

Layout of chassis	(Components of Automobile)
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1) Chassis (Frame) :

It is a skeleton frame of a vehicle on which various components or system of vehicle are mounted.

Most significant component of automobile.

2) Axles : These are the components on which chassis is mounted.

i) Front axle : It supports chassis on front side. Steering mechanism is mounted on front axle.

ii) Rear axle : It supports chassis on rear side. It consists of driving shaft enclosed in tubular structure.

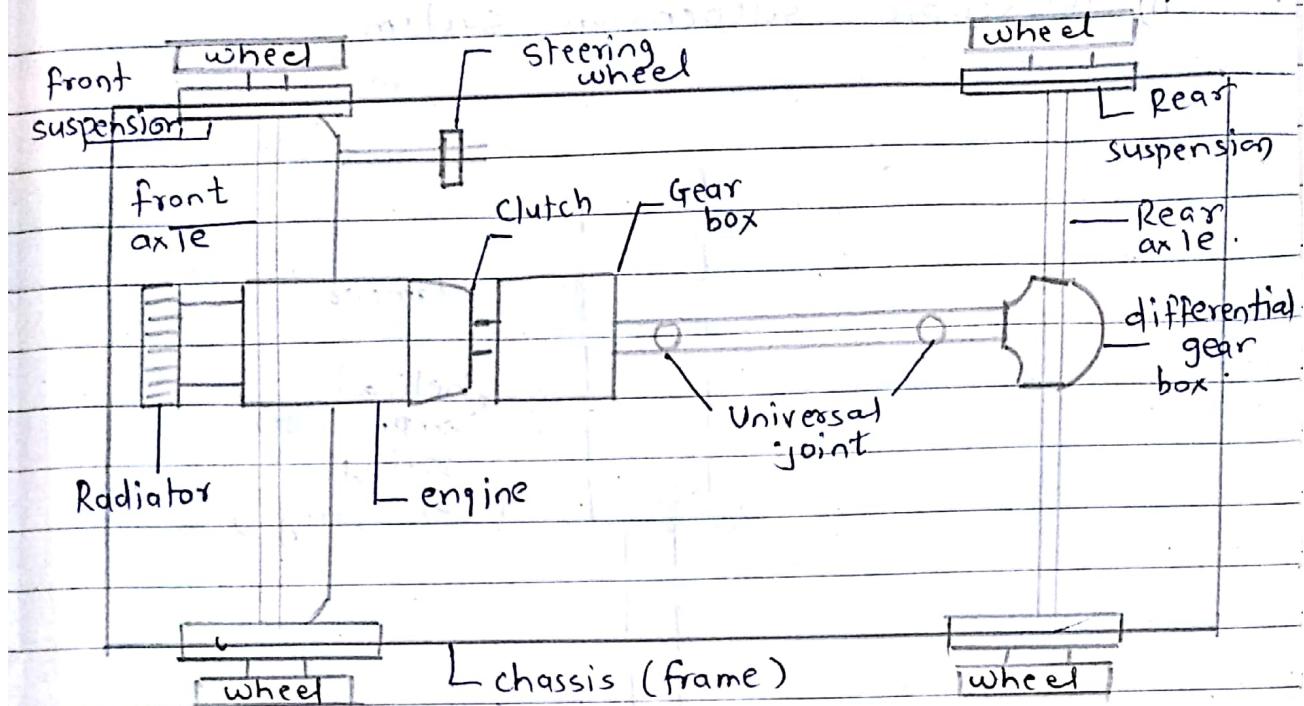
3) Wheels : It supports the axles. The load of vehicle & passengers is supported by wheels through the axles.

4) Suspension system : Chassis is mounted on the axles not directly but through the suspension system. Suspension system isolates vehicle body & passengers from road shocks.

5) Steering system : It is used for turning the wheels in the desired direction. It is mounted on front axle.

6) Engine : It is an IC engine which converts chemical energy of fuel into mechanical power at the crankshaft.

- 7) Clutch: It is mounted betⁿ engine & the gear box. It is used to engage or disengage ^{engine} from gear box as per the will of the driver.
- 8) Gear box: It receives power from engine through clutch & transmit power to the propellar shaft. In gear box, torque is increased & speed is reduced.
- 9) Propellar shaft & Universal joints: It is a mechanical element, transmit power from gear box to differential on rear axle.
- 10) Differential gear box: It transmits the power from propellar shaft to the shaft of rear axle. Shaft of rear axle is at right angles to propellar shaft. Shaft of rear axle transmit power to the wheels.
- 11) Radiator: It is a heat exchanger placed at the front of the vehicle. It cools the hot coolant coming from the engine & sends it back to the engine.



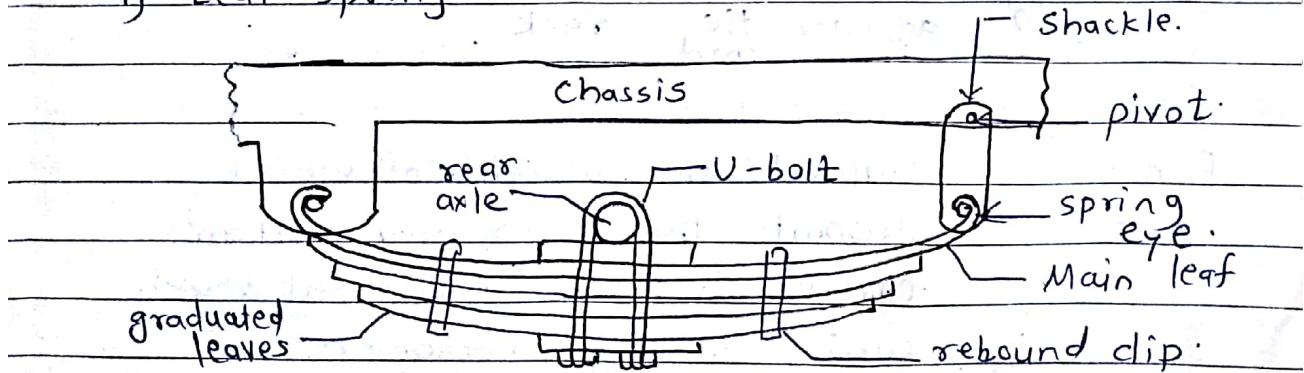
[Layout of chassis]

Suspension System →

It is mounted between the automobile chassis & the axles to isolate the vehicle body from road shocks. It consists of spring or damper. The damper (shock absorber) consists of piston cylinder arrangement filled with oil.

