

**B.E.**

Seventh Semester Examination, 2009-2010

**Automobile Engineering (ME-401-E)**

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**Note :** Attempt any *five* questions. All questions carry equal marks.

**Q. 1. (a) Explain briefly various requirements of the automobile body.**

**Ans. Various Requirements of the Automobile Body :**

This include :

- (i) **Frame :** Box, channel and tubular section cross and diagonal members.
- (ii) **Suspension Systems :** Springs, shock absorbers, torsion bar.
- (iii) **Steering System :** Steering wheel, steering column, steering gears, Pitman's arm.
- (iv) **Front Axle System :** "I" section dead axle, stub axle.
- (v) **Wheel and Tyre System :** Brake drum, brake shoe, brake lining, wheel cylinder, tube.
- (vi) **Braking System :** Pedal, master cylinder, tubings, hoses, linkages.

**Q. 1. (b) Discuss advantages and disadvantages of four wheel driver over those with only one drive axle.**

**Ans. Advantages of 4-wheel Driver Over those with Only One Drive Axle :**

- (i) Even tyre wear.
- (ii) More balanced axle load distribution.
- (iii) Better aquaplaning behaviour.
- (iv) Reduced sensitivity to side wind.
- (v) An increase in the drive-off & climbing capacity regardless of load.
- (vi) Particularly suitable for towing trailers.
- (vii) Stability reserves on clutch & compacted snow tracks.
- (viii) Better acceleration in low gear.
- (ix) Better traction on smooth surfaces in all road condition.

**Disadvantages :**

- (i) Acquisition costs.
- (ii) Around 6–10% higher kerb weight of vehicle.
- (iii) Generally somewhat lower maximum speed.
- (iv) 5% to 10% increased fuel consumption.
- (v) Lack of ABS—compatibility of some system.
- (vi) Not always clear cornering behaviour.
- (vii) Smaller boot compared with front wheel drive vehicles.

**Q. 1. (c) Discuss future trends in automobiles.**

**Ans. Future Trends in Automobiles :**

- (i) These are also called generation IV automobiles.
- (ii) They have not established themselves commercially but these are in the offing.
- (iii) They are likely to use a new technology by using non-petroleum fuels, likely fluids will be nascent hydrogen.
- (iv) Hybrid powered, solar energy powered, computer controlled & zero emission vehicles have bright future.
- (v) Much attention has been paid on producing autovehicles :
  - (a) Light in weight
  - (b) Less fuel consuming
  - (c) Least polluting making
  - (d) Fitted with electronic gadgets etc.
- (vi) Fourth generation vehicles are likely to be :
  - (a) Zero emission vehicles.
  - (b) Electric vehicles.
  - (c) Hydrogen fueled vehicles
  - (d) Hybrid energy powered vehicles.

**Q. 2. What is the function of a clutch in an automobile? Why do we use multiple clutches? Explain the constructional features and working of multi plate wet type clutch using neat diagrams.**

**Ans. Functions of Clutch :** The main purpose of clutch is allowing or discontinuing the power flow from engine to transmission system.

(i) **Gradual Engagement :** A clutch should take on power drive without undesired jerks when it is re-engaged. It help in increasing driving comfort.

(ii) **Effortless Operation :** Operation of clutch disengagement should be easier so that driver doesn't feel tired.

(iii) **Size :** Size of clutch should be such that it occupies minimum space.

(iv) **Torque Transmission :** A clutch should be able to transmit full torque produced at engine crankshaft to gear box under all condition of vehicle's operation.

(v) **Dynamic Balancing :** A clutch should be balanced both statically & dynamically.

(vi) **Vibration Damping :** A good clutch should incorporate a suitable system of springs, materials which help in damping the vibration.

