Unit-III
Vehicles & Their Specifications

Automobile:

Vehicle is a device or machine which is used to transport human as well as goods, specially on roads.

An automobile, auto car or motor car is a self propelled wheeled motor vehicle used for transporting passenger and goods on ground.

Classification of Automobile:

a. Based on Purpose:

1. Passenger vehicles
2. Goods vehicle
3. Special purpose vehicle

b. Based on Capacity

1. Heavy motor vehicle (HMV)
2. Medium load vehicle
3. Light motor vehicle (LMV)

c. Based on fuel source:

1. Petrol engine vehicle
2. Diesel engine vehicle
3. Gas vehicle
4. Electric Vehicle
5. Solar vehicle
6. Hybrid vehicle

d. Based on type of transmission

1. Automatic transmission vehicle
2. Manual transmission vehicle
3. Semi automatic transmission vehicle

e. Transport vehicle

1. Heavy Transport vehicle (HTV)
2. Light Transport vehicle (LTV)

f. On basis of body style

1. Closed cars such as hatch back, sedan, etc
2. Open cars such as convertible, sports cars
3. Special cars such as station wagon, estate version

g. On basis of drive

1. Left hand drive vehicle
2. Right hand drive vehicle

h. With respect to driving axle of vehicle

1. Front wheel drive
2. Rear wheel drive
3. All wheel drive

i. Based on of wheels

1. Two wheelers
2. Three wheelers
3. Four wheelers
4. Six wheelers

j. On basis of suspension

1. Conventional – using leaf spring
2. Independent – using coil spring

Vehicles Specifications:

The parameters which provide all details of the vehicle is called vehicle specifications.

Various automobile manufactures design and develop new type of vehicle model every year based on market needs.

Large number of similar vehicles available in the market, we need parameters for comparing various model. These parameters are called as vehicle specification.

Commonly used vehicle specifications are:

1. Vehicle Manufacturer's Name and Model Number
2. Engine Specifications
3. Type of Fuel Used
4. Transmission / Gear Box Specifications
5. Clutch Type
6. Braking System Specifications
7. Steering Mechanism Type
8. Wheels and Tyre Specifications
9. Overall dimensions- Length, Width and Height of Vehicle
10. Wheel Base, Wheel Track, Ground Clearance
11. Kerb Weight, Gross Vehicle Weight (GVW), Pay Load (for Commercial Vehicles)
12. Number of Passengers (for Passenger Vehicles)

Variant: A form or version of something that differs in some respect from other forms of the same thing or from a standard. (Model)

Engine Type: (e.g. Air cooled, 4 or 2 stroke, single or multy cylinder)

Displacement (Cubic centimeter "CC"):The term "cc" stands for Cubic Centimeters or simply cm^3 which is a metric unit to measure the engines Capacity or its volume.
Engine displacement is the measure of the cylinder volume swept by the pistons excluding the combustion chamber.

Maximum Power: In automobile engines as engine speed increases the power output of engine increases. It becomes maximum at certain engine speed. (HP @ rpm)
In engineering, time rate of doing work or delivering **energy**, expressible as the amount of work done W, or **energy** transferred, divided by the time interval t—or W/t
Maximum Power : ……PS@.....rpm [PS = pferdestarke]
1 PS = 0.98632 HP
e.g. 14 PS @ 7500 rpm means the engine is capable of delivering 14 PS power the crankshaft rotates at a speed of 7500 rpm.

Maximum Torque: Torque means a force that tends to cause rotation.
In automobile as engine speed increases the output torque of engine increases. It becomes maximum at certain speed of engine & it drops as engine speed increases further.(N-m @Rpm)

Fuel Capacity: Automotive manufacturers will design the fuel tank keeping a standard number of kilometers that a vehicle can travel with one full tank of fuel (Measured in Liters)
Cooling System: Internal combustion engine cooling uses either air or liquid to remove the waste heat from an internal combustion engine.

Drive Type: Drive type is a way of transmitting mechanical power from one place to another e.g. Chain drive, shaft drive, FWD, RWD, etc.

Fuel Supply: The function of the fuel system is to store and supply exact amount of fuel to the cylinder chamber where it can be mixed with air, vaporized, and burned to produce energy
The basic fuel supply system in an automobile petrol engine consists of a fuel tank, fuel Lines, fuel pump, fuel filter, air cleaner, carburetor, intake manifold.