→ Types of suspension system:

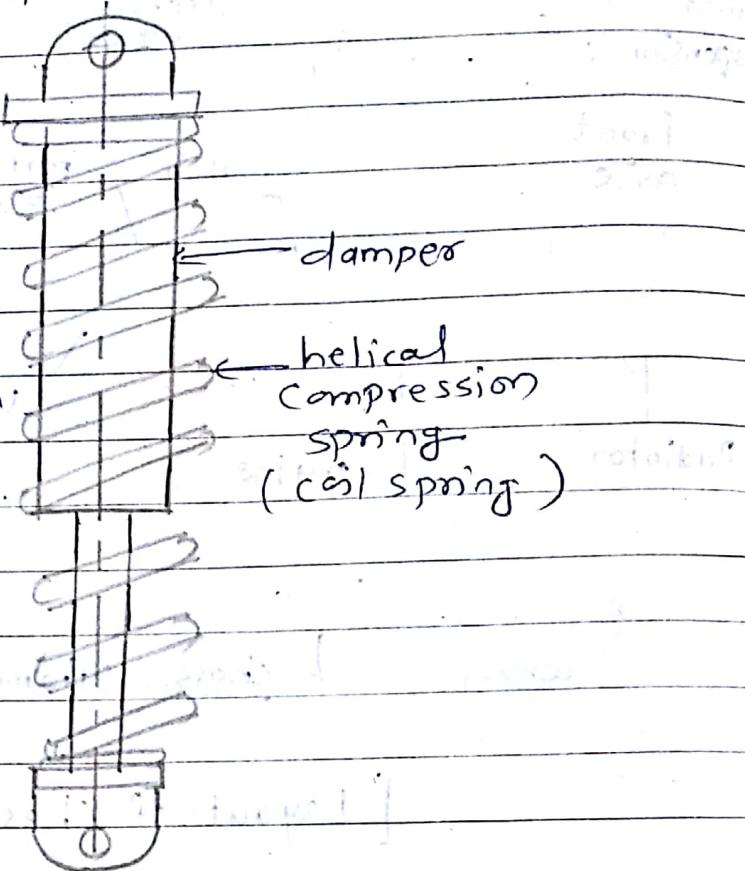
i) Leaf spring:



Appn: bus, trucks etc.

ii) Telescopic suspension system:

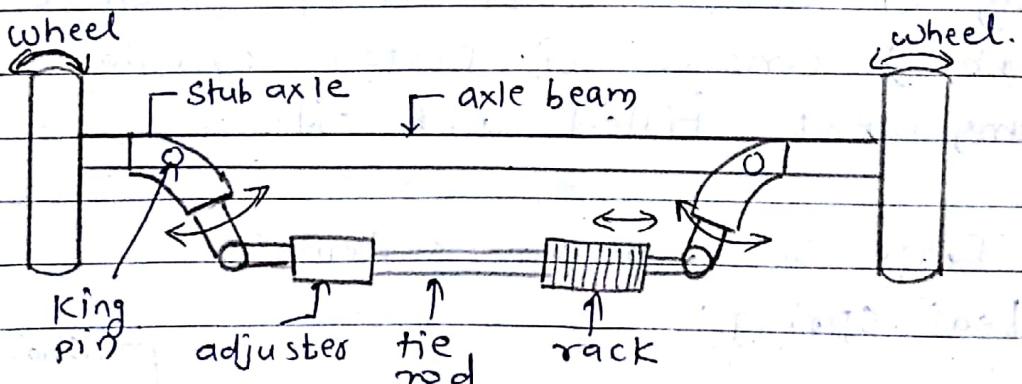
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Appn: two wheelers or cars etc.

Front Axle: \rightarrow

It is a member which carries the wheels at its ends.



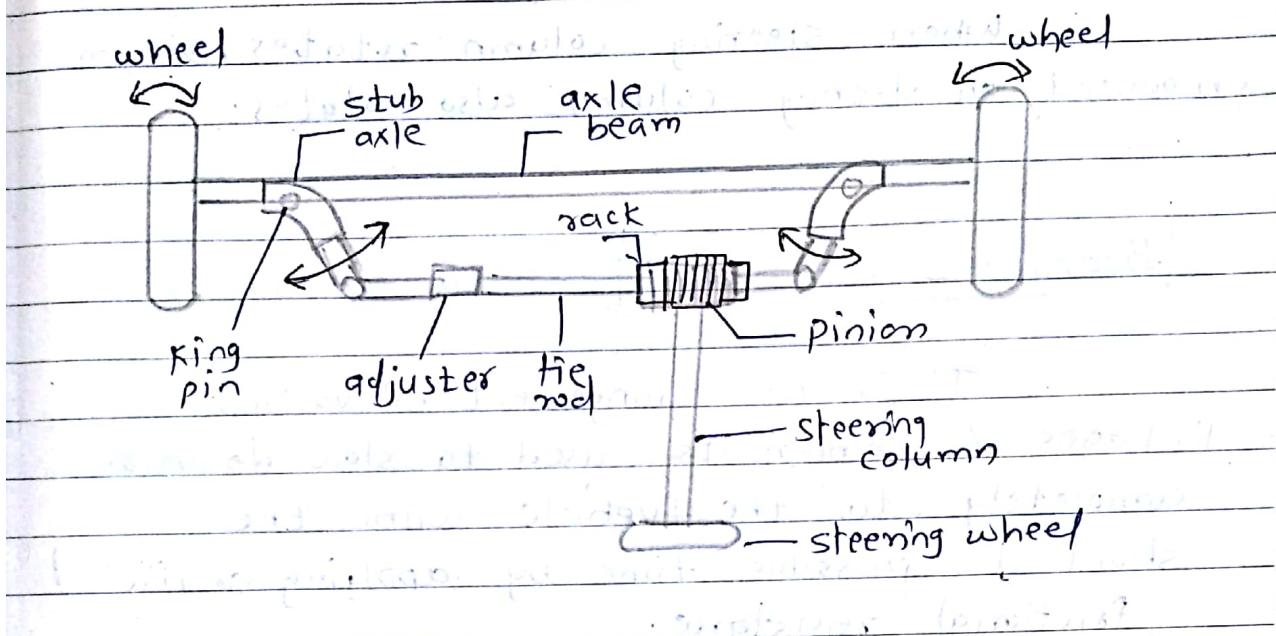
Functions: supports the weight of vehicle.