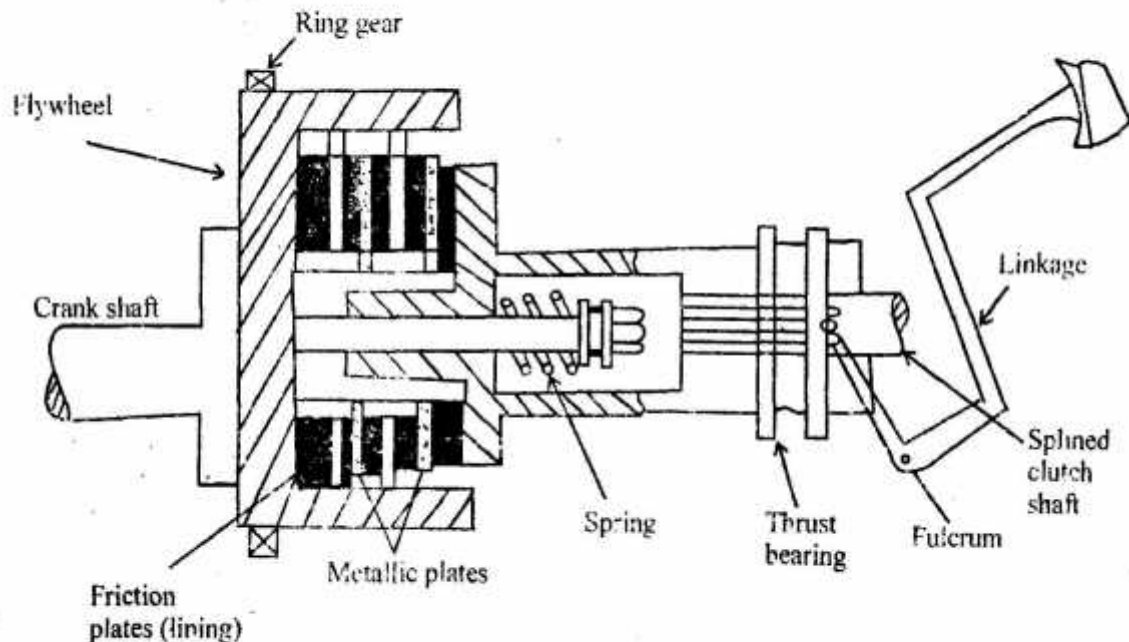
**Need of Multiplate Clutch arise due to :**

- (i) Space limitation such as in 2-wheeler.
- (ii) Requirement of high torque transmission as in racing cars & on some heavy transport vehicles.

**Constructional Feature & Working of Multiplate Wet Clutch :**

- (i) It consists of number of thin plates made of steel fitted to the engine shaft & those on gear shaft are made of phosphor bronze.

- (ii) These plates are immersed in bath of oil & also have grooved surfaces for permitting the oil to flow through them.
- (iii) These grooves help to dissipate the heat generated during the engagement & release operations.
- (iv) These clutches are generally used in conjunction with or as part of automatic transmission.



• **Q. 3. What is the necessity of a gear box in a vehicle? Describe in detail function, construction and working of a synchromesh gear box.**

• **Ans. Necessity of Gear Box :** Gear box is a speed & torque changing device between the engine & driving wheels.

It serves the following purposes in transmission system of an automobile :

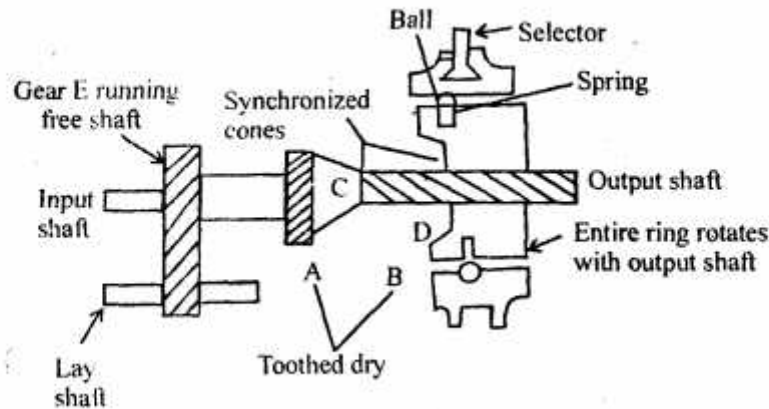
- (i) It exchange engine power for greater torque & thus provides mechanical advantages to drive the vehicle under different condition.
- (ii) It exchanges forward motion for reverse motion.
- (iii) It provides a neutral position to disallow power flow to the rest of power train.

