



Summer – 16 EXAMINATION

Subject Code: 17307

Model Answer:

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Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

	Marks
1. A) Attempt any six :	12
a) State the materials used in any four wheeler frame.	2
Answer: Materials used for four wheeler frame: (Any two material- two marks) Most frames used on light vehicles are made of low-carbon steel having a carbon content of 0.15-0.25%. i) Mild sheet steel ii) Carbon sheet steel iii) Nickel alloy sheet steel iv) Aluminum alloy (Alpax).	2
b) List the loads acting on a chassis frame.	2
Answer: Loads acting on the chassis Frame: (Any four – 2 marks) i) Static Loads ii) Inertia Loads iii) Impact loads iv) Short Duration Loads v) Momentary Duration Loads vi) Overloads	2
c) State applications of frame channel section and box section one each.	2
Answer: Applications of – (Any one application of each) Channel Section - Channel section is best suited for bending loads . This type of section is used as a long member in conventional ladder like frames of LMV (e.g. Mahindra Jeep) and HMV (e.g. Truck, Bus etc).	1
Box section – Box section is good for both bending and torsion . The cross member of conventional frame are made of box sections. This type of frame section is used in frames of motorcycles (e.g. Bajaj Pulsar, Boxer etc.)	1



B) Attempt any two:		8	
a) Differentiate between conventional and semi integral frame.		4	
Answer: Difference between conventional and semi integral frame: (Any 4 points - 4 marks)			
Sr	Conventional frame	Semi-integral frame	4
1	There are two heavy side members and cross members welded, bolted or riveted to the superstructure.	In this, heavy cross and side members are eliminated. In some vehicles half frame is fixed in the front end on which engine, gear box and front suspension is mounted.	
2	Ground clearance is more.	Ground clearance is less.	
3	Higher centre of gravity.	Lower centre of gravity.	
4	Heavier in construction.	Light in weight.	
5	When the vehicle is met with accident the frame cannot be taken easily to replace the damaged chassis frame.	When the vehicle is met with accident the front frame can be taken easily to replace the damaged chassis frame.	
6	Used in heavy vehicles like trucks and buses.	Used in FIAT car and some of the European & American cars.	
Note: Suitable credit shall be given if sketches of both are drawn.			
b) Draw a neat labeled sketch of fluid coupling.		4	
Answer:			
			4
Figure: Fluid Coupling			

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c) With neat sketch explain working of centrifugal clutch.

Answer: Working of centrifugal clutch:

When the engine is started, the speed of the driving shaft is less, so the centrifugal force is also less. Therefore, shoes (flyweights) do not move outwards and torque is not transmitted to the rear wheel. As the speed of engine increases, the centrifugal force also increases. At certain engine speed, the shoes fly off outwards due to increased centrifugal force and they come in contact with the driven member. Now both the driving and driven members rotate together and the clutch is said to be engaged. Thus the engine torque is transmitted to the rear wheel.

When the engine speed decreases, the centrifugal force also decreases. Now the shoes return back to their original position due to spring force which results in a disengagement of the clutch and torque is not transmitted to rear wheel.

