking effect on the drum.

– Should not involve any noise; drift the vehicle away from its desired path.

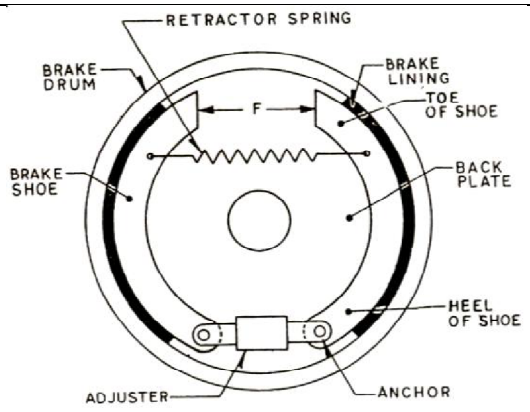
– Provision for quick heat dissipation must be incorporated.

– A secondary braking system must be incorporated, should the primary braking system fail.

Functions of the Brakes:

– To stop or slow down the vehicle in the shortest possible distance in emergencies

– To control the vehicle to be retained when descending a hill (Dissipate large quantities of heat



Drum type brakes.

Hydraulic systems:

• When you step on the brake pedal, you expect the vehicle to stop.

• The brake pedal operates a hydraulic system that is used for two reasons.

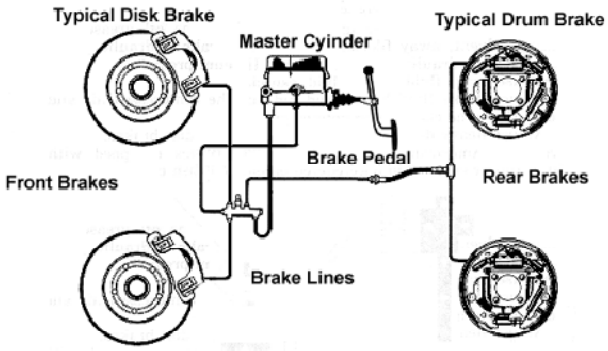
• First, fluid under pressure can be carried to all parts of the vehicle by small hoses or metal lines without taking up a lot of room or causing routing problems.

• Second, the hydraulic fluid offers a great mechanical advantage-little foot pressure is required on the pedal, but a great deal of pressure is generated at the wheels.

• The brake pedal is linked to a piston in the brake master cylinder, which is filled with hydraulic brake fluid.

• The master cylinder consists of a cylinder containing a small piston and a fluid reservoir.

• Modern master cylinders are actually two separate cylinders. Such a system is called a dual circuit, because the front cylinder is connected to the front brakes



Typical Automotive Braking System

Video Content / Details of website for further learning (if any):
https://www.mechanicalbooster.com/2017/12/air-brake-system.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 309-371.

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LECTURE HANDOUTS

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MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Antilock Braking System

Introduction : (Maximum 5 sentences)

Anti-lock Braking Systems (ABS) are designed to prevent locked-wheel skidding during hard braking or during braking on slippery surfaces.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Permanent Magnet
- Reducer
- Pick up Coil

Detailed content of the Lecture:

The front wheels of a vehicle cannot apply steering force if they are locked and sliding; the vehicle will continue in its previous direction of travel.

• The four wheel anti-lock brake systems found on many of today's vehicles hold the wheels just below the point of locking, thereby allowing some steering response and preventing the rear of the vehicle from sliding sideways while braking.

• The Rear Wheel Anti-Lock (RWAL) systems used primarily on trucks and vans is designed to prevent the rear wheels from locking up during severe braking.

• Especially since these vehicles are often designed to carry heavy loads, the rear brakes can be very touchy when the truck or van is unloaded.

• RWAL systems usually utilize a load sensing mechanism to adjust the sensitivity of the system to compensate for heavy or no load situations.

• There are conditions for which the ABS system provides no benefit.