**Synchromesh Gear Box :**

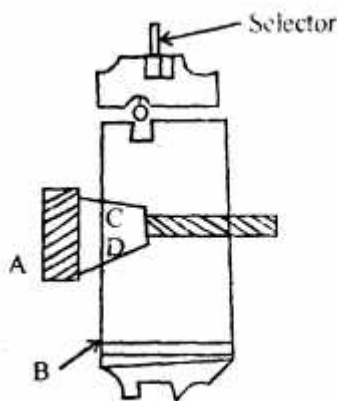
- (i) The need of a synchromesh gearbox has arisen due to undesired "double declutching" required in the operation of constant mesh gear box.
- (ii) 'Synchronizing' means matching the speeds automatic arrangement for matching the speed of engaging dogs is called synchromeshing.
- (iii) The gearbox employing such arrangement is termed as 'synchromesh gearbox.'



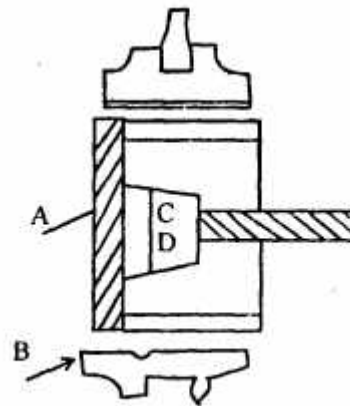
**Working :**



(i) Discharged Portion



(ii) Engaged cones but disengaged dogs



(iii) Engaged cones & Dogs on moving selector

**(i) Disengaged Position :** Neither the male synchronizing cone C meshes with its female cone D, nor the male toothed dog A overrides the female toothed dog B, the input shaft, layshaft & gears are running free.

**(ii) Movement of Selector :** Now, when the selector is moved in direction, the synchronizing cone C & D comes in contact & the friction between them either speeds up or slows down the gear E w.r.t. output shaft A.

**Further Movement of Selector :** It causes toothed dog A & B to override by overcoming spring loaded balls & thus gear E is locked to output shaft.

We call this situation of gear engagement.

**Q. 4. (a) Explain torque tube drive with the help of a neat sketch.**

**Ans. Torque Tube Drive :**

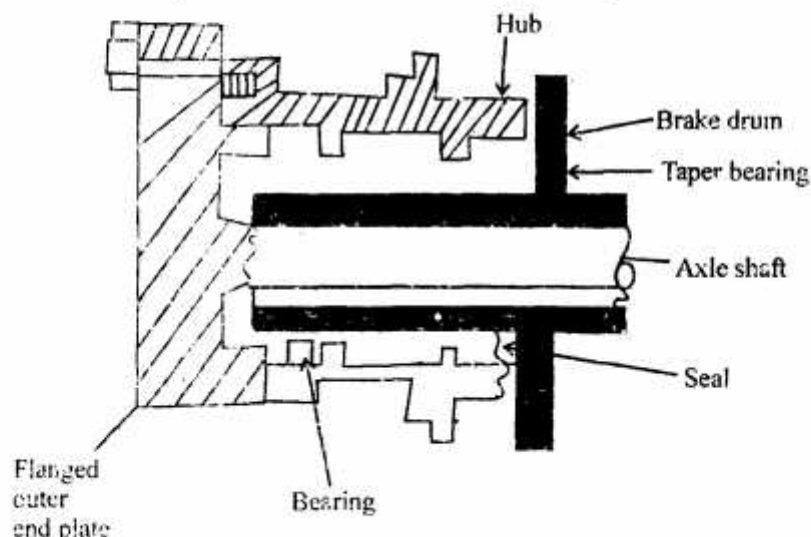
- (i) It is also called torque tube type of propeller shaft.
- (ii) A torque tube is large diameter tube fastened securely to the rear axle housing & completely enclosing the propeller shaft.
- (iii) The torque tube is fitted into spherical ball & socket surrounding one universal joint at the transmission end. These two unit carry their respective load while allowing suspension flexibility.

