

# ME 161

## Introduction to Mechanical Engineering

### Lec Note 2: Brig Gen Humayun

Please go through class notes and reference materials discussed in the class. This is just a guideline for those who missed the classes

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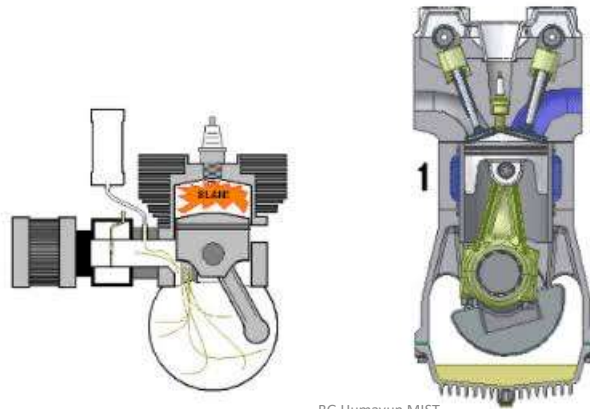
## 2. Maj Mechanical System

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## DIFFERENCE BETWEEN 2 STROKE AND 4 STROKE ENGINE



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### Comparison of 4 stroke & 2 stroke engine



Sl.No.	4 Stroke Engine	2 Stroke Engine
1	The cycle completes in 4 strokes of the piston (or) in 2 revolution of the crankshaft	The cycle completes in 2 strokes of the piston (or) in 1 revolution of the crankshaft
2	Develops one power stroke in every 2 revolution of the crankshaft	Develops one power stroke in one revolution of the crankshaft
3	Due to more no. of strokes turning moment is less uniform and heavier flywheel is needed	Due to lesser no. of strokes, turning moment is more uniform and lighter flywheel is needed

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### Comparison of 4 stroke & 2 stroke engine



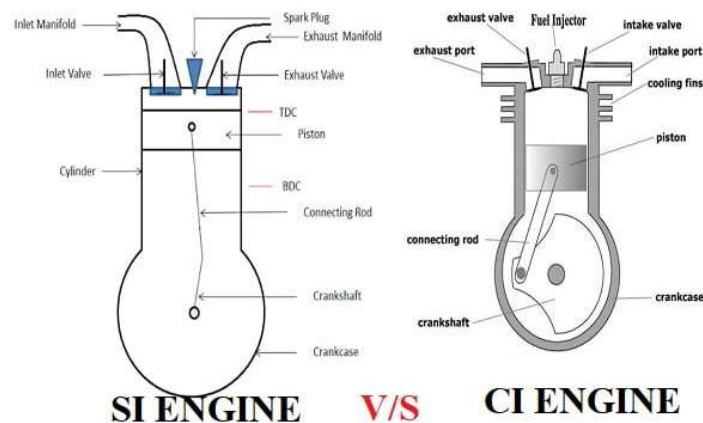
Sl.No.	4 Stroke Engine	2 Stroke Engine
4	Power produced for same size of the engine is small due to one power stroke in 2 revolutions.	Power produced for the same size of the engine is more due to one power stroke in 1 revolution.
5	Engine is heavy & bulky	Engine is light & compact
6	Lesser cooling & lubrication requirement as one power stroke is produced in 2 revolution of the crankshaft	Greater cooling and lubrication requirement as one power stroke is produced in 1 revolution of the crankshaft
7	Engine contains complicated valves and valve mechanism	Engine contains simple ports

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This is a line diagram of the Difference between SI Engine and CI Engine:



Difference between SI Engine and CI Engine

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## Comparison between Petrol & Diesel Engine



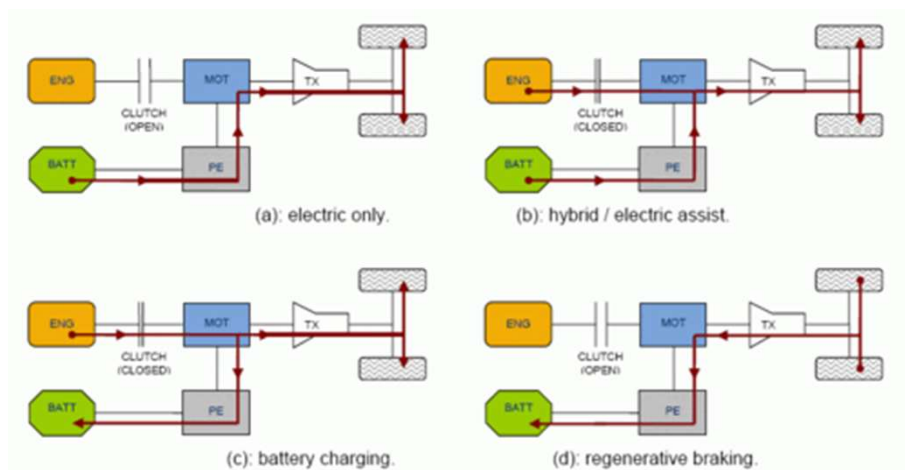
Sl.No	Details	Petrol Engine	Diesel Engine
1	Fuel Ignition	By spark plug (SI Engine)	By hot compressed air (CI engine)
2	Charge during suction stroke	Air & fuel mixture are admitted	Air alone is admitted and fuel is injected
3	Compression ratio	Low (6 to 8)	High (16 to 20)
4	Cycle of operations	Otto Cycle	Diesel Cycle
5	Weight	Light	Heavy

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## Hybrid vehicle drivetrain



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Some of the advanced technologies typically used by hybrids include

- ▶ **Regenerative Braking**
- ▶ **Electric Motor Drive/Assist**
- ▶ **Automatic Start/Shutoff**
- ▶ **Use low-rolling resistance tires**
- ▶ **Use lightweight materials**

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## TECHNOLOGY CHALLENGES AND OPPORTUNITIES

- Time of battery changing is long
- Batteries are heavy (100kg extra weight consumes 2L/100km more)
- Batteries are expensive
- Low performance in hot or cold temperatures also may damage the battery
- Very sensitive to overcharge/undercharge (Battery life reduces dramatically)
- Contain toxic heavy metals, disposal issue

Opportunity for researchers:

Advance research projects on batteries are supported by governments and industries

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## DISADVANTAGES OF HYBRID CARS

- ▶ Currently more expensive than conventional
- ▶ Heavier than conventional, due to battery pack and electric motors weight
- ▶ Limited battery life
- ▶ Expensive battery pack if you want to replace it
- ▶ Safety issues, high voltage battery and fuel
- ▶ Reliability, still under study,
- ▶ More complex computer controlled systems
- ▶ May have drivability issues
- ▶ Expensive to repair
- ▶ Towing Capacity