Supports the suspension system.

carries brake drum & front wheel.

carries steering mechanism

Steering Mechanism (Ackermann steering mechanism) \Rightarrow



Components : Axle beam

Stub axle

Tie rod

Rack & pinion

Steering column

Steering wheel

\rightarrow Axle beam - vehicle chassis is supported on axle beam through the suspension system.

Axle takes the weight of vehicle & transmit it to stub axle.

\rightarrow Stub axle : one end : wheel & other end : tie rod.

\rightarrow Tie rod : two stub axles are connected to each other by tie rod. With help of adjuster, length of tie rod can be adjusted.

\rightarrow Rack & pinion : converting rotary motion to linear motion. Oscillatory motion of stub axle

can be achieved by giving linear motion to tie rod.

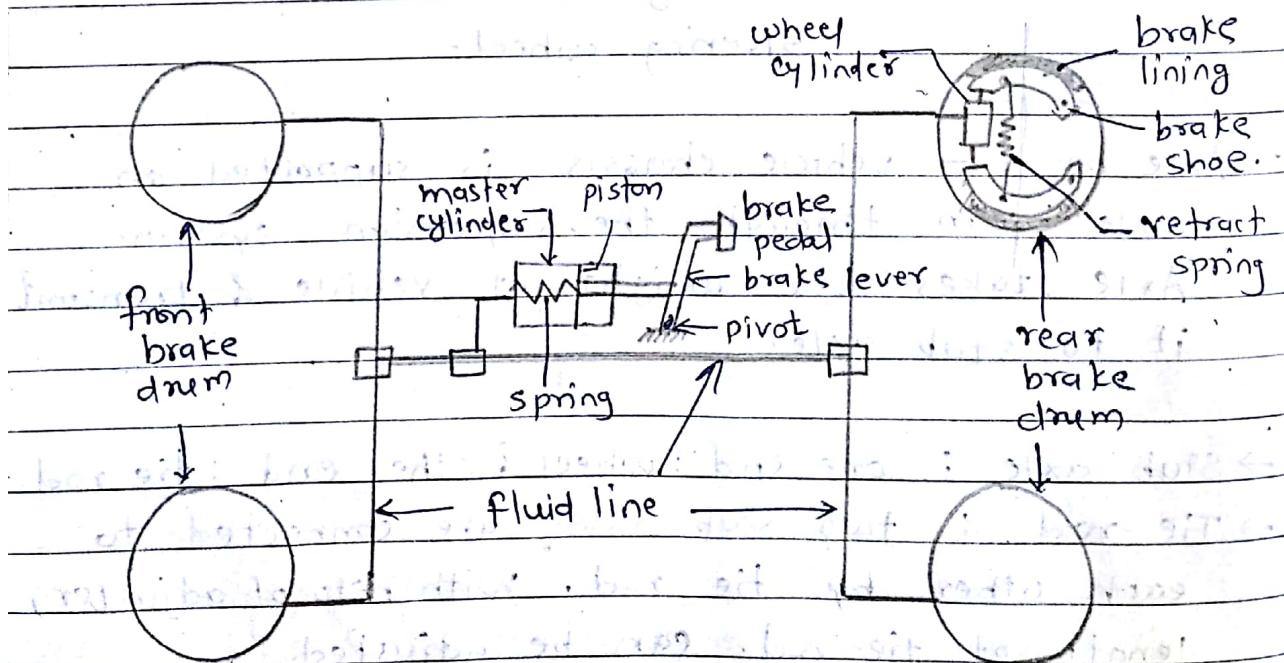
→ Steering column & wheel:

When steering column rotates, pinion mounted on steering column also rotates.

Braking System →

It is an arrangement of various linkages & components used to slow down or completely stop the vehicle within the shortest possible time by applying artificial frictional resistance.

In a process of performing function, brake absorbs K.E. of moving blade & converts it to heat energy. Heat generated by brake is unwanted energy & has to be dissipated to surrounding air.



[Layout of hydraulic
braking system]

Components of braking system:

brake pedal & brake lever

master cylinder

fluid lines

wheel cylinder

brakes

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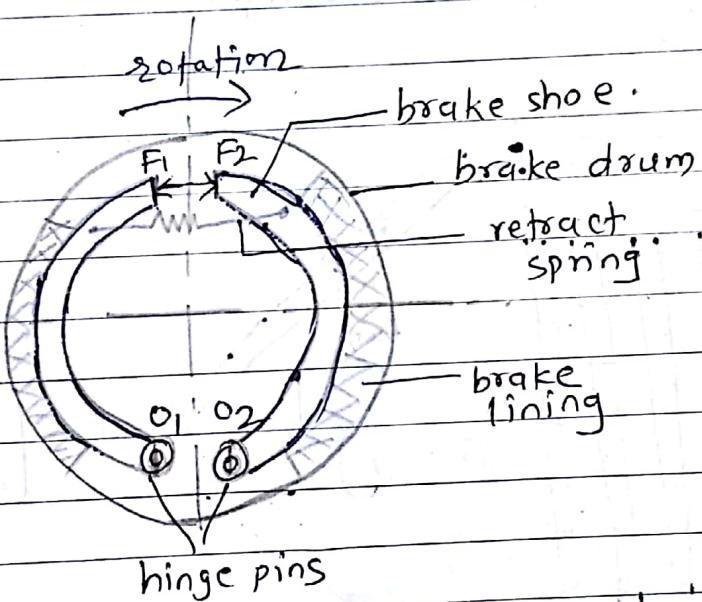
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Types of brakes : i) drum brake
ii) disk brake.

Internal expanding shoe brake:



Appl': truck, bus, car, motorcycle, Scooters.

Cooling System \rightarrow

- $\eta_{\text{thermal}}: 30\%$

- If heat lost to cylinder wall is not dissipated or removed it leads to

i) damage of cylinder due to overheating

ii) seizing of piston due to overheating

iii) burning of lubricating oil.