• Debris, gravel, snow or sheets of ice render the ABS system ineffective since it relies on an underlying amount of road traction, which is not available when driving on gravel, excessive debris,

• Hydroplaning is possible when the tires ride on a film of water, losing contact with the paved surface.

• This renders the vehicle totally uncontrollable until road contact is regained.

• Extreme steering maneuvers at high speed or cornering beyond the limits of tire adhesion can result in skidding which is independent of vehicle braking.

• For this reason, the system is named anti-lock rather than anti-skid.

• Under normal braking conditions, the ABS system functions in the same manner as a standard brake system.

• The system is a combination of electrical and hydraulic components, working together to control the flow of brake fluid to the wheels when necessary.

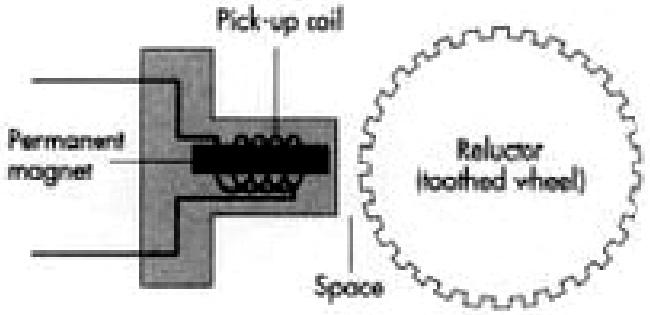
• The anti-lock brake system's Electronic Control Unit (ECU) is the electronic brain of the system, receiving and interpreting speed signals from the speed sensors.

• The ECU will enter anti-lock mode when it senses impending wheel lock at any wheel and immediately control the brake line pressure(s) to the affected wheel(s).

• The hydraulic actuator assembly is separate from the master cylinder and booster.

• It contains the wheel circuit valves used to control the brake fluid pressure to each wheel circuit.

• If the ABS becomes inoperative for any reason, the fail-safe system insures that the normal braking system is operative. The dashboard warning lamp is activated to show that the ABS is disabled.



Speed Censor Circuit

Video Content / Details of website for further learning (if any):
https://www.mechanicalbooster.com/2017/08/anti-lock-braking-system.html

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-381.

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LECTURE HANDOUTS

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MECH

III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Electronic brake force distribution (EBD)

Introduction : (Maximum 5 sentences)

Recent versions not only prevent wheel lock under braking, but also electronically control the front-to-rear brake bias. This function, depending on its specific capabilities and implementation, is known as electronic brake force distribution(EBD)

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Control unit
- Brake force
- pulse

Detailed content of the Lecture:

Controller

The controller is an ECU type unit in the car which receives information from each individual wheel speed sensor, in turn if a wheel loses traction the signal is sent to the controller, the controller will then limit the brake force (EBD) and activate the modulator which actuates the braking valves on and off.

Use

There are many different variations and control algorithms for use in ABS. One of the simpler systems works as follows,

The controller monitors the speed sensors at all times. It is looking for decelerations in the wheel that are out of the ordinary. Right before wheel locks up, it will experience a rapid deceleration.

If left unchecked, the wheel would stop much more quickly than any car could. It might take a car five seconds to stop from 60 mph (96.6 km/h) under ideal conditions, but a wheel that locks up could stop spinning in less than a second.

The ABS controller knows that such a rapid deceleration is impossible, so it reduces the pressure to

can do this very quickly, before the tire can actually significantly change speed. The result is that the tire slows down at the same rate as the car, with the brakes keeping the tires very near the point at which they will start to lock up. This gives the system maximum braking power.

This replaces the need to manually pump the brakes while driving on a slippery or a low traction surface, allowing steering even in the most emergency braking conditions.

When the ABS is in operation the driver will feel a pulsing in the brake pedal; this comes from the rapid opening and closing of the valves. This pulsing also tells the driver that the ABS has been triggered. Some ABS systems can cycle up to 16 times per second.