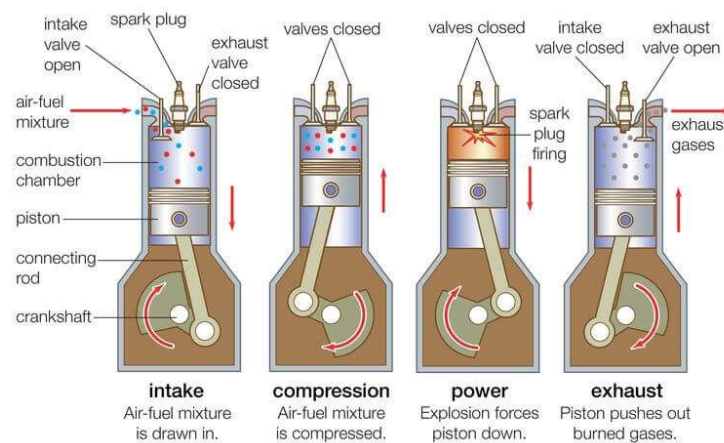


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## 4 Stoke Internal Combustion Engine

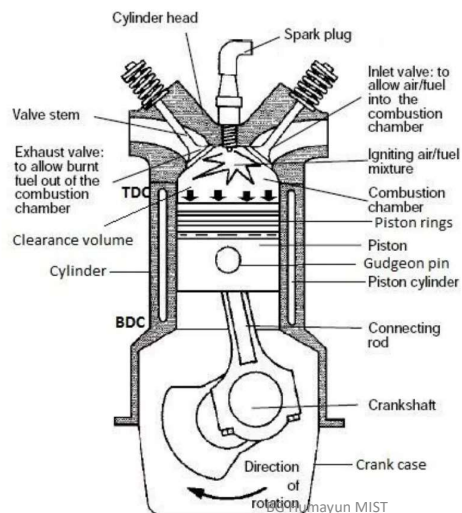


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## Basic components of a 4 stroke engine



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## Major Parts of an IC Engine with their Functions:

- An Internal Combustion Engine consists of several important parts, and those are
- : Cylinder, Cylinder Head, Piston, Piston Ring, Gudgeon pin or Piston Pin, Connecting Rod, Small End and Big End Bearing, Crank Shaft, Cam Shaft, Crank Case, Valves or Ports, Manifold, Push Rod, Rocker Arm, Spark Plug or Fuel Injector, Cooling Jackets or Fins, Flywheel

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## Cylinder head

The temperature of Engine Cylinder can be raised to 2600 degree centigrade.

According to [science direct](#) nowadays cylinder blocks made of grey cast iron, compact graphite cast iron, [nodular cast iron](#) and cast Al alloy.

### The Functions of Cylinder Head:

- In this chamber, the ignition of the charge [Air+Fuel] happens.
- It guides the piston to reciprocates.
- It is used for closing the Cylinder block.

### Cylinder Head:

The cylinder head is fitted over the Cylinder Block.

As of the cylinder block, the cylinder head is also made of same material [Cast Iron].

Generally, cylinder and cylinder head both are made by [casting](#).

- There are Valves [Inlet or Exhaust], Spark Plug [SI Engine] or Fuel Injector [CI Engine] are mounted on it.
- A gasket is provided on the Cylinder Head to avoid the leakage of the compressed fuel and make the cylinder block air-tight.

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## Piston:

The piston is generally made of Aluminium Alloy, which is good for heat transfer.

Piston converts the to-fro motion or the reciprocating motion to the rotary motion.

A piston is also used to transfer the energy [after Power Stroke] to the connecting rod.

### The Functions of Piston:

Piston provides the to and fro movement.

It converts the reciprocating movement to rotary motion.

It helps to transfer the energy to the connecting rod.

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**Piston Ring:**

Piston Rings are attached to the periphery of the Piston, generally made of steel alloys.

In an Internal Combustion Engine, three piston rings are used.

The top one is named the compression ring, and the bottom one is named the oil ring.

**The Functions of Piston Rings:**

The compression ring is used for preventing the leakage of burnt gases into the lower chamber.

And Oil Ring is used for preventing the leakage of oil inside the engine block. Also, it scrapes the oil from the cylinder wall.

Lastly, the middle ring is for safety purposes if by chance the leakage of burnt gas or oil happened than it can prevent that.

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**Gudgeon Pin or Piston Pin:**

Gudgeon Pin [Piston Pin or Wrist Pin] is used to connect connecting rod with the piston.

It is made of Steel alloy to bear the high strength.

And, it is generally, made by forging process.

**The Functions of a Gudgeon Pin:**

To connect the piston with the connecting rod

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**Connecting Rod:**

Connecting Rod is generally used to transfer the reciprocating motion to the rotary motion of the crankshaft.

The one end [smaller] is connected with the Piston with the help of piston pin, and the other end [bigger] is connected with the crankshaft with the help of a crank pin.

Connecting rod is made of Steel Alloy or Aluminium Alloy. However, in recent days connecting rod is also made of T6-2024 and T651-7075 aluminium alloys. These alloys are so lighter and capable of bear the high strength and high impact.

**The Functions of Connecting Rod:**

It is used to convert the to and fro [reciprocating motion] of the piston to circular motion.

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**The Functions of Small End and Big End Bearing:**

To provide smoother functioning between the piston, connecting rod and crank.

To minimize power loss due to friction.

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**Crank Shaft:**

This is the rotating member of an IC Engine which convert the reciprocating movement of the piston to rotary motion.

All the pistons of the engine are connected with the crankshaft by the help of connecting rod and one end of this crankshaft is connected with Flywheel. [I will discuss flywheel later on this article].

It is made of forged steel or Cast Iron. [Source [Science Direct](#)]

A crankshaft is consisted of the number of Crank and Crank Pin, according to the size of the engine it can be defined. If the engine is 6-cylinder then the amount of crank and crankpin is 6, and when it goes down to 3 or 4, then the number of crank and crankpin reduces accordingly.

A crankshaft consists of four major parts,

Main Journal

Crank Pins

Crank Webs

Counterweights

**The Functions of Crank Shaft:**

The crankshaft converts the reciprocation movement of piston o the rotary motion.

It drives the flywheel and camshaft.

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**The Functions of the Cam Shaft:**

It helps to open the poppet valves [Inlet and Exhaust] at the proper time.

**The Functions of the Crank Case:**

It protects the crankshaft and connecting rod from debris.

In some engines, the crankcase is used for sump of lubrication oil.

**The Functions of Valves:**

During suction stroke inlet v/v allow the charge [Air+Fuel or only Air] to go inside the engine cylinder.