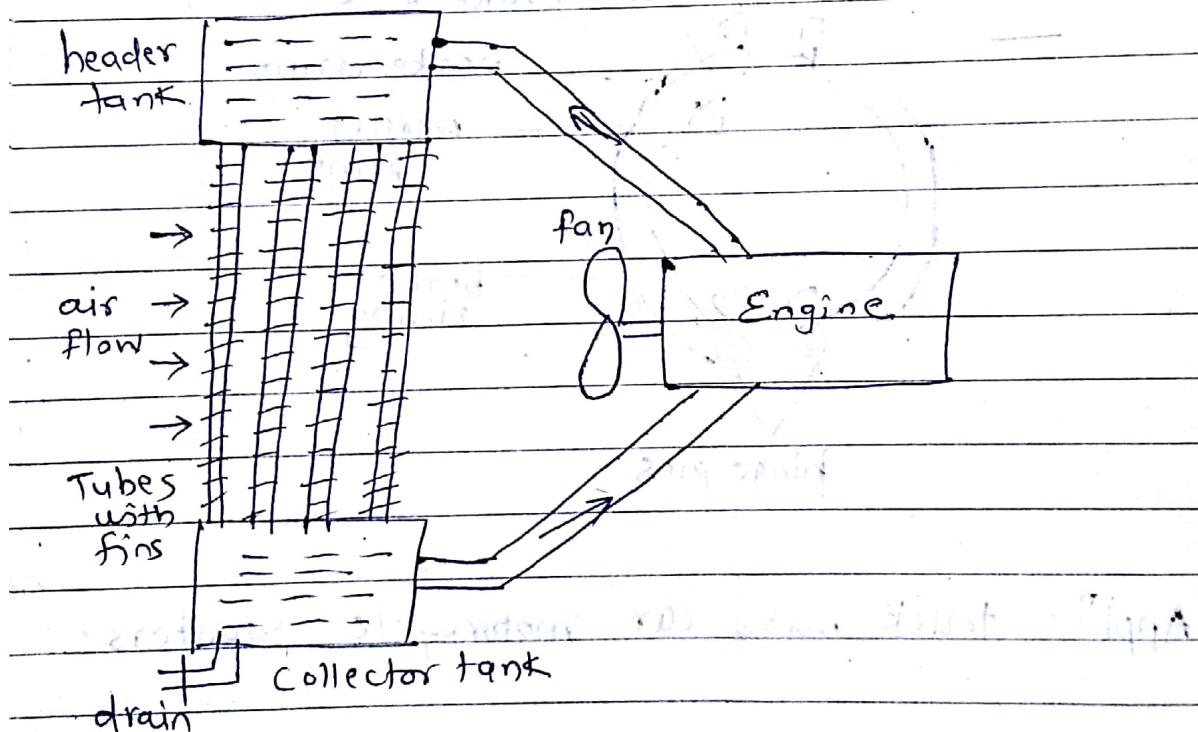
Therefore, it is necessary to provide cooling system to dissipate heat.

→ Methods of Cooling : Air cooling
water cooling.

→ In air cooling, fins are provided on the surface of cylinder. Fins increases surface area available for dissipation of heat.

Appn : two wheelers.

→ Water cooling system uses water/coolant as medium of cooling.



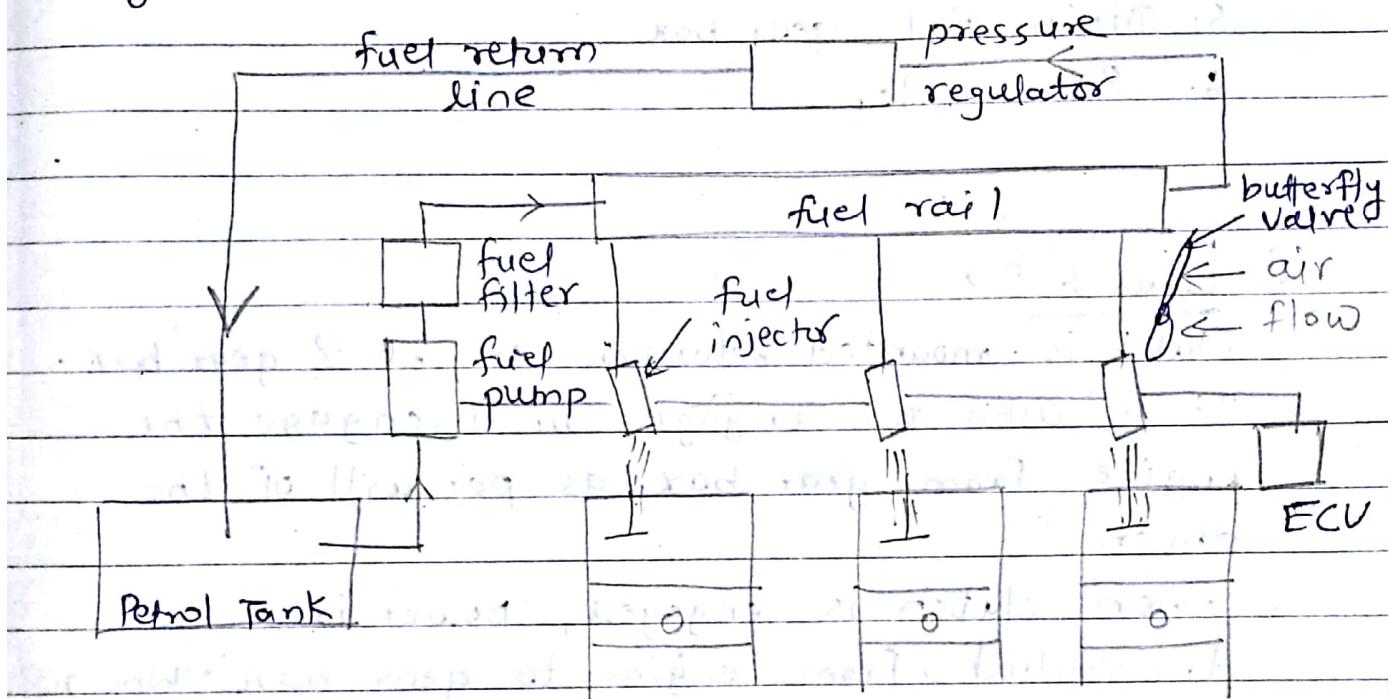
[Water Cooling System]

Appn : four wheelers.