Video Content / Details of website for further learning (if any):

https://www.autoguide.com/auto-news/2019/01/what-is-electronic-brake-force-distribution-ebd-.html

Important Books/Journals for further learning including the page nos.:

Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-381.

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III / V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **IV**

Topic of Lecture: Traction Control

Introduction : (Maximum 5 sentences)

A traction control system (TCS), is typically (but not necessarily) a secondary function of the anti-lock braking system (ABS) on production motor vehicles, designed to prevent loss of traction of driven road wheels. TCS is activated when throttle input and engine torque are mismatched to road surface conditions.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Brake force
- Throttle
- Over steer

Detailed content of the Lecture:

Intervention consists of one or more of the following:

 Brake force applied to one or more wheels

 Reduction or suppression of spark sequence to one or more cylinders

 Reduction of fuel supply to one or more cylinders

 Closing the throttle, if the vehicle is fitted with drive by wire throttle

 In turbocharged vehicles, a boost control solenoid is actuated to reduce boost and therefore engine power.

Typically, traction control systems share the electro hydraulic brake actuator (which does not use the conventional master cylinder and servo) and wheel speed sensors with ABS.

Operation:

 When the traction control computer (often incorporated into another control unit, like the anti-lock braking system module) detects one or more drive wheels spinning significantly faster than another, it

 This braking action on the slipping wheel(s) will cause power to be transferred to the wheels that are not due to the mechanical action within a differential, all wheel drive vehicles also often have an electronically controlled coupling system in the transfer case or transaxle that is engaged (in an active part time AWD), or locked up tighter (in a true full-time set up that drives all the wheels with some power all the time) to supply the non-slipping wheels with (more) torque.

 This often occurs in conjunction with the power train computer reducing available engine torque by electronically limiting throttle application and/or fuel delivery, retarding ignition spark, completely shutting down engine cylinders, and a number of other methods, depending on the vehicle and how much technology is used to control the engine and transmission.

Traction Control in Cornering

 Traction control is not just used for improving acceleration under slippery conditions. It can also help a driver to corner more safely.

 If too much throttle is applied during cornering, the drive wheels will lose traction and slide sideways. This occurs as understeer in front wheel drive vehicles and oversteers in rear wheel drive vehicles. Traction control can prevent this from happening by limiting power to the wheels.

 It cannot increase the limits of grip available and is used only to decrease the effect of driver error or compensate for a driver's inability to react quickly enough to wheel slip. Automobile manufacturers state in vehicle manuals that traction control systems should not encourage dangerous driving or encourage driving in conditions beyond the drivers' control.

Video Content / Details of website for further learning (if any):
https://mycardoeswhat.org/safety-features/traction-control/

Important Books/Journals for further learning including the page nos.:
Kirpal Singh., "Automobile Engineering", Vol 1 & 2, Seventh Edition", Standard Publishers, New Delhi, 1997. Page No. 380-384.

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LECTURE HANDOUTS

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Use of Natural Gas, LPG in Automobiles

Introduction:

Alternative fuels, known as non-conventional or advanced fuels, are any materials or substances that can be used as fuels, other than conventional fuels. Conventional fuels include: fossil fuels (petroleum (oil), coal, propane, and natural gas), as well as nuclear materials such as uranium and thorium, as well as artificial radioisotope fuels that are made in nuclear reactors**.**

Prerequisite knowledge for Complete understanding and learning of Topic:

This mixture may also not be purified by simple distillation, as it forms an azeotropic mixture. Biobutanol has the advantage in combustion engines in that its energy density is closer to gasoline than the simpler alcohols (while still retaining over 25% higher octane rating); however, biobutanol is currently more difficult to produce than ethanol or methanol. When obtained from biological materials and/or biological processes, they are known as bio alcohols (e.g. "bioethanol"). There is no chemical difference between biologically produced and chemically produced alcohols.