- (iv) Thus, while normal engine power transmission takes place through the propeller shaft, the braking & acceleration causes sudden torque are borne by torque tube
- (v) In modern vehicles, this type of construction is replaced by Hotchkins drive.

**Q. 4 (b) Discuss the constructional details of a fully floating axle with the help of a sketch.**

**Ans. Fully Floating Axle :**

- (i) In an ideal arrangement, the rear wheel should rotate on bearing placed outside the axle casing & the half shaft should drive the wheel through some connection.
- (ii) But if the arrangement is such that the half-shaft doesn't carry any vertical or side loads & merely serves to transmit torque to the wheel, it is referred fully floating axle.



- (iii) The construction shows an axle shaft whose outer end is flanged & the flange is connected to the hub by means of axle pin. The hub incorporates two taper roller bearing mounted on the ends formed on axle tube.
- (iv) The hub & bearing are secured by adjusting nut, lockwasher & lockout. The brake drum is attached by means of shouldered hub bolts which are pegged in hub flange.
- (v) The taper roller bearing bear the side loads while axle tube & wheel supports the weight of vehicle.
- (vi) The mounting system of full floating axle is strong & robust in construction but is very costly.
- (vii) Suitable for heavy vehicle.

**Q. 5. What is independent suspension? Explain any three methods to achieve the same in front axle of automobiles. Compare the same with rigid suspension.**

**Ans. Independent Suspension :** It is a term used to describe any arrangement by which the wheels are connected to the carriage unit in a manner such that the rise & fall of one wheel has no effects on others.

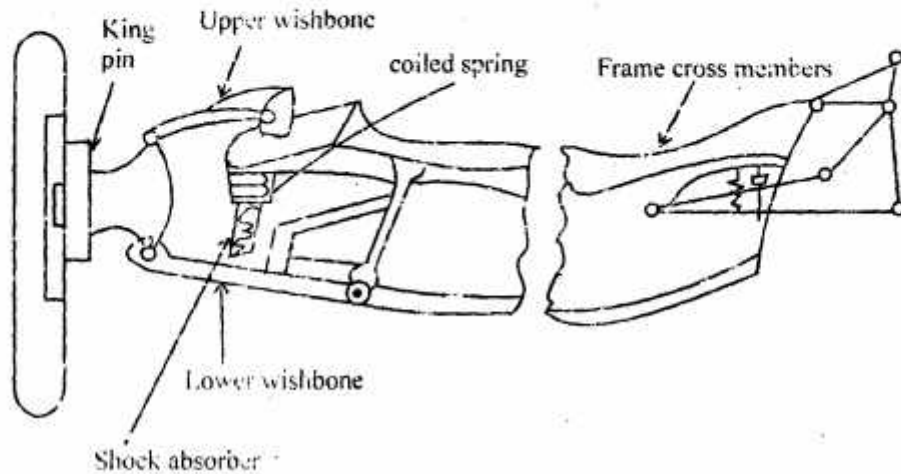
**Three Methods to Achieve in Front Axle of Automobiles :**

- (i) **Wishbone Type :** As used in Fiat, Sierra, Sumo
- (ii) **MacPherson Strut Type :** As used in Maruti 800

(iii) **Vertical Slide Type** : As used in Morgan.