Fuel Supply & Fuel Injection System

(SI Engine) \Rightarrow

Traditionally carburetor is an essential element of fuel supply in SI engine. It is now being replaced in petrol four-wheelers by multi-point fuel injection (MPFI) system.



Elements of MPFI system : Petrol tank

Fuel Pump

Fuel filter

Fuel rail

Fuel injector

Pressure regulator

Electronic control Unit

Note : ECU decides amount of fuel injected & timing of fuel injection in each cylinder.

Power Transmission System \rightarrow

Components of power transmission system:

1. Clutch
2. Gear box
3. Propeller shaft
4. Universal joint
5. Differential gear box
6. Rear axle.

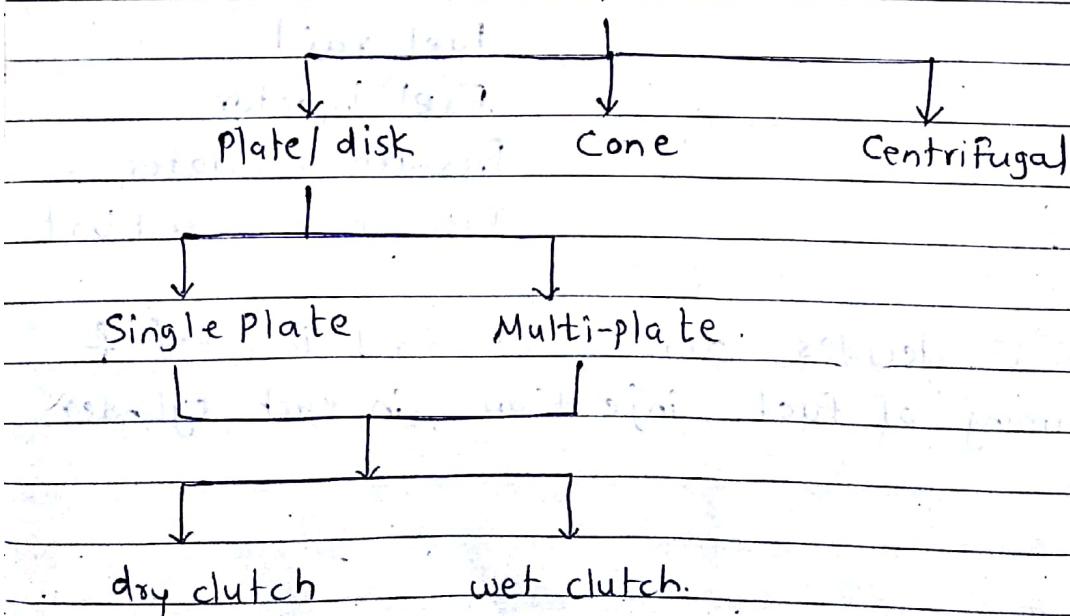
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1] Clutch \rightarrow

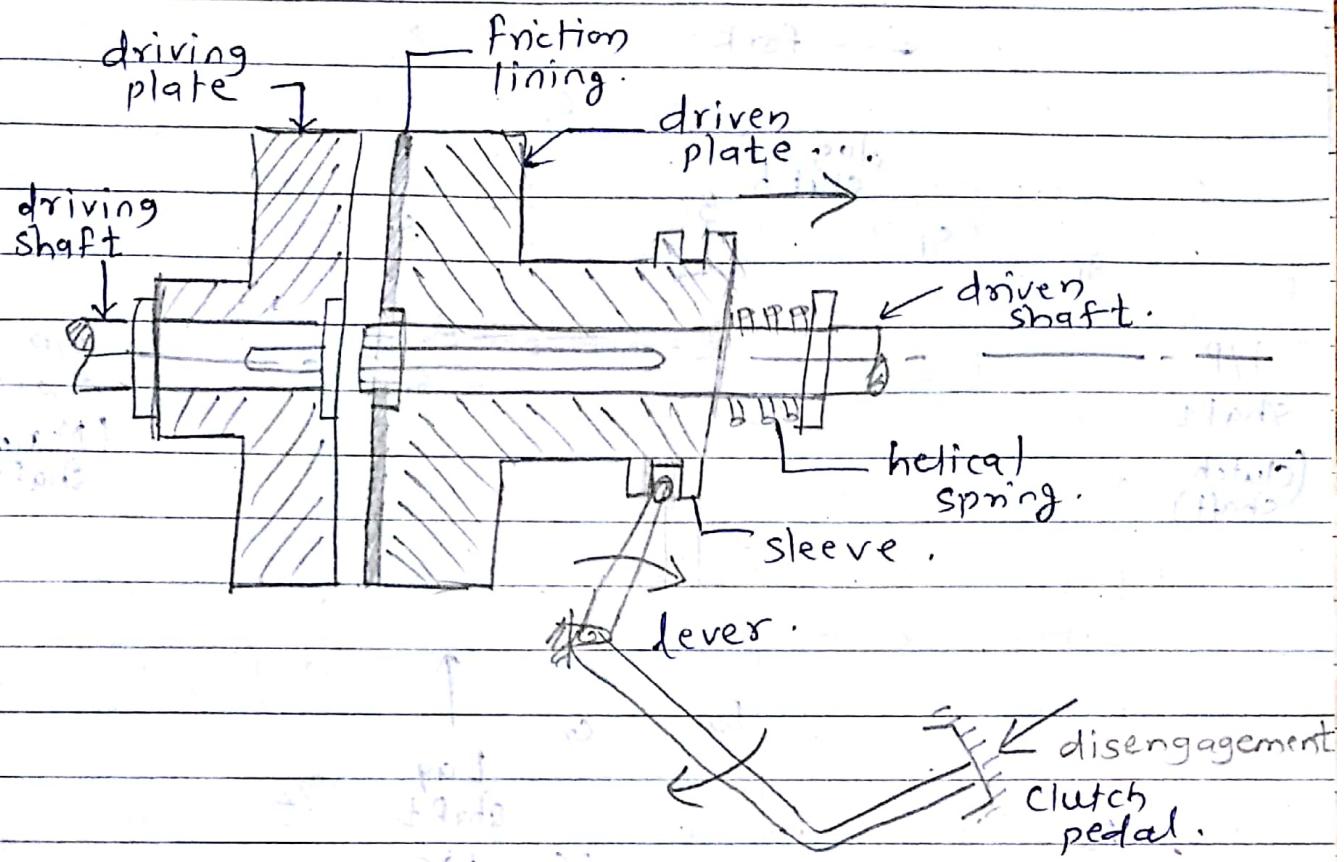
- Clutch is mounted between engine & gear box.
- It is used to engage or disengage the engine from gear box as per will of the driver.
- When clutch is engaged, power is transmitted from engine to gear box. When clutch is disengaged by pressing clutch pedal, there is no power transmission from engine to gear box.