Detailed content of the Lecture:

4.2 Types:

- Alcohols
- Vegetable oils
- Bio-diesel
- Bio-gas
- Natural Gas

- Hydrogen

4.3 Alcohols

Alcohol has been used as a fuel. The first four aliphatic alcohols (methanol, ethanol, propanol, and butanol) are of interest as fuels because they can be synthesized chemically or biologically, and they have characteristics which allow them to be used in internal combustion engines. The general chemical formula for **alcohol fuel is $C_nH_{2n+1}OH$.**

Most methanol are produced from natural gas, although it can be produced from biomass using very similar chemical processes. Ethanol is commonly produced from biological material through fermentation processes. This mixture may also not be purified by simple distillation, as it forms an azeotropic mixture. Biobutanol has the advantage in combustion engines in that its energy density is closer to gasoline than the simpler alcohols (while still retaining over 25% higher octane rating); however, biobutanol is currently more difficult to produce than ethanol or methanol. When obtained from biological materials and/or biological processes, they are known as bio alcohols (e.g. "bioethanol"). There is no chemical difference between biologically produced and chemically produced alcohols.
One advantage shared by the four major alcohol fuels is their high octane rating. This tends to increase their fuel efficiency and largely offsets the lower energy density of vehicular alcohol fuels (as compared to petrol/gasoline and diesel fuels), thus resulting in comparable "fuel economy" in terms of distance per volume metrics, such as kilometres per liter, or miles per gallon.

Advantages

- Is cheaper and more efficient and does not damage environment as much.
- Made from a renewable energy source, corn in the US, sugar cane in Brazil, or anything else that can produce ethanol.
- It reduces certain greenhouse emissions, CO and UHC's
- Higher octane rating, engine can have higher compression

Disadvantages

- Less energy content, it has 1/3 less energy than gasoline
- Emits cancer causing emissions 40x more than gasoline. Acetaldehyde, and formaldehyde.
- Takes more energy to produce that it you get out. only 83% back.

Material incapability.

- Ethanol destroys aluminium, rubber, gaskets, and many other things, so special materials are used in FFV's and to transport it.
- May corrode parts of engine, you may have to fill in more often as alcohol

runs out quickly.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=zKA4TYMgiqU

Important Books/Journals for further learning including the page nos.:

R.K.Rajbut, “Internal Combustion Engines”, Lakshmi Publications of India LTD,Chennai, ISBN 81-7008-637-X.Pg No 32- 35.

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LECTURE HANDOUTS

MECH | **III/V**

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Use of Biodiesel, Bio ethanol

Introduction:

Hydrogen fuel is a zero-emission fuel which uses electrochemical cells or combustion in internal engines, to power vehicles and electric devices. It is also used in the propulsion of spacecraft and can potentially be mass-produced and commercialized for passenger vehicles and aircraft.

Prerequisite knowledge for Complete understanding and learning of Topic:

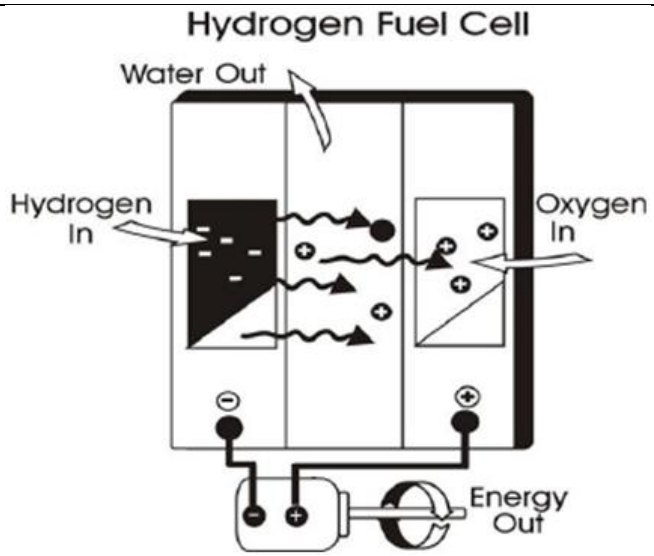
Hydrogen is one of two natural elements that combine to make water. Hydrogen is not an energy source, but an energy carrier because it takes a great deal of energy to extract it from water. It is useful as a compact energy source in fuel cells and batteries.