Clutch: A **clutch** is a mechanical device that engages and disengages power transmission, especially from a drive shaft

Transmission: The power generated in the engine of the automobile is transmitted to the wheels for their movement with the help of transmission system

Gear Box: This is a component which houses the complete gear mechanism. The purpose of the gear box is to change the engine torque and speed in to torque and speed required by the wheels of an automobile

Compression Ratio: the ratio of the maximum to minimum volume in the cylinder of an internal combustion engine.

Suspension: To isolate the passengers and the other vehicle components from the irregularities of road surface suspension system is used. It consist spring and damper assembly.

Speedometer: An instrument on a vehicle's dashboard indicating its speed.
(Analogue / Digital)

Ground Clearance**: Ground clearance** is the minimum amount of distance between the bottom of the **vehicle** body and the **ground**.

Wheel Base: **wheelbase** is the distance between the centers of the front and rear **wheels**

Weight:
Kerb weight: The weight of a car without occupants or baggage. (the **weight** of our **vehicle** when empty)

Gross weight: The Gross Vehicle Weight is basically the maximum total weight of your vehicle counting the curb weight plus the weight of your passengers, fuel, any accessories added to the vehicle

Chassis: A chassis is a base frame of a vehicle upon which rest of the components are set.

Ignition System: An **ignition** system generates a spark or heats an electrode to a high temperature to ignite a fuel-air mixture in spark **ignition** internal combustion engines, oil-fired and gas-fired boilers, rocket engines, etc.
he **purpose** of the **ignition system** is to create an electric spark in the engine combustion chamber, at exactly the right time, which will ignite the mixture of air & fuel.

Vehicle Specification Parameters	
Engine	Fuel Type: Petrol/ Diesel
	Engine Type
	Method of cooling
	Displacement
	No of cylinders
	Max. Power
	Max. Torque
	Valves per cylinder
	Fuel delivery: Carburetor/ Fuel pump/ injectors
	Compression Ratio
	Bore/ Stroke
	Compression Ratio
	Top Speed
Fuel Consumption	Fuel Tank Capacity (Liters)
	Reserve fuel capacity (Liters)
	Mileage (kmpl)
	Overall riding Range
Transmission	Gear box: 4 Speed/ 5 Speed etc
	Clutch: Centrifugal clutch / wet multi plate clutch / single plate clutch
	Manual / Automatic/ Semi automatic
Braking	Front brake type : Drum/ Disc
	Rear brake type : Drum/ Disc
Suspension	Front Suspension: Telescopic Hydraulic Shock absorber
	Rear Suspension: Spring Loaded Hydraulic Damper
Wheels & Tyres	Wheel Type & Size: Spoke or Alloy wheel
	Tyre: Tubeless
	Tyre Size
Battery	Voltage: 12 V/ 18 V/ 24 V
Body Dimensions	Wheel Base
	Length (mm)
	Width (mm)
	Height (mm)
	Wheel Base (mm)
	Ground Clearance (mm)
	Kerb weight (kg)
	Gross weight (kg)
	Front Track
	Rear Track
	Turning Radius/ No of Doors/ Seating

Vehicle Specification of Two Wheeler:

Specification	Honda Shine 
Engine Type	Single Cylinder, 4-Stroke, SI Engine
Displacement	124.73 cc
Max Power	10.30 PS @ 7500 rpm
Cooling System	Air Cooled
Drive Type	Chain Drive
Fuel Supply	Carburetor
Clutch	Wet, Multi Plate
Transmission	Manual
Gear Box	5 Speed
Bore (Dia.)	52.4 mm
Stroke	57.8 mm
Compression Ratio	9.2:1
Front Suspension	Telescopic Fork
Speedometer	Analogue
Length	2007 mm
Width	762 mm
Height	1085 mm
Fuel Capacity	10.5 L
Ground Clearance	160 mm
Weight	120 Kg
Tyre Size (Dia.)	Front :-18,
Tyre Type	Tubeless
Front Brake	Disc brake
Rear Brake	Drum brake

Two-wheeler Specification Comparison:

	Passion Pro 110	Honda Unicorn 150	Bajaj Pulsar NS200
Engine Type	Single Cylinder, 4-Stroke, OHC with i3S	Single Cylinder, 4-Stroke, SI Engine	Single Cylinder, 4-Stroke, 4-Valve, SOHC, Triple Spark, DTS-i Engine
Displacement	109.15 cc	149.2 cc	199.5 cc
Max Power	9.5 PS @ 7500 rpm	12.91 PS @ 8000 rpm	23.5 PS @ 9500 rpm
Max Torque	9 Nm @ 5500 rpm	12.8 Nm @ 5500 rpm	18.3 Nm @ 8000 rpm
Cooling System	Air Cooled	Air Cooled	Liquid Cooled
Fuel Supply	Carburettor	Carburettor	Fuel Injection
Gear Box	4 Speed	5 Speed	6 Speed
Compression Ratio	10:1	9:1	11:1
Mileage (Overall)	73 kmpl	60 kmpl	36 kmpl
Front/ Rear Brake	Drum/Drum	Disc/Drum	Disc/Disc

Vehicle Specification of Light Motor Car:

Specification	Maruti Baleno Zeta 
Fuel Type	Petrol
Fuel Tank Capacity (Lit.)	37
Engine Displacement (cc)	1197
Body Type	Hatchback
Max Power (bhp@rpm)	83.1bhp@6000rpm
Engine Type	Petrol Engine
Displacement (cc)	1197
Max Torque (nm@rpm)	115Nm@4000rpm
No of Cylinder	4
Valves Per Cylinder	4
Valve Configuration	DOHC (dual overhead cam)
Fuel Supply System	MPFI (Multi Point Fuel Injection)
Transmission Type	Manual
Gear Box	5 Speed
Drive Type	FWD
Ground Clearance (mm)	170
Length (mm)	3995
Width (mm)	1745
Height (mm)	1510
Wheel Base (mm)	2520
Total Weight (kg)	880
Front Suspension	Mac Pherson Strut
Rear Suspension	Torsion Beam
Steering Type	Power
Steering Column	Tilt & Telescopic
Steering Gear Type	Rack & Pinion
Front Brake Type	Disc
Rear Brake Type	Drum
Tyre Size / Type	16 / Tubeless, Radial

Vehicle Specification of Bus:

Specifications	Volvo 9400 14.5 M 
Length	14500 mm
Height	3600 mm
Width	2600 mm
Wheelbase	8350 mm
Gross Vehicle Weight	22,200 kg
Suspension	Electronically Controlled Air Suspension (ECS)
Brakes	All disc brakes with EBS
No. of Doors	01 - Front
Diesel Engine	Volvo D11C 410
Transmission	Automatic Gear Shifting System 12-Speed splitter/range gearbox
Max. Power	410 hp @1600-1900 rpm
Max. Torque	1980 Nm @1600-1900 rpm
No. of Cylinders	6
Turning radius	11.54 mt

Vehicle Specification of Truck:

Model	Ashok Leyland CT 3118 HD 	
Engine	Power: 180 HP @ 2500 rpm Torque: 660Nm @ 1200~1900 rpm	
Clutch	Single plate dry type - 15” Axial spring clutch	
Gear Box	Synchromesh	
Prop Shaft	Coupling shafts & Drive Shaft	
Rear Axle	Fully floating	
Front Axle	I’ section, non-driven	
Suspension	Front – Multi-leaf Spring - Shock Absorbers: Spring width – 90 mm	Rear Inverted Semi-elliptic multi leaf with V-Rod
Frame Dimensions	chassis Frame -279 x 90 x 8mm	
Steering	Power steering	
Brakes	Dual circuit, full air S cam. Parking brakes on rear wheels only	
Fuel Tank	300 (Plastic) Rectangle shape	
Electrical	24V ; 110 AH battery X 2 nos. 85A alternator capacity	
Tyres	20 Cross ply and Radial	
Max Speed	60 Kmph	

Vehicle Specification of Three Wheeler:

PETROL/LPG/CNG/DIESEL

- Power:7.6 KW at 5000 rpm
- Torque:17Nm at 3500 rpm
- Cubic Capacity:198.88 cc
- Transmission:4 forward + 1 reverse gear
- Clutch: Wet multidisc type
- Engine Type: 4 Stroke
- Engine Cooling: Air Cooled
- Kerb weight:348 Kg
- Wheel Base:2000 mm
- Overall width:1300 mm
- Overall length:2635 mm
- Overall Height:1700 mm

Introduction to Engine Components:

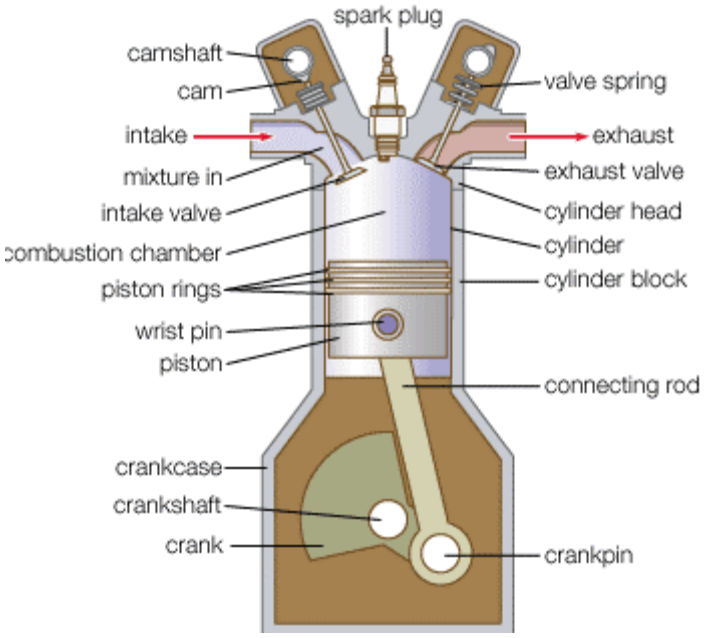
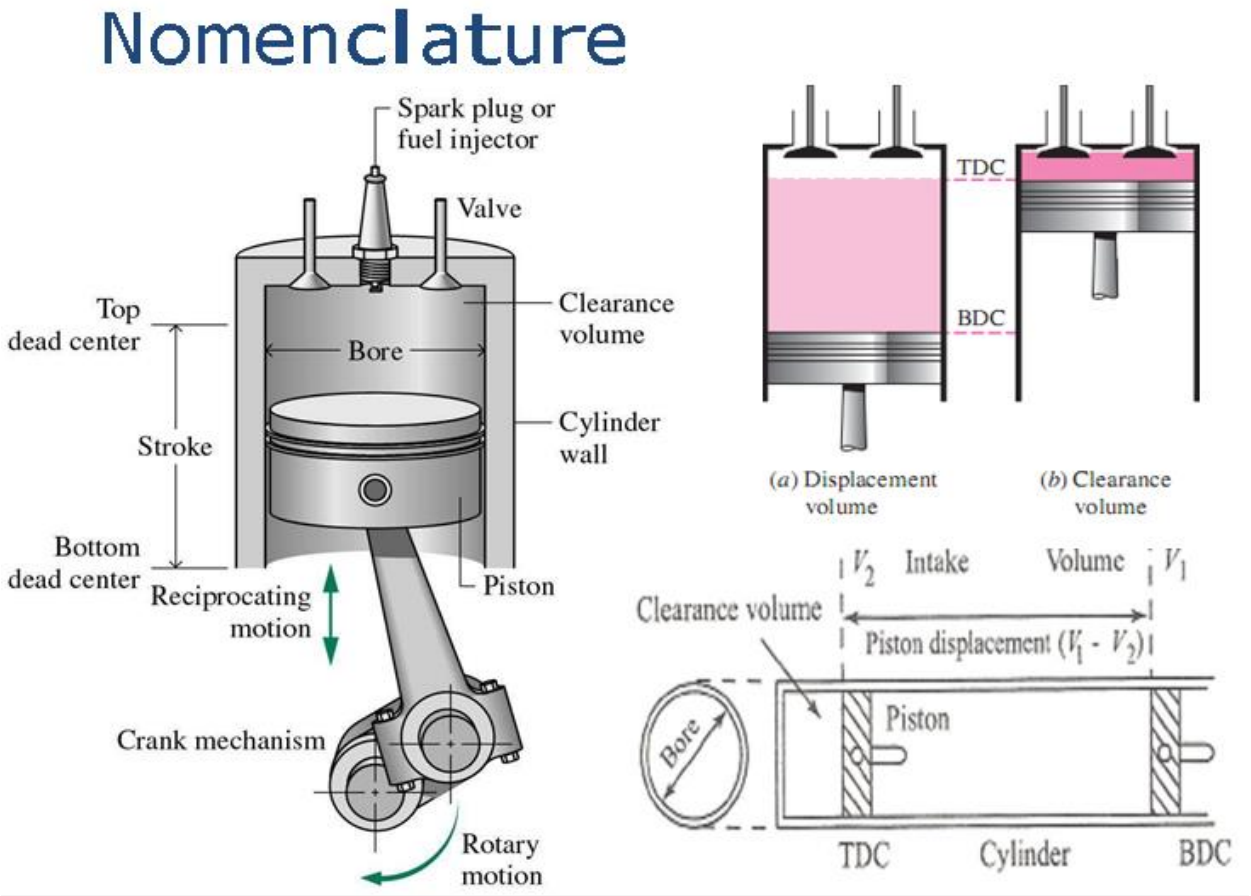