Friction Clutch



Classification

Single plate clutch :



Appln: trucks, buses, cars etc.

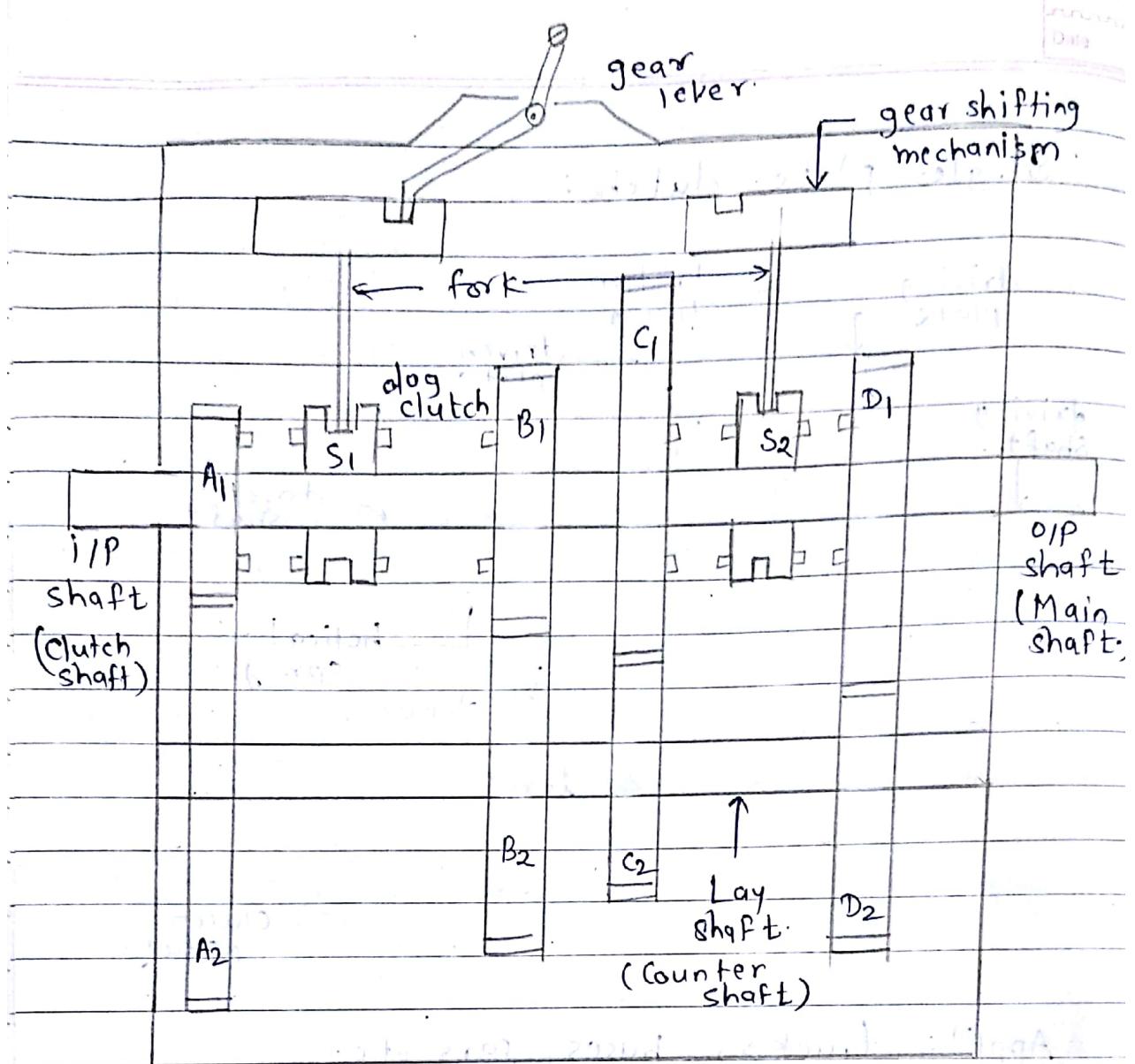
2] Gear box \rightarrow

- It receives the power from engine through clutch & transmit the power to the propellar shaft.

- In gear box, torque is increased & speed is reduced.

- It produces different speed ranges for the vehicle.

Types of gear box : Constant mesh gear box
Sliding mesh gear box.
Synchromesh gear box.



Layout of Constant Mesh Gear Box.

1st gear: I/P shaft - gear A₁ - gear A₂ - Lay shaft - O/P shaft — dog clutch — gear C₁ — gear C₂

$$\text{Gear ratio (i)} = \frac{n_i}{n_o} = \frac{\text{speed of I/P shaft of gear box}}{\text{speed of O/P shaft of gear box}}$$