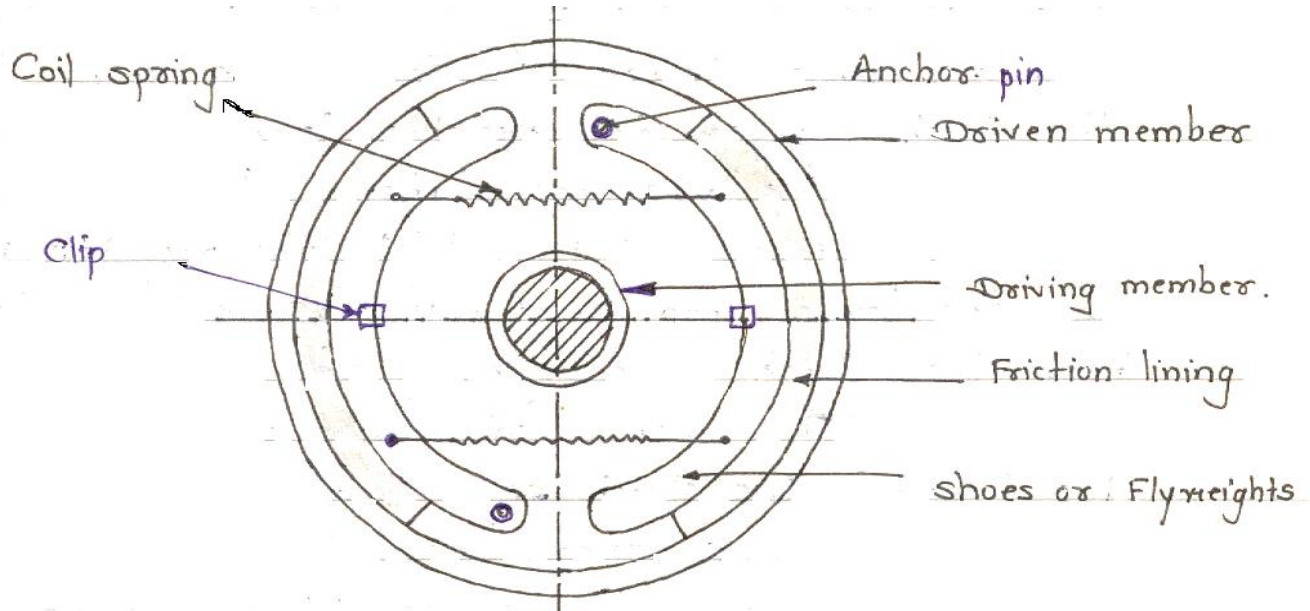


Figure: Centrifugal Clutch

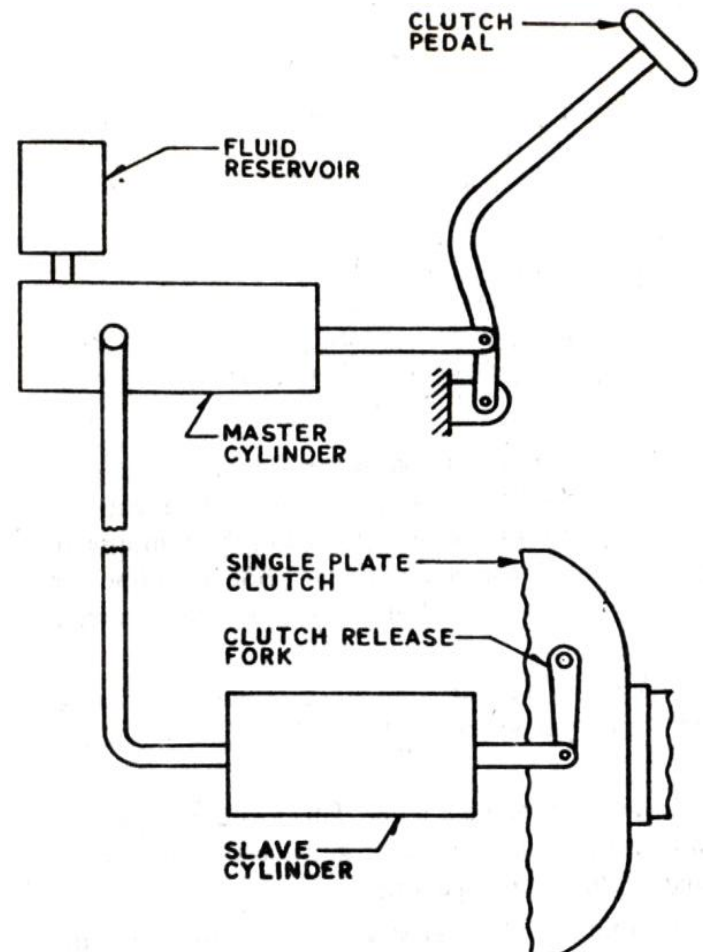
2. Solve any four:

a) Distinguish between dry and wet clutches (4 Points)

Answer: Difference between Dry and Wet clutch: (Any four point - four marks)

Sr.	Dry clutch	Wet clutch
1	Torque transmission capacity is higher.	Torque transmission capacity is lower (35-50% of dry clutch)
2	Heat dissipation is fair.	Heat dissipation is much better.
3	Heat transfer occurs between metal and air.	Heat transfer occurs between metal and oil.
4	Coefficient of friction is high, since the friction materials are operating dry.	Since the friction materials are operating in oil, coefficient of friction is low.
5	Clutch plate is non-perforated type.	Clutch plate has perforations.
6	Tolerance to engagement time is comparatively smaller.	Tolerance to engagement time is longer.
7	Life is less.	Life is longer as compare to dry clutch.
8	Cost is less.	Cost is high.
9	Application- Generally single plate clutch.	Application- generally in multi-plate clutch.