**Wishbone Type** : It consists of following main parts :

- (i) Smaller upper wishbone & longer lower wishbone.
- (ii) Connecting arm to connect upper & lower wishbone with the king pin.
- (iii) Coiled spring enclosing a shock absorber.
- (iv) Frame cross member.

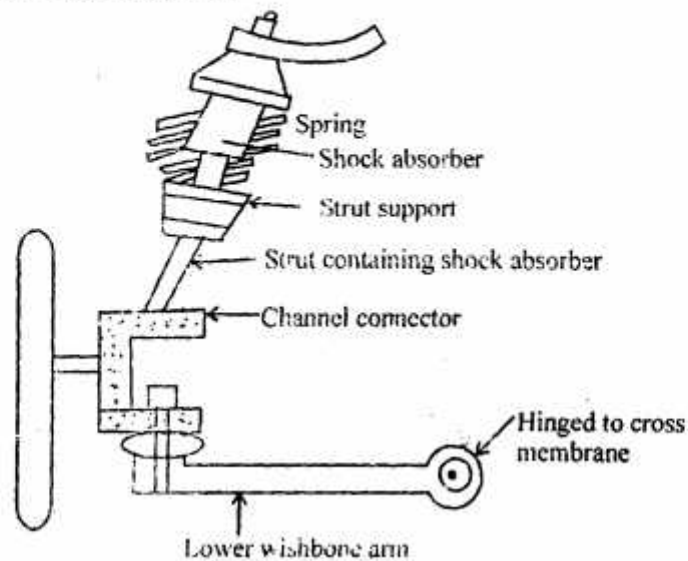


(v) During the motion when the wheel encounter a bump, the weight of vehicle is transferred to coil spring through the connecting arm, upper wishbone & cross arm.

(vi) This is then transmitted to lower wishbone which pushes up the shock absorber.

(vii) Consequently it damps down the vibration.

**MacPherson Strut Type Suspension :**



- (i) It consist of lower wishbone & upper wishbone is replaced by strut.
- (ii) One end of lower wishbone is hinged to cross-member of vehicle's frame while other end is fastened to channel shaped connector.
- (iii) This channel is centrally attached to stub axle & also strut to its upper side. The strut end are so shaped that they hold on shock absorber & coiled spring enclosing in it.

	<b>Rigid Axle Suspension</b>	<b>Independent Suspension</b>
(i) Condition of axle & wheel when one of wheel meets & bump.	Axle tilts & wheels are no longer remain vertical.	Axle doesn't tilts & wheel remain vertical.
(ii) Road adhesion	Decreased	Increased
(iii) Riding comfort	Reduced	Increased
(iv) Stability of vehicle	Disturbed	Maintained safe
(v) Effect on wheel	Wheel may wobble	No chance of wheel wobbling
(vi) Type of spring used	Leaf spring	Helical, torsion bar.

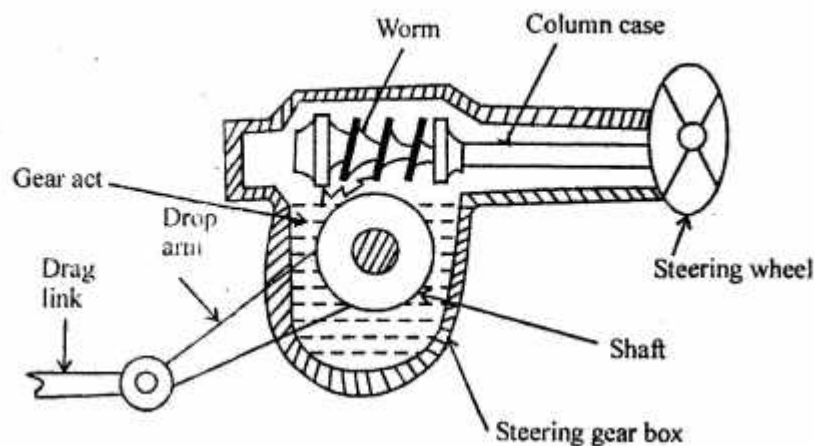
**Q. 6. (a) What do you understand from the term 'backlash' in steering gears? Sketch any one steering gear and explain the constructional features provided to adjust backlash.**

**Ans. Backlash :** It is the difference between the tooth space of one gear & tooth thickness of mating gear measured on the pitch circle.