And after the exhaust stroke, through exhaust v/v the burnt gas is going out of the cylinder.

They also seal the piston-cylinder when compression stroke happens.

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### Functions of Manifolds:

Through the manifold, the fresh charge comes into the engine cylinder and burnt gases come out from the engine cylinder.

### Functions of Cooling Jackets or Fins:

To reduce the temperature of the engine.

To protect the engine from wear and tear.

### The Functions of Flywheel:

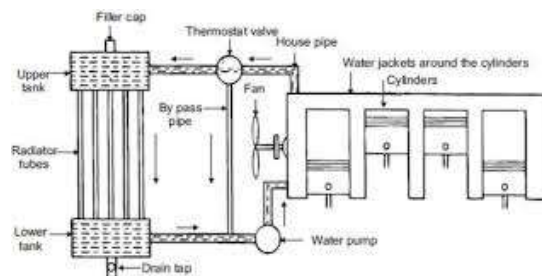
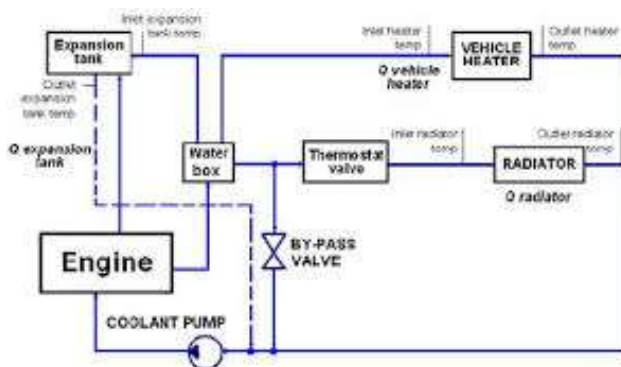
The main function of the flywheel is to store excess energy during the power stroke and supply that energy to the rest of the three strokes to complete the cycle.

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## Cooling system of engine



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- **How Does a Cooling System Work?**

- The coolant flows from the water pump, through the ways which are located inside the [engine block](#). On its way it gathers the heat produced by the cylinders. After that it goes up to the cylinder head (or heads in a [V type engine](#)) where it collects the residual heat from the [combustion chambers](#). Then the coolant makes its way to the thermostat in case the thermostat is opened to allow the [fluid](#) to pass. From there the coolant goes through the thin flattened tubes that make up the core of the [radiator](#).
- Inside there, the coolant is cooled by the air flow through the [radiator](#). From here it flows out of the radiator by the lower radiator hose. It then goes back to the water pump. After this stage the temperature of the coolant is reduced and it can gather more heat from the [engine](#). The capacity of a cooling system depends upon the engine. The cooling system for a bigger and powerful engine in a heavy vehicle will need high capacity than a compact car with a comparatively much smaller engine. In a bigger vehicle the radiator is bigger with numerous tubes for the coolant to flow through.

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- **Components of Cooling System in Engine**

- The main parts of a cooling system are explained below
  - Water Pump.
  - [Radiator](#).
  - Thermostat.
  - Coolant Temperature Sensor (CTS).
  - Coolant (Antifreeze + Water).
  - Radiator cooling fans.
  - Heater core.
  - Hoses
  - Head [gaskets](#) and manifold gaskets.
  - Freeze plugs.

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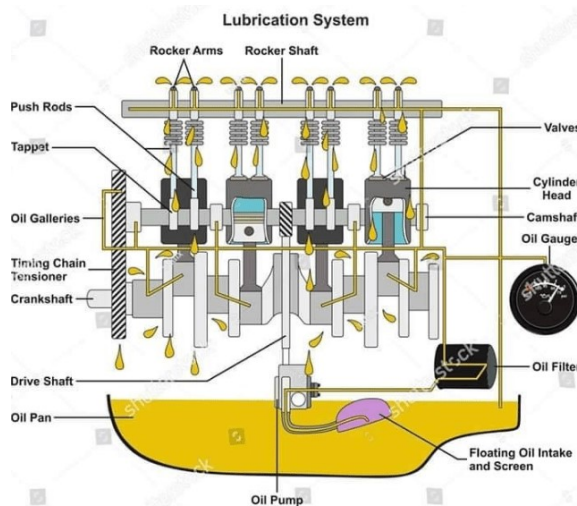
### • Thermostat Valve

- Thermostat is a device (valve) used to determine the temperature of the coolant. If the coolant is hot enough, the thermostat opens to allow the coolant to flow through the radiator. When the coolant is not of high temperature then the flow to the radiator is constrained. In such condition, there is a provision of a bypass system. The fluid goes to the bypass system and gets back to the engine.
- This system is important as it maintains the constant and continuous flow of coolant throughout the engine. This continuous flow maintains the temperature and eradicates the formation of hot spots. When the flow to the radiator is choked, optimum operating temperature of the engine is achieved sooner. This will aid in a cold day by allowing the heater to start supplying high temperature air to the inside very fast.

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### Lubrication System

The reservoir of oil is held in the sump (deep part of the oil pan).

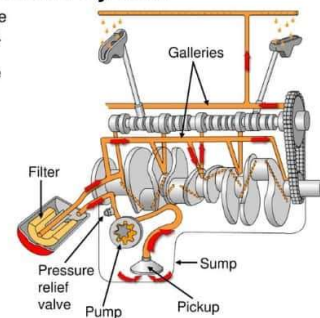
The oil is drawn into the engine through a pickup.

Oil is forced round the system by a pump.

The system is protected from over high pressure, by a pressure relief valve.

Particulates are strained out by a filter.

The oil is circulated around in galleries within the head and block.

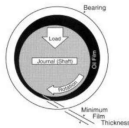


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## Purpose of Lubrication System

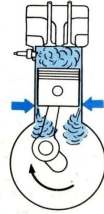
### •Lubricate

Reduces *Friction* by creating a thin **film (Clearance)** between moving parts



### •Seals

The oil helps form a seal between piston rings and cylinder walls (*Reduces Blow-By*)



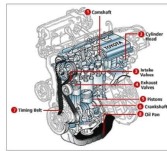
Internal oil leak (blow-by) will result in **BLUE SMOKE** at the tail pipe.

### •Cleans

As it circulates through the engine, the oil picks up metal particles and carbon, and brings them back down to the pan.

### •Cools

Picks up heat when moving through the engine and then drops into the cooler oil pan, giving up some of this heat.



### •Absorbs shock

When heavy loads are imposed on the bearings, the oil helps to cushion the load.

### •Absorbs Contaminants

The additives in oil helps in absorbing the contaminants that enter the lubrication system.