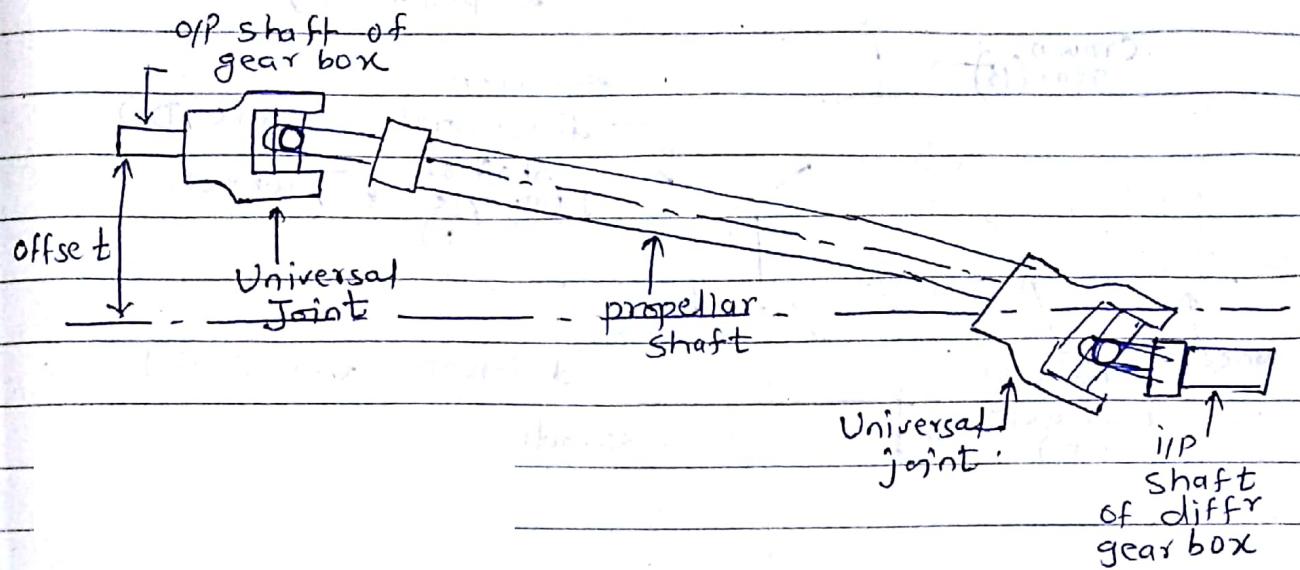
$$\text{I/P power} = P_i = \frac{2\pi n_i T_i}{60 \times 1000}$$

ni : i/p speed
Ti : i/p torque

$$\text{O/P Power} = P_o = \frac{2\pi n_o T_o}{60 \times 1000}$$

no : o/p speed
To : o/p torque.

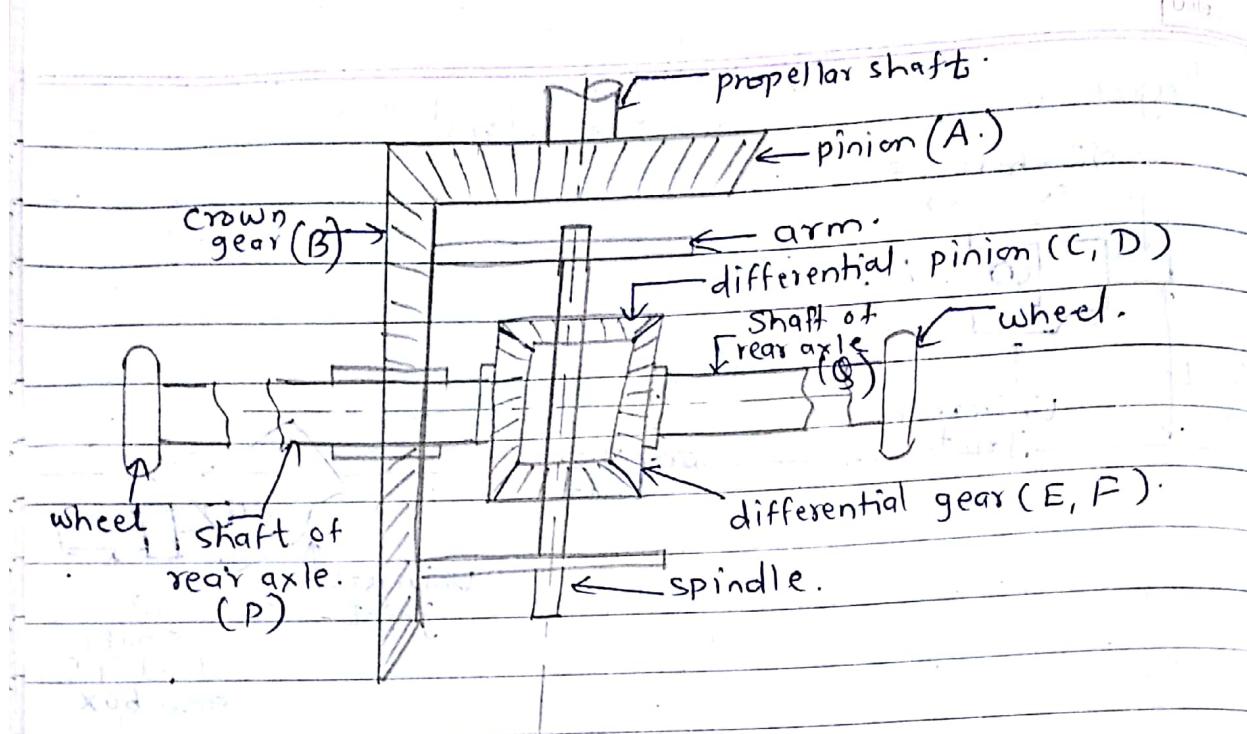
Propellar Shaft & Universal Joint →



- It is located in rear part of vehicle.
- Power is transmitted from gear box to differential gear box through long shaft as propellar shaft.
- Postⁿ of i/p shaft of differential gear box is at much lower level as compared to O/P shaft of gear box.
- Axes of two shaft are parallel but there is some offset. To connect these two shaft universal joint is used

Differential Gear Box →

- It transmit the power from propellar shaft to the shaft of rear axle.
- Functions :
- i) Shaft of rear axle is at right angles to the propellar shaft. So diff'r gear box transmit power at right angle.
 - ii) Diff'r gear box allow two wheels to rotate at different speeds when vehicle is taking a turn.
 - iii) It increases the torque & reduces the speed from propellar shaft to rear axle shaft.



→ Vehicle Safety →

Necessity : It is necessary to ensure the safety of passengers inside the vehicle as well as safety of pedestrians on the road.