Fig. IC Engine Components



Main Components of Reciprocating IC Engine:

Cylinder:

- The hollow cylindrical structure closed at one end with cylinder head in which the pistons reciprocate back and forth
- Made of hard and high thermal conductivity materials
- Combustion of fuel takes place inside the cylinder

Cylinder head:

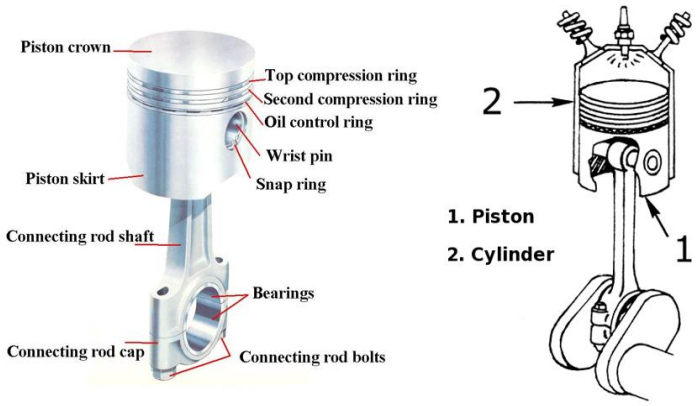
- Covers one end of the cylinder and consists of valves/ports & spark plug/Injector

Piston:

- It is a cylindrical component which is fitted perfectly inside the cylinder providing a gas tight space with piston rings and lubricants.
- The main function of piston is to transmit the force exerted by the burning of fuel to the connecting rod.

Piston Rings:

- The outer periphery is provided with several grooves in to which the piston rings are fitted
- The upper ring is known as compression ring and the lower one is called oil rings



Water jackets:

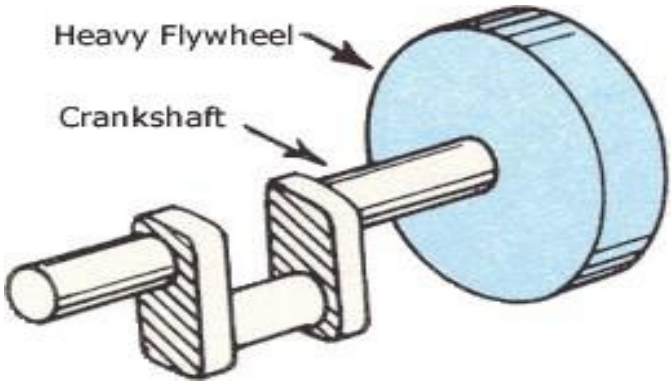
- Through which cooling water is circulated to prevent overheating of the engine.

Connecting rod:

- Element which interconnects piston and the crank.
- Transforms the reciprocating motion of the piston in to rotary motion of the crankshaft
- Two ends: 1. Small end-connected to the piston by Gudgeon pin
  2. Big end-connected to the crankshaft by Crank pin

Crank and crank shaft:

- Crank is the rotating member which receives power from the connecting rod and transmits to the crank shaft.
- Crank shaft is the principal rotating part of the engine which controls the sequence of reciprocating motions of the piston.

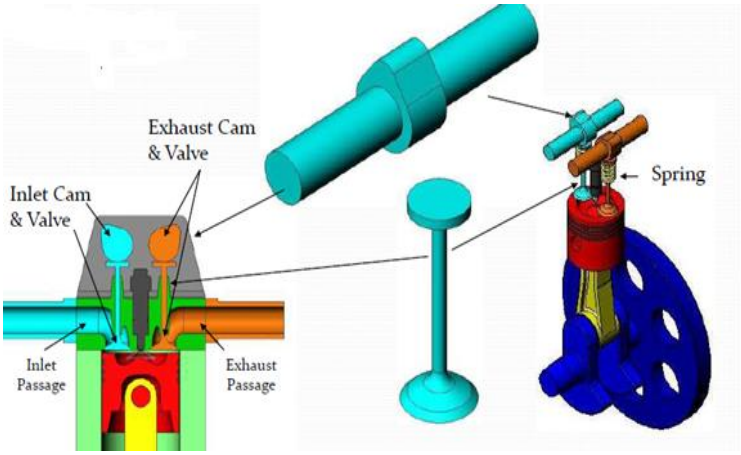


Flywheel:

- Heavy wheel mounted on the crank shaft
- It absorbs the energy during power stroke and release it during non power stroke
- Reduce the torque and speed fluctuations
- Absorbs vibration from the crankshaft
- Supports for clutch mechanism

Spark plug: Spark plug is located near the top of the cylinder of SI engine. It initiates the combustion of the fuel

Valve: Provided in the cylinder head for the admission of fresh air/air fuel mixture in to the engine cylinder and for rejection of burnt gases operated by cams and camshaft.