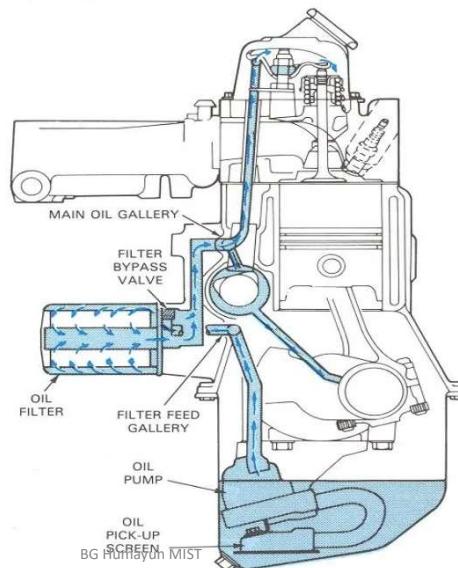
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## Lubricating System Parts

- Oil sump
- Oil pump
- Pick-up screen
- Pressure regulator
- Oil filter
- By-pass valve
- Oil galleries
- Dipstick
- Pressure indicator



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A good lubricant generally possesses the following characteristics:

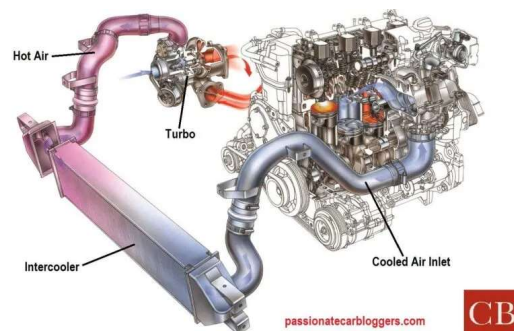
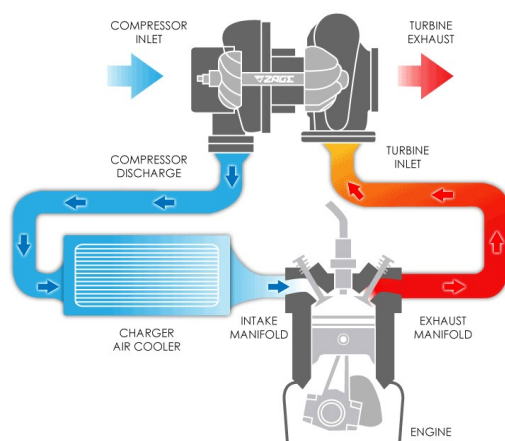
- A high boiling point and low freezing point (in order to stay liquid within a wide range of temperature)
- A high viscosity index
- Thermal stability
- Hydraulic stability
- Demulsibility
- Corrosion prevention
- A high resistance to oxidation

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## Turbocharger with intercooler working principle

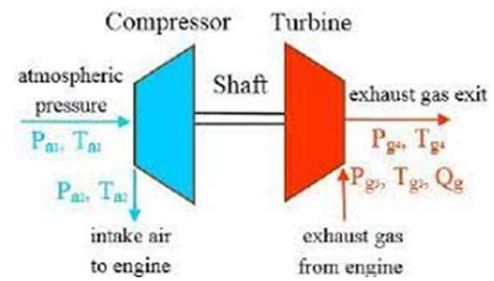
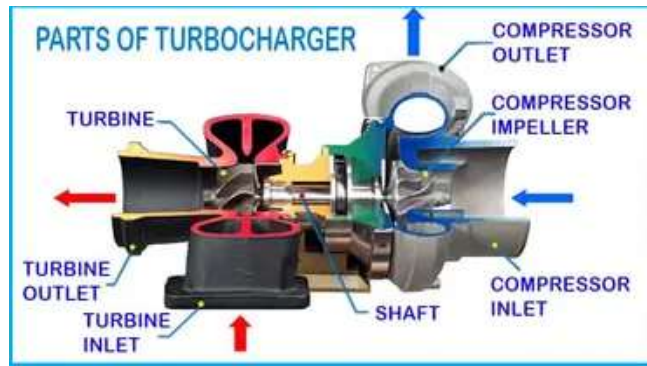


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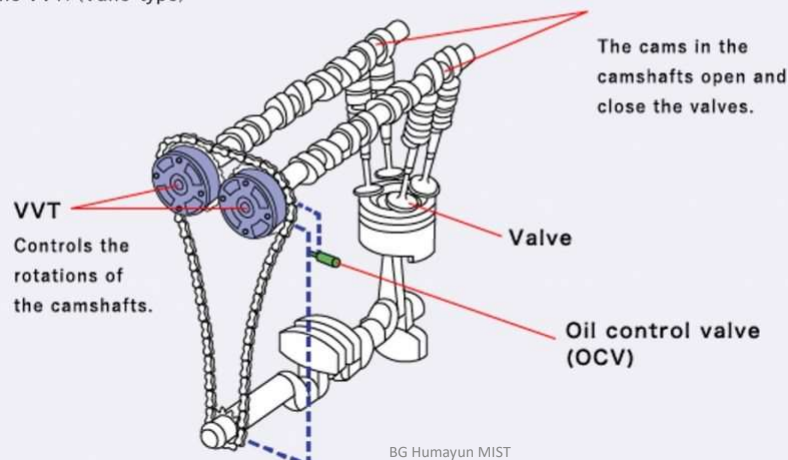
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## VVT (Variable Valve Timing)

VVT adjusts the opening/closing timing of the intake and exhaust valves using camshafts.

An oil control valve (OCV), responsible for controlling oil flow into the camshafts, determines the rate of rotation of the VVT. (Vane-type)



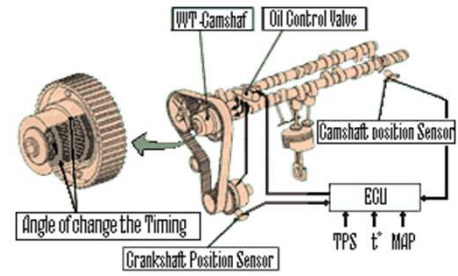
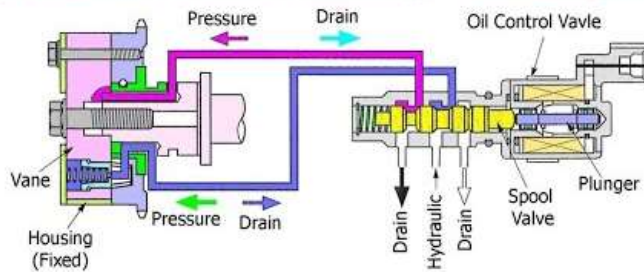
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# VVT-i

(Variable Valve Timing – intelligent)