Detailed content of the Lecture:

Hydrogen fuel is a zero-emission fuel which uses electrochemical cells or combustion in internal engines, to power vehicles and electric devices. It is also used in the propulsion of spacecraft and can potentially be mass-produced and commercialized for passenger vehicles and aircraft.

Hydrogen is one of two natural elements that combine to make water. Hydrogen is not an energy source, but an energy carrier because it takes a great deal of energy to extract it from water. It is useful as a compact energy source in fuel cells and batteries.

Hydrogen is the lightest and most abundant element in the universe. It can be produced from a number of feedstock's in a variety of ways. The production method thought to be most environmentally benign is the electrolysis of water, but



gas. Once produced, hydrogen can be stored as a gas, liquid, or solid and distributed as required. Liquid storage is currently the preferred method, but it is very costly. Hydrogen-powered vehicles can use internal combustion engines or fuel cells. They can also be hybrid vehicles of various combinations. When hydrogen is used as a gaseous fuel in an internal combustion engine, its very low energy density compared to liquid fuels is a major drawback requiring greater storage space for the vehicle to travel a similar distance to gasoline

Advantages:

- Emits only water vapour, assuming there is no leakage of hydrogen gas
- It can store up to 3x as much energy as conventional natural gas.

Disadvantages:

- Leakage of H gas (see above) will have detrimental impacts on the stratosphere (California Institute of Technology)
- Production of hydrogen gas currently relies on natural gas and electrolysis and to replace all the vehicles would require 10x as much as currently is used
- Storage is really tough because hydrogen is such a low density gas
- Distribution and infrastructure needs to be refurbished to cope with hydrogen, which can metals by making them brittle
- Use in fuel cells requires catalysts, which usually require a component metal (most often platinum). Platinum is extremely rare, expensive and environmentally unsound to produce.

Video Content / Details of website for further learning (if any): NIL

Important Books/Journals for further learning including the page nos.:

Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2001. Pg no (4-6).

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LECTURE HANDOUTS

MECH | **III/V**

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Gasohal Hydrogen in Automobiles

Introduction:

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other hydrocarbons, carbon dioxide, nitrogen and hydrogen sulfide. Natural gas is an energy source often used for heating, cooking, and electricity generation. It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals

Prerequisite knowledge for Complete understanding and learning of Topic:

Natural gas is found in deep underground natural rock formations or associated with other hydrocarbon reservoirs in coal beds and as methane clathrates. Petroleum is also another resource found in proximity to and with natural gas. Most natural gas was created over time by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material.

Detailed content of the Lecture:

Natural gas is an energy source often used for heating, cooking, and electricity generation. It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals.

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other hydrocarbons, carbon dioxide, nitrogen and hydrogen sulfide

is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material.

Advantages:

- Natural gas (largely methane) burns more cleanly than the other fossil fuels (45% less carbon dioxide emitted than coal and 30% less than oil)
- It is easily transported via pipelines and fairly easily using tankers (land and sea)
- It can be piped into homes to provide heating and cooking and to run a variety of appliances.
- Where homes are not piped, it can be supplied in small tanks.
- It can be used as a fuel for vehicles (cars, trucks and jet engines) where it is cleaner than gasoline or diesel.
- It is used to produce ammonia for fertilizers, and hydrogen, as well as in the production of some plastics and paints.
- It's relatively abundant, clean burning and seems easy to distribute.
- It's also lighter than air, so if there is a leak it will tend to dissipate, unlike propane, which is heavier than air and pools into explosive pockets.
- It can be used for heating, cooking, hot water, clothes dryer, backup generator power, and so forth.
- Some places will supply it to your house by way of underground pipes.
- Natural gas is more economical than electricity,
- It is faster when used in cooking and water heating and most gas appliances are cheaper than electrical ones.
- Gas appliances also do not create unhealthy electrical fields in your house.