Fuel injector

- Purpose of fuel injector is to supply the metered quantity of fuel at high pressure in to the cylinder of CI engine/ MPFI engine
- Fuel pump : Electrically or mechanically driven pump to supply fuel

Terminology used in IC Engine :

Top Dead Center (TDC):

Position of the piston when it stops at the furthest point away from the crankshaft.

Top because this position is at the top of the engines (not always), and dead because the piston stops as this point. In some engines TDC is not at the top of the engines(e.g: horizontally opposed engines, radial engines,etc,.)

When the piston is at TDC, the volume in the cylinder is a minimum called the clearance volume

Bottom Dead Center (BDC):

Position of the piston when it stops at the point closest to the crankshaft.

Some sources call this Crank End Dead Center (CEDC) because it is not always at the bottom of the engine.

Stroke (L):

Distance traveled by the piston from one extreme position to the other: TDC to BDC or BDC to TDC.

Bore (d):

It is defined as cylinder diameter or piston face diameter; piston face diameter is same as cylinder diameter (minus small clearance).

Swept volume/Displacement volume (Vs):

Volume displaced by the piston as it travels through one stroke. Swept volume is defined as stroke times bore.

Clearance volume (Vc):

It is the minimum volume of the cylinder available for the charge (air or air fuel mixture) when the piston reaches at its outermost point (top dead center or inner dead center) during compression stroke of the cycle.

Minimum volume of combustion chamber with piston at TDC.

Compression ratio (r):

The ratio of total volume to clearance volume of the cylinder is the compression ratio of the engine.

$$\text{Compression Ratio (r)} = \frac{TVolume\ of\ cylinder}{Clearance\ volume\ of\ cylinder} = \frac{Swept\ volume + Clearance\ volume}{Clearance\ volume}$$

$$\text{Compression Ratio (r)} = \frac{Vs+Vc}{Vc}$$

Engine Specifications

Parameters	Maruti Swipt
Mileage	28.4 kmpl
Fuel Type	Diesel
Displacement	1248 CC
Maximum Power	74 bhp@4000 rpm
Maximum Torque	190 Nm@2000 rpm
Transmission	Automatic
Tank Capacity	37 Liters
Service cost (Avg. of % Years)	4483 Rs.

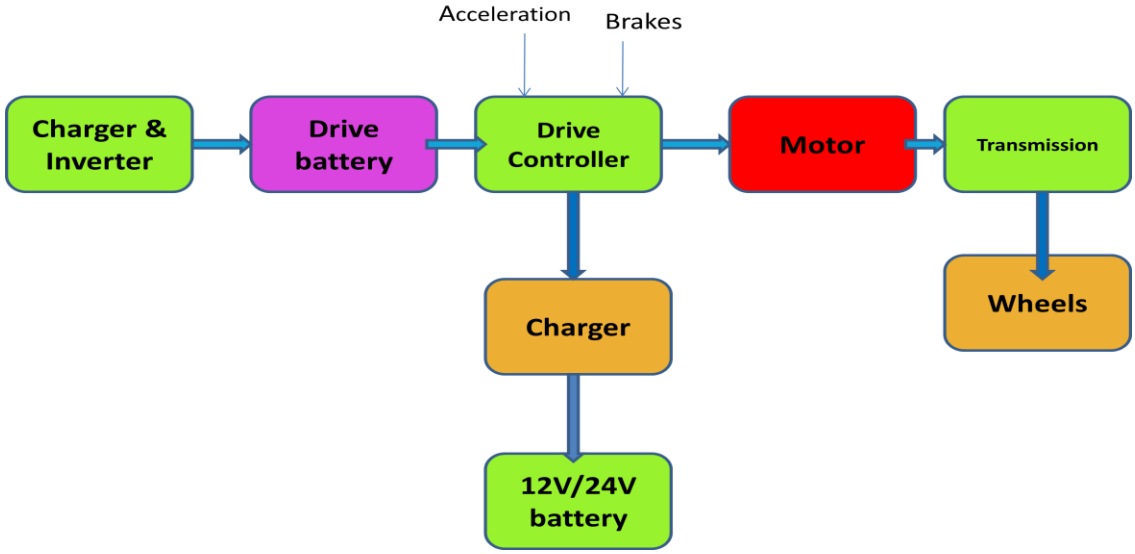
ENGINE Specification of **Hyundai Creta**	
Fuel Type	Petrol
Max Power	122 bhp @ 6400 RPM
Max Torque	154 Nm @ 4850 RPM
Transmission Type	Manual
No of gears	6 Gears
Cylinders	4, Inline
Valve/Cylinder (Configuration)	4, DOHC
Engine Type	VTVT Petrol Engine
Engine Description	1.6-litre 121.3bhp 16V VTVT Petrol Engine (Variable
Fuel Supply System	MPFI
Top Speed	165 Kmph
Acceleration (0-100 kmph)	10.5 Seconds