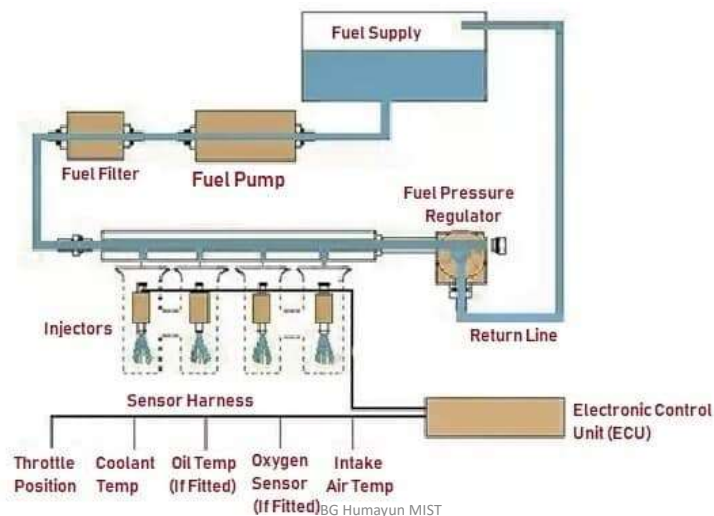


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## Electronic fuel injection (EFI) system

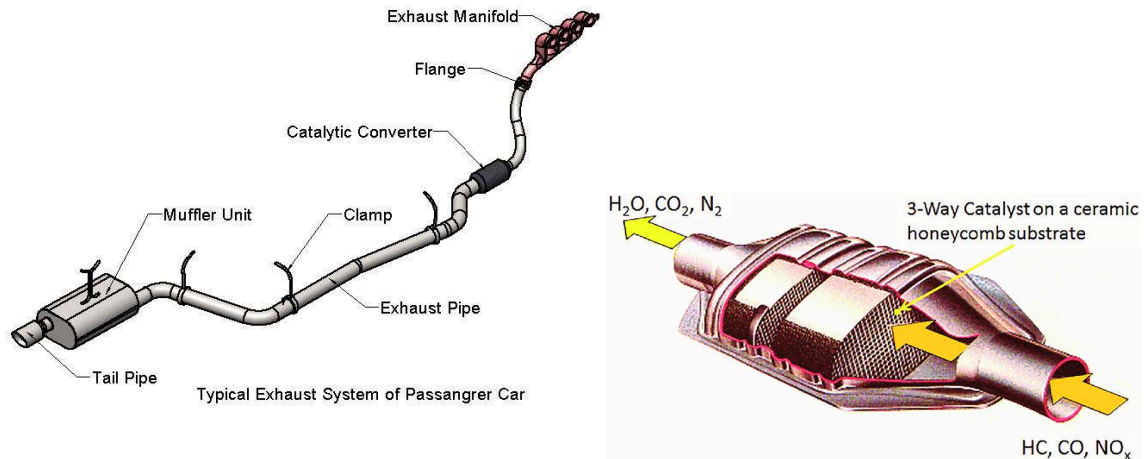


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## Component of exhaust system



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## Function of Catalytic converter



A **catalytic converter** is an [exhaust emission control](#) device that converts toxic gases and [pollutants](#) in [exhaust gas](#) from an [internal combustion engine](#) into less-toxic pollutants by [catalyzing](#) a [redox reaction](#).

Catalytic converters are usually used with internal combustion engines fueled by [gasoline](#) or [diesel](#), including [lean-burn](#) engines.

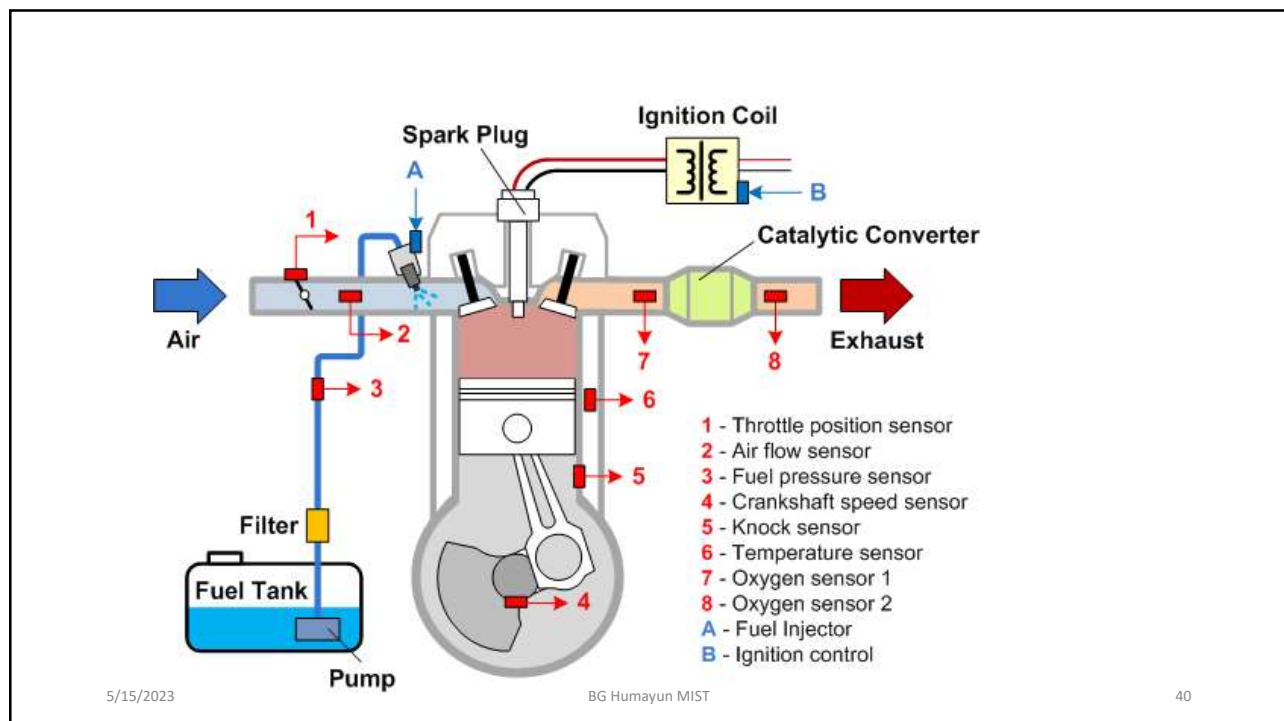
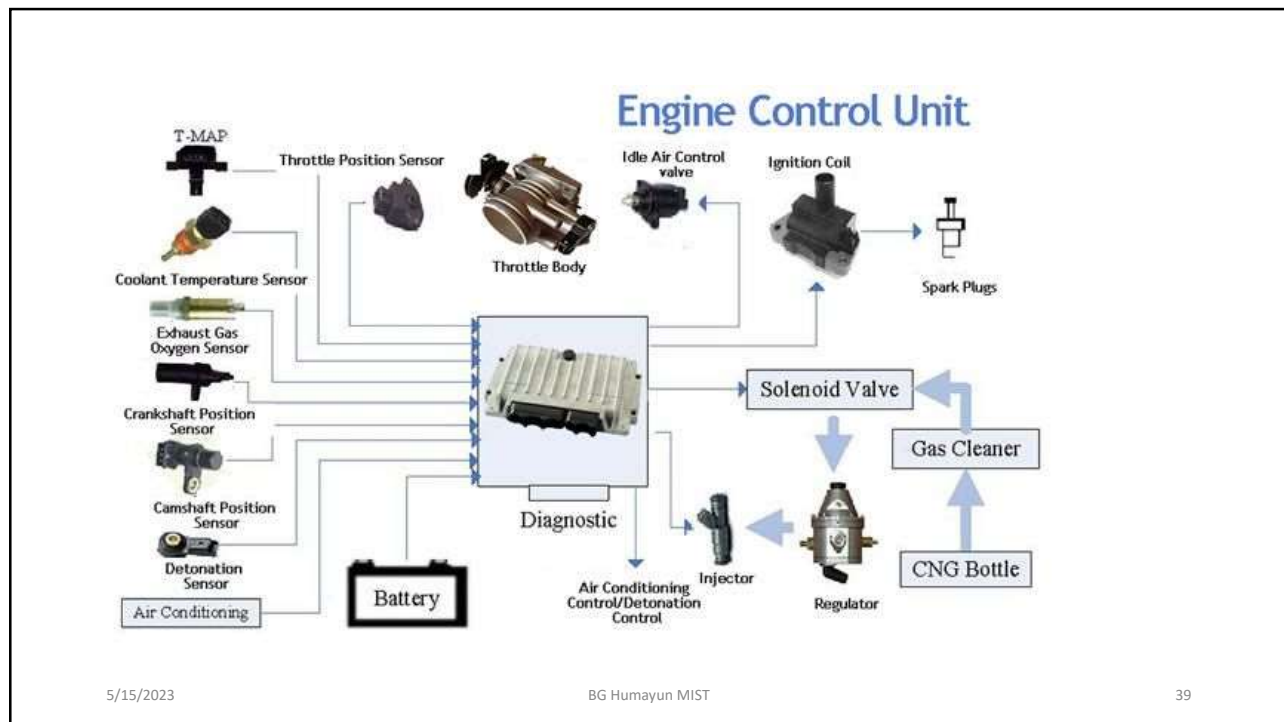
"two-way" converters combine [oxygen](#) with [carbon monoxide](#) (CO) and [unburned hydrocarbons](#) (HC) to produce carbon dioxide (CO<sub>2</sub>) and [water](#) (H<sub>2</sub>O).