Types : i) Active (Primary) Safety system
 ii) Passive (Secondary) safety system.

i) Active (Primary) Safety system : These are safety system which help to prevent the accidents.

e.g. Antilock braking system (ABS)

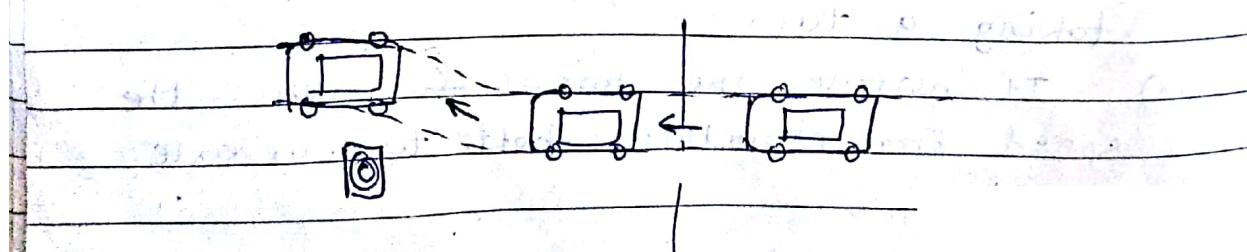
Electronic stability control (ESC)

Cruise control (CC)

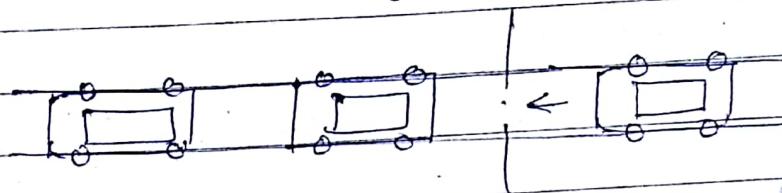
Tyre pressure monitoring system (TPMS)

Night vision system (NVS)

With ABS : Good steering control.



Without ABS (No steering control):



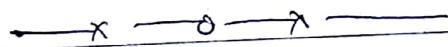
Advantages: increases braking distance on slippery road.

improves steerability
maintains steering control.

ii) Passive (Secondary) Safety System:

These systems protect passengers once accident takes place. These system do nothing until the vehicle crash.

Examples: Seat belts,
Air bags,
Laminated glass.



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Numericals

Gear box : Types

- i) Constant mesh
- ii) Synchromesh
- iii) Sliding

Functions of gear box:

increase torque, reduces speed

Gear ratio: $i_1 = \frac{n_i}{n_o}$ = speed of IIP shaft of gear box
 (i) speed of OIP shaft of gear box.

$$\text{IIP power} = P_i = \frac{2\pi n_i T_i}{60 \times 1000} \text{ kW}$$

$$\text{OIP power} = P_o = \frac{2\pi n_o T_o}{60 \times 1000} \text{ kW}$$

$$r_2 = \frac{n_o T_o}{n_i T_i}$$

if $\eta = 100\%$.

$$n_i T_i = n_o T_o$$

① Auto engine is running at 6000 rpm.

Speed of propeller shaft is 1500 rpm in first gear & 7500 rpm in 5th gear.

Detr gear ratio in 1st & 5th gear.

$$\text{Soln: } 1^{\text{st}} \text{ gear } i = \frac{6000}{1500} = 4$$

$$5^{\text{th}} \text{ gear } i = \frac{6000}{7500} = 0.8$$

② Auto engine is developing 70 kW power at 4000 rpm. If gear ratio in 1st gear is 3.9:1 det'r

i/p torque of gear box

o/p torque of gear box

o/p speed of gear box

$$\text{Sol}^n : P_i = 70 \text{ kW}$$

$$n_i = 4000 \text{ rpm}, i = 3.9$$

$$\text{i/p torque} : P_i = \frac{2\pi n_i T_i}{60 \times 1000}$$

$$\therefore T_i = 167 \text{ N-m}$$

$$\text{o/p speed} : n_o = \frac{n_i}{i} = \frac{4000}{3.9}$$

$$\therefore n_o = 1025 \text{ rpm}$$

$$\text{o/p torque} : n_o T_o = n_i T_i$$

$$\therefore T_o = 651 \text{ N-m}$$

- (3) Car engine is developing 81 bhp at 5500 rpm. Gear ratio in fifth gear is 0.83. If the efficiency of gear box is 90%.

(i) i/p torque of gear box

(ii) o/p torque

(iii) o/p speed

$$\text{Sol}^n : P_i = 81 \text{ hp} = 81 \times 0.73 \text{ kW}$$

$$n_i = 5500 \text{ rpm}$$

$$i = 0.83 \quad ; \quad \eta = 0.9$$

$$P_i = 59.57 \text{ kW} = \frac{2\pi n_i T_i}{60 \times 1000}$$

$$T_i = 103 \text{ N-m}$$

$$i = \frac{n_i}{n_o} \Rightarrow n_o = 6626 \text{ rpm}$$

$$\eta = \frac{P_o}{P_i} \quad T_o = 77.26 \text{ N-m.}$$

- (4) A pinion with 120 mm pitch circle dia meshes with gears of 400 mm pitch circle dia. No. of teeth on pinion is 18 & it rotates at 1440 rpm. Find (i) gear ratio ii) No. of teeth on gear (iii) speed of gear.

$$\text{Ans: } G = \frac{d_g}{d_p} = \frac{400}{120} = 3.33$$

$$G = \frac{Z_g}{Z_p} \Rightarrow Z_g = 60$$

$$G = \frac{n_p}{n_g} \quad \therefore n_g = 432 \text{ rpm.}$$

- (5) A pinion of pitch circle diameter 150 mm meshes with gear having 80 teeth. Gear ratio is 4 & speed of gear is 500 rpm. Find (i) dia. of gear (ii) speed of pinion (iii) No. of teeth of pinion

$$\text{Ans: } G = \frac{d_g}{d_p} \quad \therefore d_g = 600 \text{ mm}$$

$$G = \frac{n_p}{n_g} \quad \therefore n_p = 2000 \text{ rpm}$$

$$G = \frac{Z_g}{Z_p} \quad \therefore Z_p = 20$$

- (6) P.C.D. of pinion is 200 mm. Gear ratio is 3. Pinion is attached to motor having 1440 rpm & 20 kW power.

Number of teeth on pinion is 20. Find

- (i) torque reqd to transmit power at pinion
- (ii) no. of teeth of gear.

Solⁿ : $P = \frac{2\pi n_p T_p}{60} \Rightarrow T_p = 132 \text{ N-m}$

$$G = \frac{Z_g}{Z_p} \Rightarrow Z_p = 60.$$

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