Disadvantages:

- Even though it is cleaner than coal and oil, it still contributes a large amount of carbon dioxide to greenhouse gases.
- By itself natural gas is mostly methane, which is 21 times more dangerous for greenhouse warming than carbon dioxide so any leakage of the gas (from animals, landfills, melting tundra, etc.) contributes strongly to greenhouse emissions.
- If your house is not properly insulated it can be very expensive.
- It can leak, potentially causing an explosion.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=zKA4TYMgiqU

Important Books/Journals for further learning including the page nos.:

R.K.Rajbut, “Internal Combustion Engines”, Lakshmi Publications of India LTD,Chennai, ISBN 81-7008-637-X.Pg No 32- 35.

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LECTURE HANDOUTS

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Engine Modifications, Performance, Combustion Characteristics in S.I Engines

Introduction:

Vegetable oil is an alternative fuel for diesel engines and for heating oil burners.For engines designed to burn diesel fuel, the viscosity of vegetable oil must be lowered to allow for proper atomization of the fuel; otherwise incomplete combustion and carbon build up will ultimately damage the engine.

Prerequisite knowledge for Complete understanding and learning of Topic:

This type of fuel is better for the atmosphere because, unlike other fuels, it does not give off harmful chemicals which can influence the environment negatively. The popularity of biodiesel fuel is consistently increasing as people search out alternative energy resources.

Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat with an alcohol producing fatty acid esters.

Detailed content of the Lecture:

Benefits of vegetable oil run vehicles:

- CO2 neutral
- Economical, cheaper than diesel
- Excellent system-energy efficiency (from raw "crude" to refined product)
- Sulphur-free
- Protects crude oil resources
- 100% biodegradable

- Low fire hazard (flashpoint > 220°C)
- Practical to refuel at home
- Easy to store, more ecological than bio-diesel
- A chance for the farming community and agriculture

Disadvantages of vegetable oil run vehicles:

- Loss of space and/or vehicle load capacity due to additional fuel storage
- Loss of manufacturer guarantee in new vehicles for use of an alternative fuel
- Motor oil needs to be replaced more often in a direct injection engine as a safety precaution to avoid build-up
- Currently no public network of filling stations are available, must refuel at home

Biodiesel

Fuel that is made from natural elements such as plants, vegetables, and reusable materials. This type of fuel is better for the atmosphere because, unlike other fuels, it does not give off harmful chemicals which can influence the environment negatively. The popularity of biodiesel fuel is consistently increasing as people search out alternative energy resources.

Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat with an alcohol producing fatty acid esters.

Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with petro diesel. Biodiesel can also be used as a low carbon alternative to heating oil.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=zKA4TYMgiqU

Important Books/Journals for further learning including the page nos.:

R.K.Rajbut, “Internal Combustion Engines”, Lakshmi Publications of India LTD,Chennai, ISBN 81-7008-637-X.Pg No 32- 35.

MUTHAYAMMAL ENGINEERING COLLEGE

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L-41,42

LECTURE HANDOUTS

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Performance, Combustion Characteristics in C.I Engines with alternate fuels

Introduction:

Liquefied petroleum gas, also called LPG, GPL, LP Gas, liquid petroleum gas or simply propane or butane, is a flammable mixture of hydrocarbon gases used as a fuel in heating appliances and vehicles. LPG is prepared by refining petroleum or "wet" natural gas, and is almost entirely derived from fossil fuel sources, being manufactured during the refining of petroleum (crude oil), or extracted from petroleum or natural gas streams as they emerge from the ground. **LPG is a mixture of propane and butane (this is called autogas).**

Prerequisite knowledge for Complete understanding and learning of Topic:

There is reduction in power output for LPG operation than gasoline operation.