Comparison of Engine Specifications:

Engine Specifications	Hyundai Accent 	TATA 407 LPT 	TATA 1518 TC 
Torque	125 Nm @ 4500 rpm	250 Nm @ 4000 rpm	590 Nm @ 2000 rpm
Power	94 BHP @ 5500 rpm	70 BHP @ 4000 rpm	180 BHP @ 2500 rpm
No of Cylinders	4	4	4
Cubic Capacity	1527 cc	2400 cc	6000 cc
Bore and Stroke	78 mm and 82 mm respectively	97 mm and 100 mm respectively	150 mm and 200 mm respectively
Braking System	Front Disk, Rear Drum	Dual circuit full Air S-cam brakes	Air brakes with ABS
Cost	Rs. 7.11 Lakh	Rs. 9.70 Lakh	Rs. 21.4 Lakh

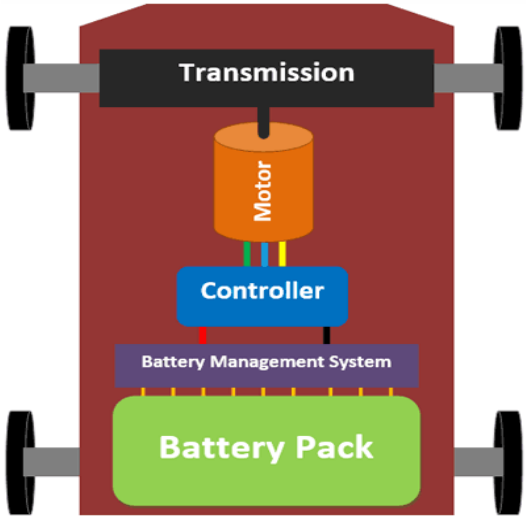
Electric Vehicle:

- Electric cars are the automobile vehicle which are powered by electric engine and electric energy
- Electric vehicles are powered by electric motor instead of heat engine.
- An electric vehicle (EV) is a vehicle that uses one or more electric motors or traction motors for propulsion.
- Components:
  - Battery pack
  - Electric Motor
  - Transmission
  - Inverter
  - Power electronic controller
  - DC/DC converter
  - Wheels



Working:

- High Capacity battery is used which can be lead based nickel based or lithium ion based.
- It is charged from the electric electric plug point outside vehicle
- Battery provide high current energy to inverter. It converts Ac to DC current.
- Motor used with DC shunt winding
- When pedal of the car is pressed, then Controller takes and regulates electrical energy from batteries and inverters
- With the controller set, the inverter then sends a certain amount of electrical energy to the motor (according to the depth of pressure on the pedal)
- Electric motor converts electrical energy into mechanical energy (rotation)
- Rotation of the motor rotor rotates the transmission so the wheels turn and then the car moves.



- **Advantages:**
  - Simple design and limited no of Components
  - Minimum running cost.
  - Highly reliable
  - Doesn't create any type of pollution
  - Noise free operation
  - Reduce dependence on oil and gasoline
  - No fire hazards.
- **Disadvantages:**
  - Battery need Frequent charging
  - High replacement cost of battery
  - Distance travel range limitations
  - Due to battery pack vehicle weight is more
  - High speed range is low in case of electric vehicle.

Hybrid Vehicle:

Hybrid vehicle is automobile propelled by two power sources electric motor & I C engine. Hybrid electric vehicle is a progressive transformation from conventional automobile vehicle powered by only I C engine to battery electric vehicle power by electric motor.