**Steering Gear :** Transforms rotary motion of steering wheel into reciprocating motion of drag link.

**(i) Worm & Worm-Wheel Type Steering Gear :**

- (i) The upper end of worm is attached to the steering column. While the lower end meshes with toothed worm-wheel.
- (ii) The toothed wheel is mounted on a common shaft alongwith drop arm.



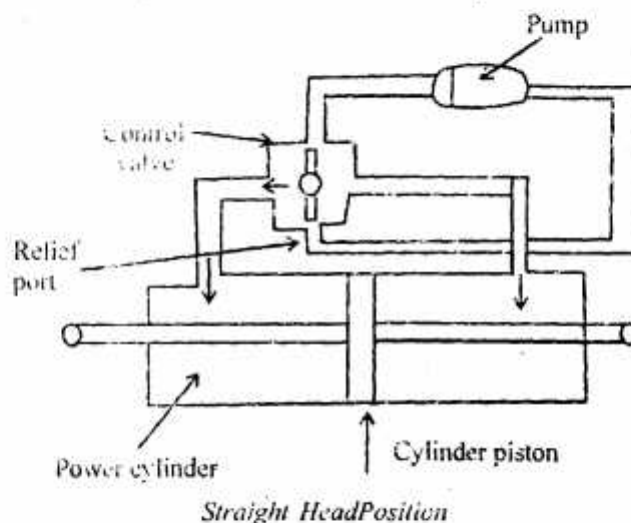


- (iii) When a vehicle is to be steered, the driver rotates the steering wheel due to which worm also rotate.
- (iv) Several complete revolution of steering wheel make the same number of revolution in the worm. This causes the worm-wheel to move in an arc of about  $60-80^\circ$ . Consequently, the drop arm also moves by the same link which transmits motion to outward linkages.

**Q. 6. (b) Describe the construction and working of power steering gear with a neat sketch.**

**Ans. Construction & Working of Power Steering Gear with Neat Sketch :** Power steering is one type of hydraulic device for utilizing engine power as steering effort.

- (i) Consequently, the engine is used to drive a pump to develop a fluid pressure. This pressure acts on the piston within the power cylinder so that piston assists the rack effort.
- (ii) The amount of assistance depends on extent of pressure acting on the piston.
- (iii) Therefore, if more steering force is required the pressure must be raised.



**(i) Neutral (Straight-Head) Position :** Fluid from the pump is sent to control valve, if the control valve is in neutral position, all the fluid will flow pass through the control valve into relief port & back to pump. At this time hardly any pressure is created & because the pressure on the cylinder piston is equal on both sides, the piston will not move in either direction.

**(ii) When Turning :** When the steering main shaft is turned in either direction, the control valve also moves closing one of fluid passage. The other passage then open wider, causing a change in fluid flow volume of at the same time, pressure is created. Consequently, a pressure difference occurs between both side of piston & piston moves in direction of lower pressure. Thus, the fluid in that cylinder is forced back to pump through control valve.

**Q. 7. (a) What is the principle of operation of hydraulic brakes? Discuss main parts of hydraulic brakes. Compare hydraulic and pneumatic brakes.**

**Ans. Principle of Operation of Hydraulic Brake :**

- (i) The hydraulic brake system works on the principal of Pascal's law which states that "the confined liquid transmit pressure intensity equally in all directions.
- (ii) The liquid remain confined within the master cylinder, oil lines & wheel cylinders.



(iii) In the principle of hydraulic brake, a more important term is pressure intensity.