- Starting load on the battery for an LPG engine is higher than gasoline engine due to higher ignition system energy required.
- LPG system requires more safety. In case of leakage LPG has tendency to accumulate near ground as it is heavier than air.
- This is hazardous as it may catch fire.
- Volume of LPG required is more by 15 to 20% as compared to gasoline.
- LPG operation increases durability of engine and life of exhaust system is increased.

Detailed content of the Lecture:

Relative fuel consumption of LPG is about ninety percent of that of gasoline by volume.

- LPG has higher octane number of about 112, which enables higher

 Due to gaseous nature of LPG fuel distribution between cylinders is improved and smoother acceleration and idling performance is achieved.

 Fuel consumption is also better.

 Engine life is increased for LPG engine as cylinder bore wear is reduced & combustion chamber and spark plug deposits are reduced.

 As LPG is stored under pressure, LPG tank is heavier and requires more space than gasoline tank.

 There is reduction in power output for LPG operation than gasoline operation.

 Starting load on the battery for an LPG engine is higher than gasoline engine due to higher ignition system energy required.

 LPG system requires more safety. In case of leakage LPG has tendency to accumulate near ground as it is heavier than air.

 This is hazardous as it may catch fire.

 Volume of LPG required is more by 15 to 20% as compared to gasoline.

 LPG operation increases durability of engine and life of exhaust system is increased.

 LPG has lower carbon content than gasoline or diesel and produces less CO2which plays a major role in global warming during combustion.

The normal components of LPG are propane (C3H8) and butane (C4H10).
Small concentrations of other hydrocarbons may also be present.
Methane - 0%, Ethane - 0.20%, Propane - 57.30%,Butane - 41.10%, Pentane - 1.40%

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=zKA4TYMgiqU

Important Books/Journals for further learning including the page nos.:

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LECTURE HANDOUTS

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Electric Vehicles

Introduction:

Liquefied petroleum gas, also called LPG, GPL, LP Gas, liquid petroleum gas or simply propane or butane, is a flammable mixture of hydrocarbon gases used as a fuel in heating appliances and vehicles. LPG is prepared by refining petroleum or "wet" natural gas, and is almost entirely derived from fossil fuel sources, being manufactured during the refining of petroleum (crude oil), or extracted from petroleum or natural gas streams as they emerge from the ground. .

Prerequisite knowledge for Complete understanding and learning of Topic:

Relative fuel consumption of LPG is about ninety percent of that of gasoline by volume.

- LPG has higher octane number of about 112, which enables higher compression ratio to be employed and gives more thermal efficiency.
- Due to gaseous nature of LPG fuel distribution between cylinders is improved and smoother acceleration and idling performance is achieved.
- Fuel consumption is also better

Detailed content of the Lecture:

LPG operation increases durability of engine and life of exhaust system is increased.

- LPG has lower carbon content than gasoline or diesel and produces less CO2which plays a major role in global warming during combustion.

Methane - 0%

Ethane - 0.20%

Propane - 57.30%

Butane - 41.10%

Pentane - 1.40%

Advantages

- LPG is cheaper than petrol (up to 50%)
- It produces less exhaust emissions than petrol
- It is better for the engine and it can prolong engine life
- In some vehicles, it can provide better performance
- Has a higher octane rating than petrol (108 compared to 91).

Disadvantages

- It isn't highly available
- The initial cost for converting your vehicle to LPG can cost up to $3000. However the average car can repay the cost of the conversion in about 2 years
- It has a lower energy density than petrol
- No new passenger cars come readily fitted with LPG (they have to be converted)
- The gas tank takes up a considerable amount of space in the car boot

Video Content / Details of website for further learning (if any):
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LECTURE HANDOUTS

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Hybrid Vehicles

Introduction:

Fuel that is made from natural elements such as plants, vegetables, and reusable materials. This type of fuel is better for the atmosphere because, unlike other fuels, it does not give off harmful chemicals which can influence the environment negatively. The popularity of biodiesel fuel is consistently increasing as people search out alternative energy resources..