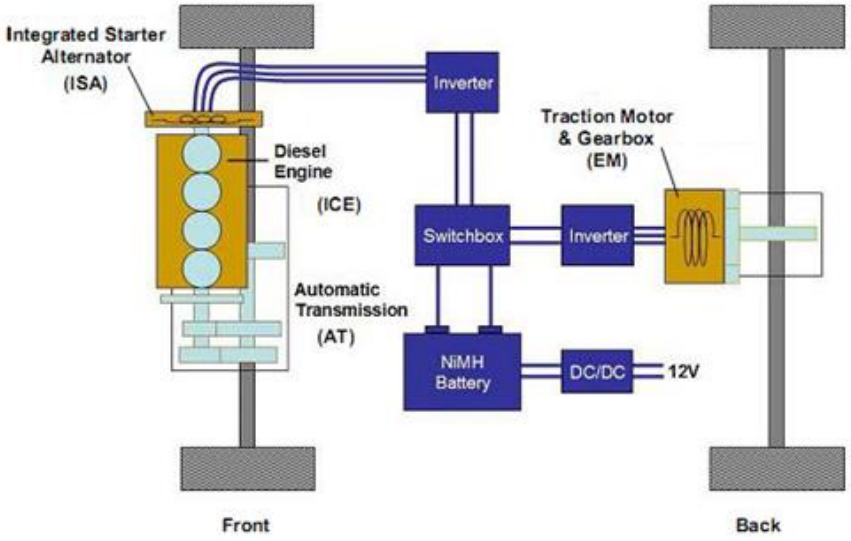
Hybrid vehicle minimizes the drawback of I C Engine powered vehicle and retains the advantage of it.

A **hybrid vehicle** uses two or more distinct types of power, such as internal combustion engine to drive an electric generator that powers an electric motor, e.g. in diesel-electric trains using diesel engines to drive an electric generator that powers an electric motor.

Components:

(i) Engine
(ii) Transmission System
(iii) Switch Box
(iv) Inverter

(v) Battery
(vi) Electric Motor
(vii) Wheels



The combination of Internal combustion engine & electric motor results in a hybrid vehicle. The optimum strategy for hybrid vehicle is to use electric drive during slow moving areas in city & IC engine during high speed on highway. This would result in reduced pollution in cities and improve mileage.

This type of hybrid cars is often called as standard hybrid or parallel hybrid. HEV has both an ICE and an electric motor. In this types of electric cars, internal combustion engine gets energy from fuel (gasoline and others type of fuels), while the motor gets electricity from batteries. The gasoline engine and electric motor simultaneously rotate the transmission, which drives the wheels.

- **Advantages:**
  - Efficiency is more then that of IC Engine vehicle
  - Highly reliable
  - Reduce fuel cost & harmful emission from it while run on battery.
  - Battery is continuously regarded by motor generator
  - Lower emission and better mileage
  - It does not use energy during idle state when it run on battery.
  - It reduces dependency on fuel
- **Disadvantages:**
  - High Cost of Vehicle
  - High replacement cost of battery
  - Due to battery pack vehicle weight is more
  - Poor handling: as smaller engine and heavy battery pack takes extra space in vehicle
  - Higher maintenance cost.

Cost analysis of vehicle:

The cost of vehicle is depend on following factors:

1. Type of engine: According to the type of engine or its capacity the cost of vehicle changes. For high power engines, the cost of vehicle is very high.

2. Safety features: If a vehicle includes safety, feature like ABS, air bag etc. then the cost of vehicle increases. It also depends on the number of airbags in a vehicle.

3. Material of vehicle (Raw material): The material of vehicle is one of the important factors in cost analysis. For high grade material the cost of vehicle increases rapidly. Now-a-days some parts of vehicle are replaced by fiber parts to reduce the cost of vehicle.

4. Production method: Some manufactures like BMW, Audi etc. use fully automatic machines for production of vehicle. This increases accuracy and finishing of vehicle. But this increases the cost of vehicle. Hence as per the production method the cost of vehicle changes.

5. Research and development (R and D): It is a hidden cost of vehicle. It requires long time and number of technical people.

6. Royalty: The innovations likes ABS, Air bags etc. are all innovations by Bosch Company and not by car manufacturers. The manufacturers need to pay royalty to Bosch for using the technology.

7. Dealer profit

8. Insurance and taxation

9. Availability of spare parts

10. Advertisement (Posters, ads, campaigns etc.)

11. Quantity of production

12. Labor cost, etc.