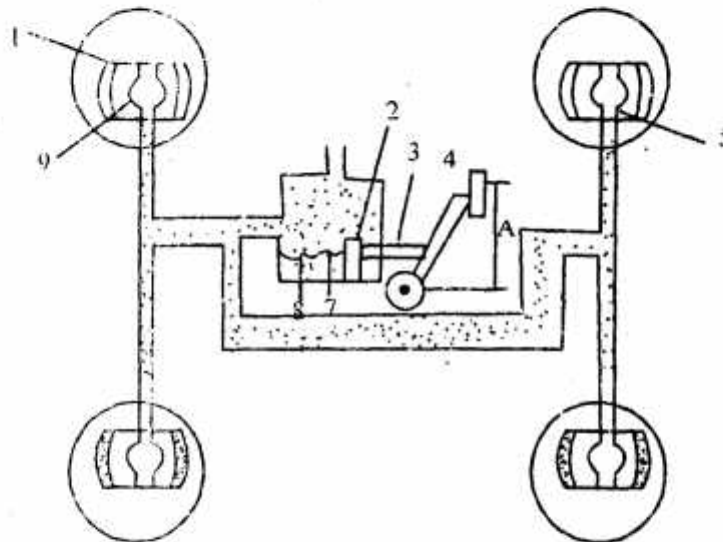
It is represented as  $P = \frac{F}{A}$

A = Cross-sectional area of master cylinder.

**Important Components of Hydraulic Brake :**

- (i) Master cylinder, operated by foot pedal.
- (ii) Wheel cylinder.
- (iii) Brake fluid pipeline.

**Working :**



- (i) Shoe
- (ii) Master cylinder piston
- (iii) Rod
- (iv) Pedal
- (v) Brake cylinder
- (vi) Brake line
- (vii) Master cylinder
- (viii) Return species
- (ix) Brake cylinder piston.

- (i) When the driver depresses pedal, the effort is transmitted through the rod to piston of master cylinder.
- (ii) The piston moves in the cylinder & compresses return spring, forcing out the fluid from the cylinder into brakeline through the by-pass.
- (iii) Piston of brake cylinder are acted by upon by fluid & press against the shoes, bringing their linings tightly against the working surface of the drums.
- (iv) As soon as the pedul is released, the return spring pushes piston back. At the same time, the compression springs of brake shoe move piston to their initial positions & fluids begin to flow in reverse direction.

**A comparison Between Hydraulic & Pneumatic Brake :**

- The working medium is fluid or liquid in hydraulic brake system whereas air is the working medium in pneumatic brake system.
- Pneumatic brakes are more powerful than hydraulic brakes.
- Pneumatic brakes are conveniently located anywhere on the chassis.

**Q. 7. (b) Discuss wheel balancing and rotation of tyres in automobiles.**

**Ans. Wheel Balancing & Rotation of Tyres :** Wheel balancing refer to such a setting of front wheels & the steering mechanism that provides an easier directional control to vehicle.

(i) A correct steering means such a steering state in which all the wheels undergo only a pure rolling motion under all conditions of vehicle's motion whether straight, negotiating, a leftward or right ward rolling without slipping.