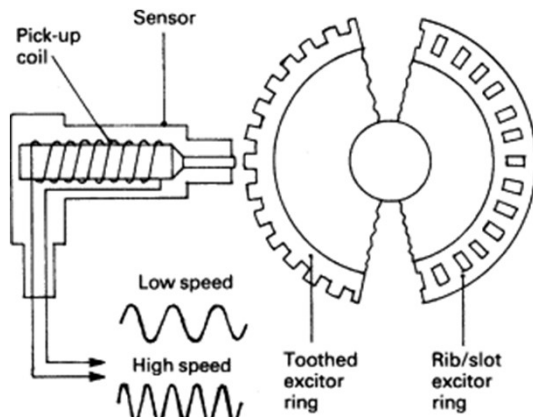
"three-way" converters that also reduce [oxides of nitrogen](#) (NO<sub>x</sub>)

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### What Is A Speed Sensor?

A **vehicle speed sensor (VSS)** is a small component mounted on your car's transmission that lets the car's onboard computer know how **fast** you're moving. It's also known as a wheel speed sensor, transmission speed sensor, or output shaft speed sensor.

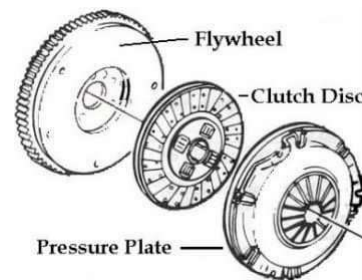
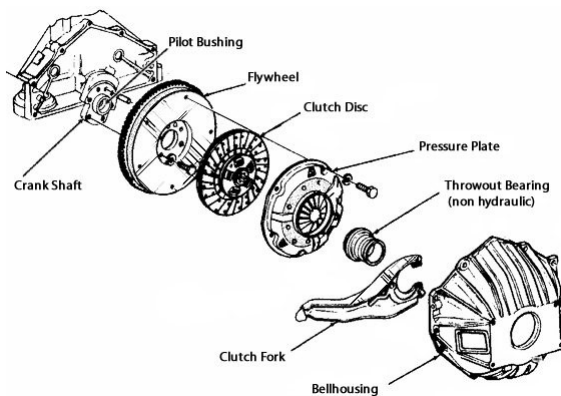
### How does the speed sensor work?

The vehicle speed sensor measures the **rotational speed** of the gears in your transmission system. Then, it converts this measurement into an analog signal or a low voltage square wave **signal** and relays it to **electronic control units (ECUs)** inside your car.

In turn, the ECUs use this signal to adjust your car's speedometer readings, the ABS module, and transmission system.

Your car's cruise control system may also rely on data generated by the speed sensor. Without it, your car wouldn't be able to maintain a constant vehicle speed.

## Main Component of clutch



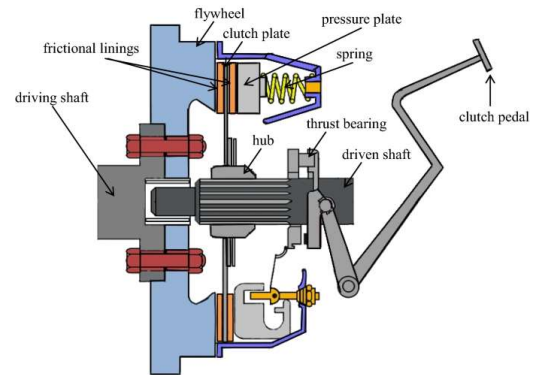
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## How does clutch system in car works

- It transmits [engine](#) power to the gear box, and allows transmission to be interrupted while a gear is selected to move off from a stationary position, or when gears are changed while the car is moving.
- When a car is moving under power, the clutch is engaged. A pressure plate bolted to the flywheel exerts constant force, by means of a diaphragm spring, on the driven plate.