Prerequisite knowledge for Complete understanding and learning of Topic:

Biogas typically refers to a gas produced by the breakdown of organic matter in the absence of oxygen. It is a renewable energy source, like solar and wind energy. Furthermore, biogas can be produced from regionally available raw materials and recycled waste and is environmentally friendly and CO2 neutral.

Detailed content of the Lecture:

Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. Biogas comprises primarily methane (CH4) and carbon dioxide (CO2) and may have small amounts of hydrogen sulphide (H2S), moisture and siloxanes.

The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can

Advantages of Biogas Energy

- It's a renewable source of energy.
- It's a comparatively lesser pollution generating energy.
- Biomass energy helps in cleanliness in villages and cities.
- It provides manure for the agriculture and gardens.
- There is tremendous potential to generate biogas energy.
- Biomass energy is relatively cheaper and reliable.
- It can be generated from everyday human and animal wastes, vegetable and agriculture left-over etc.
- Recycling of waste reduces pollution and spread of diseases.
- Heat energy that one gets from biogas is 3.5 times the heat from burning wood.
- Because of more heat produced the time required for cooking is lesser.

Disadvantages of Biogas Energy

- Cost of construction of biogas plant is high, so only rich people can use it.
- Continuous supply of biomass is required to generate biomass energy.
- Some people don't like to cook food on biogas produced from sewage waste.
- Biogas plant requires space and produces dirty smell.
- Due to improper construction many biogas plants are working inefficiently.
- It is difficult to store biogas in cylinders.
- Transportation of biogas through pipe over long distances is difficult.
- Many easily grown grains like corn, wheat are being used to make ethanol. This can have bad consequences if too much of food crop is diverted for use as fuel.
- Crops which are used to produce biomass energy are seasonal and are not available over whole year.

Video Content / Details of website for further learning (if any):
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Important Books/Journals for further learning including the page nos.:

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LECTURE HANDOUTS

MECH

III/V

Course Name with Code : **19MEC08 & Automobile Engineering**

Course Faculty : **Dr.T.Yuvaraj**

Unit : **V**

Topic of Lecture : Fuel Cells

Introduction:

Hydrogen fuel has higher brake thermal efficiency and even can operate at lower engine loads with better efficiency. It can be noticed that brake thermal efficiency is improved to about 31 percentage with hydrogen fuelled engine compared to gasoline fuelled engine. Comparison of brake thermal efficiency of the fuels is shown in Fig. Here brake thermal efficiency of hydrogen is much better than the brake thermal efficiency of gasoline engine even at a low speed.

Prerequisite knowledge for Complete understanding and learning of Topic:

NOx levels of both engines. Significant decrease in NOx emission is observed with hydrogen operation. Almost 10 times decrease in NOx can be noted, easily. The cooling effect of the water sprayed plays important role in this reduction. Also operating the engine with a lean mixture is kept NOx levels low.

Detailed content of the Lecture:

4.17 Engine Design modification for all other Alternative Fuels

Spark plugs

Use cold rated spark plugs to avoid spark plug electrode temperatures exceeding the auto-ignition limit and causing backfire. Cold rated spark plugs can be used since there are hardly any spark plug deposits to burn o□.

Ignition system

Avoid uncontrolled ignition due to residual ignition energy by properly grounding the ignition system or changing the ignition cable's electrical resistance. Alternatively,

Injection system

Provide a timed injection, either using port injection and programming the injection timing such that an initial air cooling period is created in the initial phase of the intake stroke and the end of injection is such that all fuel is inducted, leaving no fuel in the manifold when the intake valve closes; or using direct injection during the compression stroke.

Hot spots

Avoid hot spots in the combustion chamber that could initiate pre-ignition or backfire.

Compression ratio

The choice of the optimal compression ratio is similar to that for any fuel, it should be chosen as high as possible to increase engine e□ciency, with the limit given by increased heat losses or appearance of abnormal combustion (in the case of fuel primarily pre-ignition).

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=zKA4TYMgiqU

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