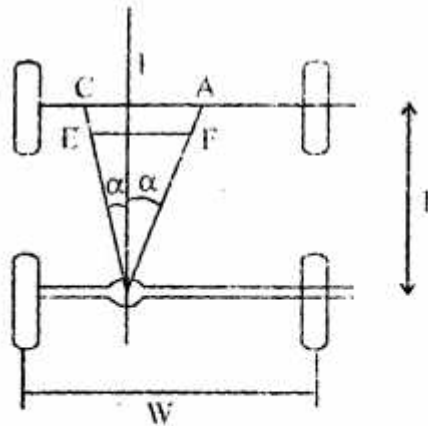


Fig. (i) Vehicle Moving Straight

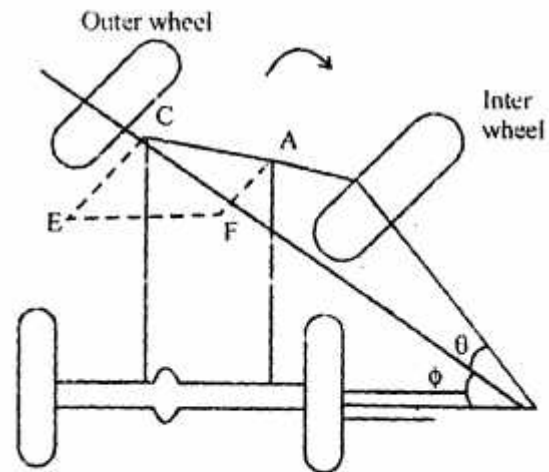


Fig. (ii) Vehicle Moving Right Turn

(i) Fig. (ii) shows a vehicle moving straight ahead wheel base of length 'l' & track width of 'w'.

(iv) A & C are stub axle ends, CE & AF are steering arm.

**For Correct Steering :**

$$\tan \theta = \frac{l}{BO} \quad \& \quad \tan \phi = \frac{l}{DO}$$

$$\cot \theta = \frac{BO}{l} \quad \& \quad \cot \phi = \frac{DO}{l}$$

$$\boxed{\cos \phi - \cot \theta = \frac{DO - OB}{l} = \frac{W}{l}}$$

**Ackerman's Steering Mechanism :**

- It consists of four-bar mechanism. ACEF whose link AC is kept fixed.
- The joints A, C, E & F are turning pair, link AF & CE are equal length but AC & EF are unequal.

$$\frac{AF}{AC} = 0.25$$

$$AC = w' = 0.85 \text{ to } 0.9w$$

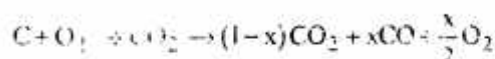
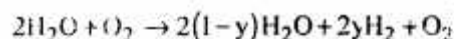
$$\theta = 23^\circ, \phi = 20^\circ, \alpha = 15^\circ$$

**Q. 8. (a) What are the sources of atmospheric pollution from the automobile? Explain various pollution control techniques used in practice.**

**Ans. Various Pollutants Emitted from the Automobile :**

- (i)  $\text{CO}_x$
- (ii)  $\text{SO}_x$
- (iii)  $\text{NO}_x$

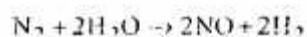
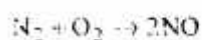
**Mechanism of Formation of CO :** CO is generally formed when mixture is rich in fuel. The amount of CO-formed increases as mixture becomes more and more rich in fuel.



A relatively small amount of  $\text{CO}$  will remain in exhaust, its concentration increasing with rich mixtures.

**Mechanism of Formation of NO :**

At high combustion temperature,



A significant amount of NO will be formed at the end of combustion.

**Q. 8. (b) Explain construction and operation of positive crank case ventilation system used in automobiles.**

**Ans. Crank Case Ventilation :** Crank case ventilation is required owing to the following reasons :

- (i) Various contaminants such as water, gasoline, blowby gases etc., enter the crank case due to several reasons & may cause sludge & corrode metal parts.
- (ii) To relieve any pressure build-up in crank case which may cause leakage of the crank case shaft seal.

In practice, following 2 types of ventilation system are used :

- (i) Open system
- (ii) Closed system

**(i) Open System :** In this system, fresh air supply is inducted into the crank case during the compression stroke (due to creation of small vacuum). The entering air picks up the contaminants (water vapour, gases &  $\text{H}_2\text{SO}_4$  vapour) & discharge them to the atmosphere during expansion stroke.

The main disadvantage of this system that natural ventilation is quite inadequate during idling or running at low speeds.

**(ii) Closed System :**

- (i) In closed system the fresh air supply is taken to crank case from the carburettor.
- (ii) Air cleaner & the breather outlets are connected to intake manifold through a PCV valve to ensure the burning of all crank case gases in combustion chamber.