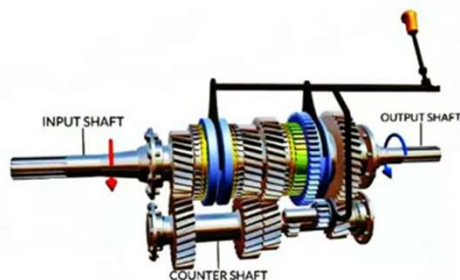
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## Transmission gear box

- **Manual transmission** also known as “**Gearbox**” is a type of transmission system. It is used in motor vehicles, which converts the torque and speed available from the engine and transmits the power to the wheels.



The gearbox ( Gear box ) is a mechanical device used to increase the output torque or to change the speed (RPM) of a motor. The shaft of the motor is connected to one end of the gearbox and through the internal configuration of gears of a gearbox, provides a given output torque and speed determined by the gear ratio.

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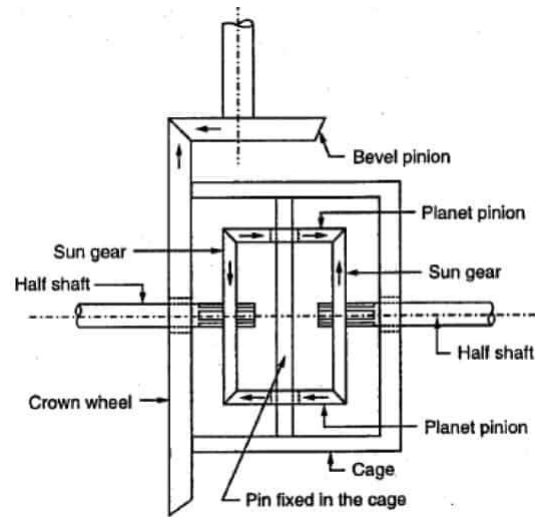
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## Differential

Differential gear, in automotive mechanics, gear arrangement that permits power from the engine to be transmitted to a pair of driving wheels, dividing the force equally between them but permitting them to follow paths of different lengths, as when turning a corner or traversing an uneven road.



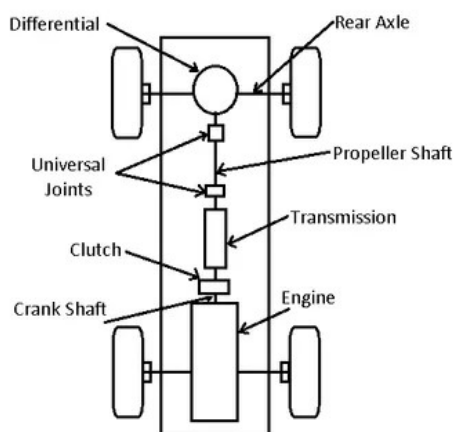
**Figure: Working of differential**

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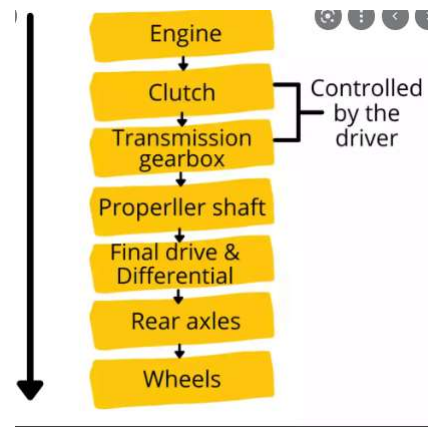
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## Transmission of power engine to wheel in automobile



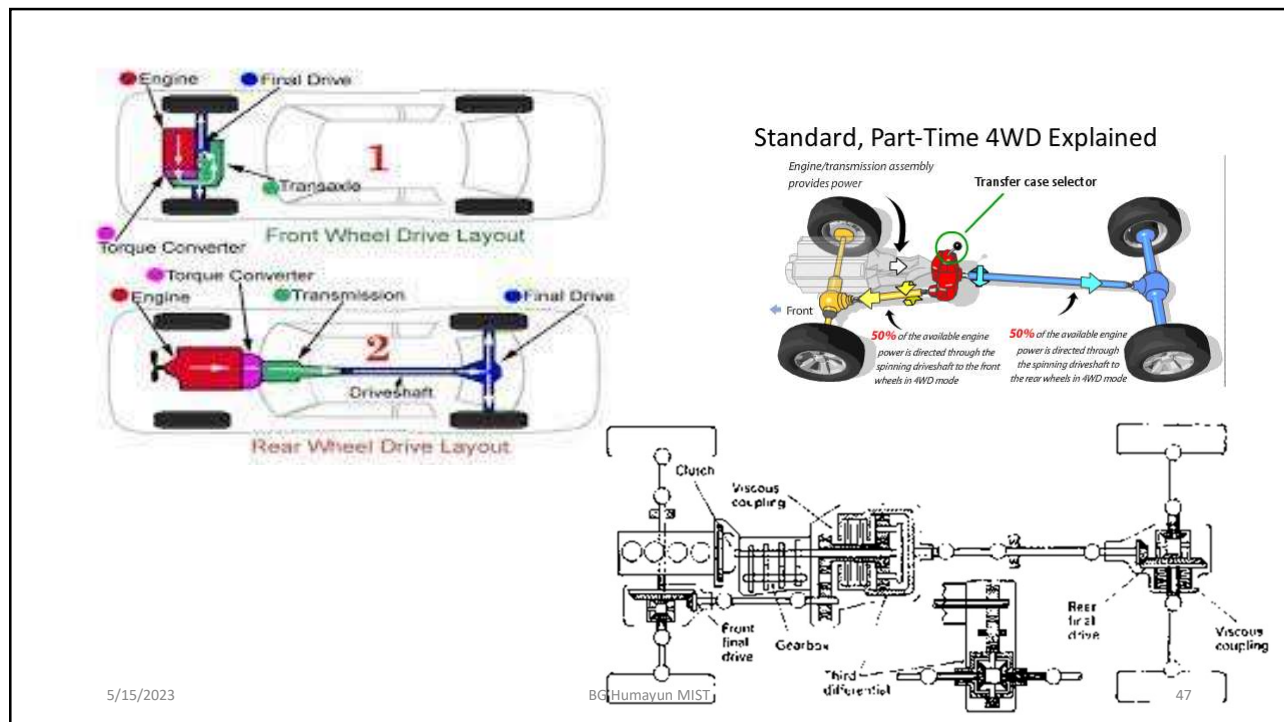
**Automobile Power Transmission System**



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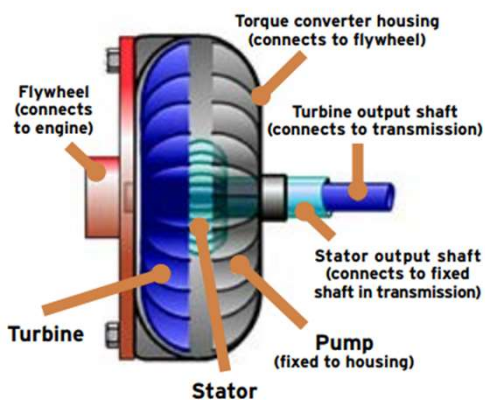


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## Fluid coupling/Torque converter



Fluid coupling is also known as hydraulic coupling. It is a **hydrodynamic device** which is used to transfer rotational power from one shaft to another by the use of transmission fluid. It is used in the automotive transmission system,

A **torque converter** is a type of [fluid coupling](#) that transfers rotating power from a [prime mover](#), like an [internal combustion engine](#), to a rotating driven load. In a vehicle with an [automatic transmission](#), the torque converter connects the power source to the load. It is usually located between the engine's [flexplate](#) and the transmission. The equivalent location in a manual transmission would be the mechanical [clutch](#).

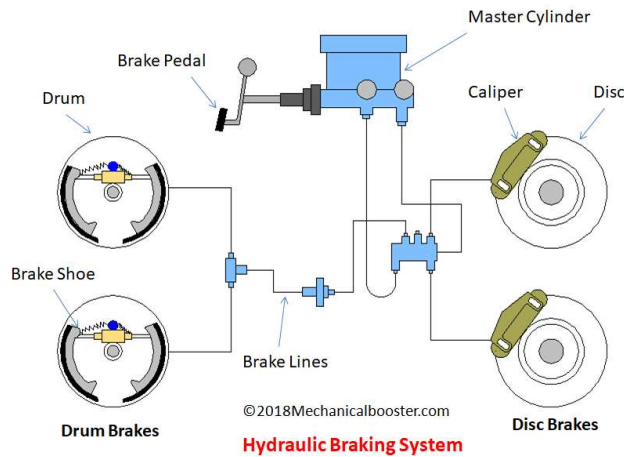
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## Components of a brake system



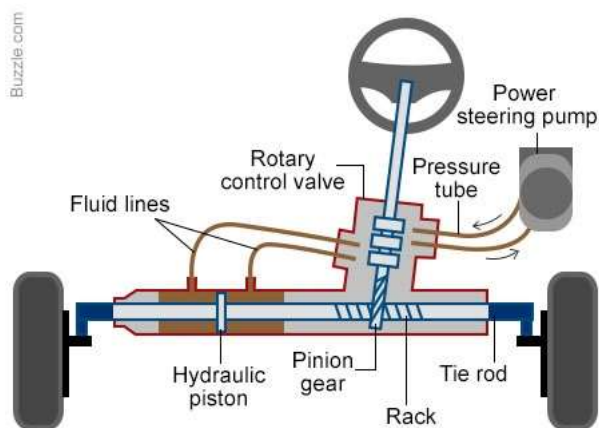
The function of vehicle brake system is **to stop or slow down the moving motor vehicle or prevent it from moving when in stationary position**. All the braking systems use the force of friction for their operation. Friction opposes the relative motion of the bodies that are in contact with each other.

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## Components of steering system

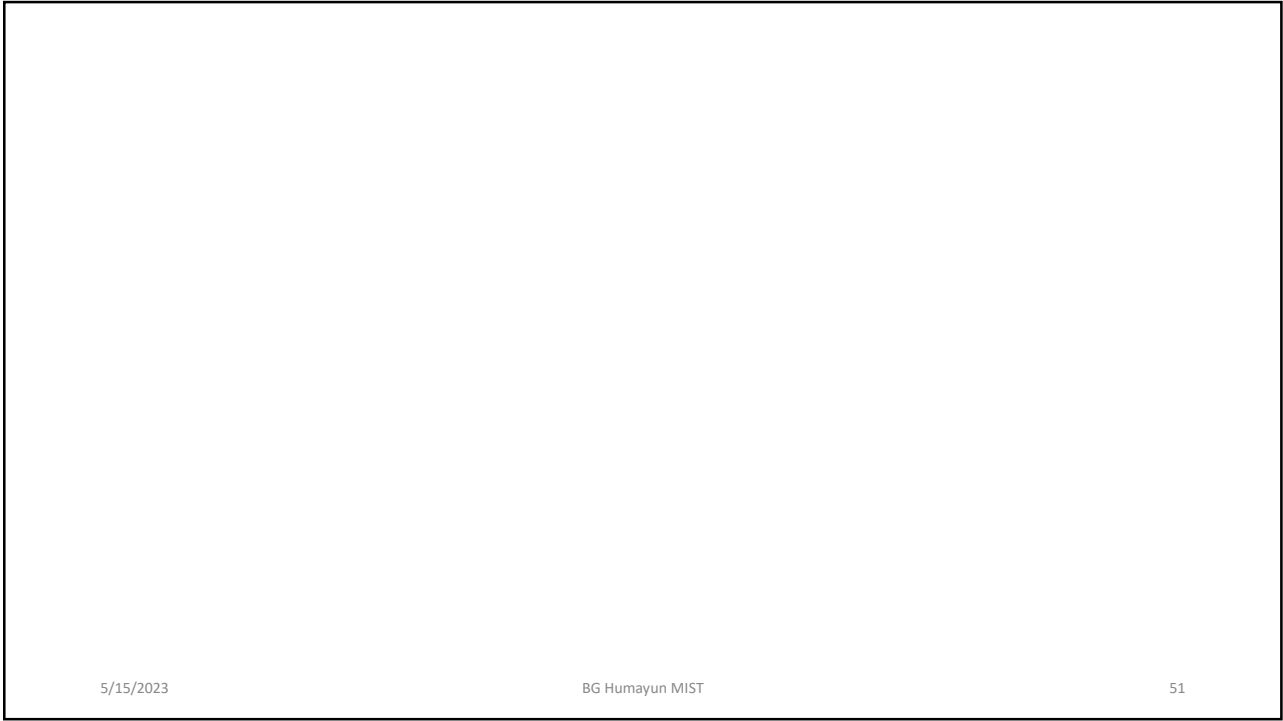


The basic aim of steering is **to ensure that the wheels are pointing in the desired directions**. This is typically achieved by a series of linkages, rods, pivots and gears.

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