b) State the vehicle in which centrifugal clutch and single plate clutch are used.	4
<p>Answer: Applications of –</p> <p>Centrifugal clutch:</p> <ol style="list-style-type: none">1. Used in Automatic transmission vehicles like mopeds and two wheelers without gear.2. Used in semi-automatic transmission vehicles like some modern cars. <p>Single plate clutch:</p> <ol style="list-style-type: none">1. Most commonly used in cars.2. Used in Light commercial vehicles and heavy transport vehicles.	2 2
c) State the working of hydraulically operated clutch with neat sketch.	4
<p>Answer: Working of hydraulically operated clutch:</p> <p>A hydraulically operated clutch mechanism is shown in the figure. The mechanism consists of master and slave cylinders. The cylinders are connected by hydraulic lines. When the clutch pedal is pressed the fluid under pressure from the master cylinder reaches the slave cylinder which is mounted on the clutch itself. The fluid under pressure actuates the slave cylinder push rod which further operates the clutch release fork to disengage the clutch. In India, this type of clutch has been used in Standard 20, Swaraj Mazda and Eicher Mitsubishi's vehicles etc.</p>  <p>Fig. Hydraulically operated single plate clutch.</p>	2



f) Differentiate between sliding mesh and constant mesh gear box. 4

Answer: **Differentiate between sliding mesh and constant mesh gearbox: (Any 4 points- 04 marks)**

Sr.	Sliding mesh gear box	Constant mesh gear box
1	It consists of spur gear.	It consists of helical gear.
2	The main shaft gears are not in mesh constantly with the counter shaft gears, which can slide and mesh.	All the gears on the main shaft are in constant mesh with the corresponding gears on the countershaft.
3	Selector fork unit is used in this gear box for engaging the gears.	Dog clutch unit is used in this gear box for engaging the gears.
4	The size of gearbox is very large.	The size of gearbox is small as compare to sliding mesh gearbox.
5	This gearbox produces more noise.	It gives quieter operation and makes gear changing is easier.
6	Wear of dog teeth on top gear of main shaft on account of engaging & disengaging is more because only two or three teeth are involved.	Wear of dog teeth on account of engaging & disengaging is less because here all teeth of dog clutches are involved.
7	This gear box cannot be used for higher speed ratios.	This gear box can be used for higher speed ratios.
8	It is the oldest type of gearbox used in motor vehicles.	Constant mesh gear box has been used in 2& 3-wheelers.

3. Solve any four: 16

a) Draw a constant mesh gear box in neutral gear position (3 –forward and 1- reverse) 4

Answer: (Note: Correct labeled sketch – 4 marks)

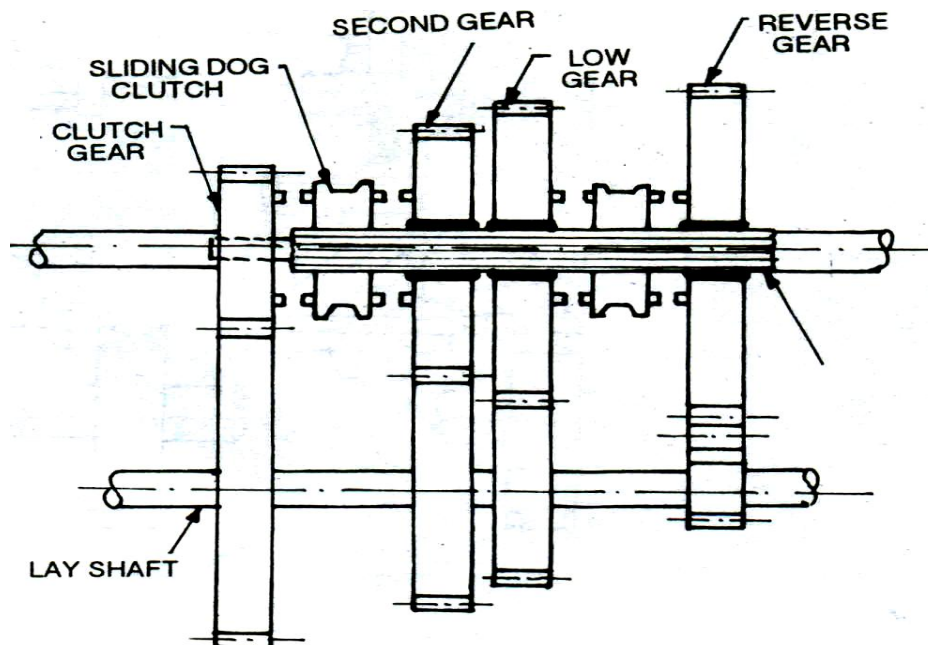


Figure- constant mesh gear box in neutral gear position.

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b) Explain with neat sketch gear selector mechanism with gear lever on top of gear box.

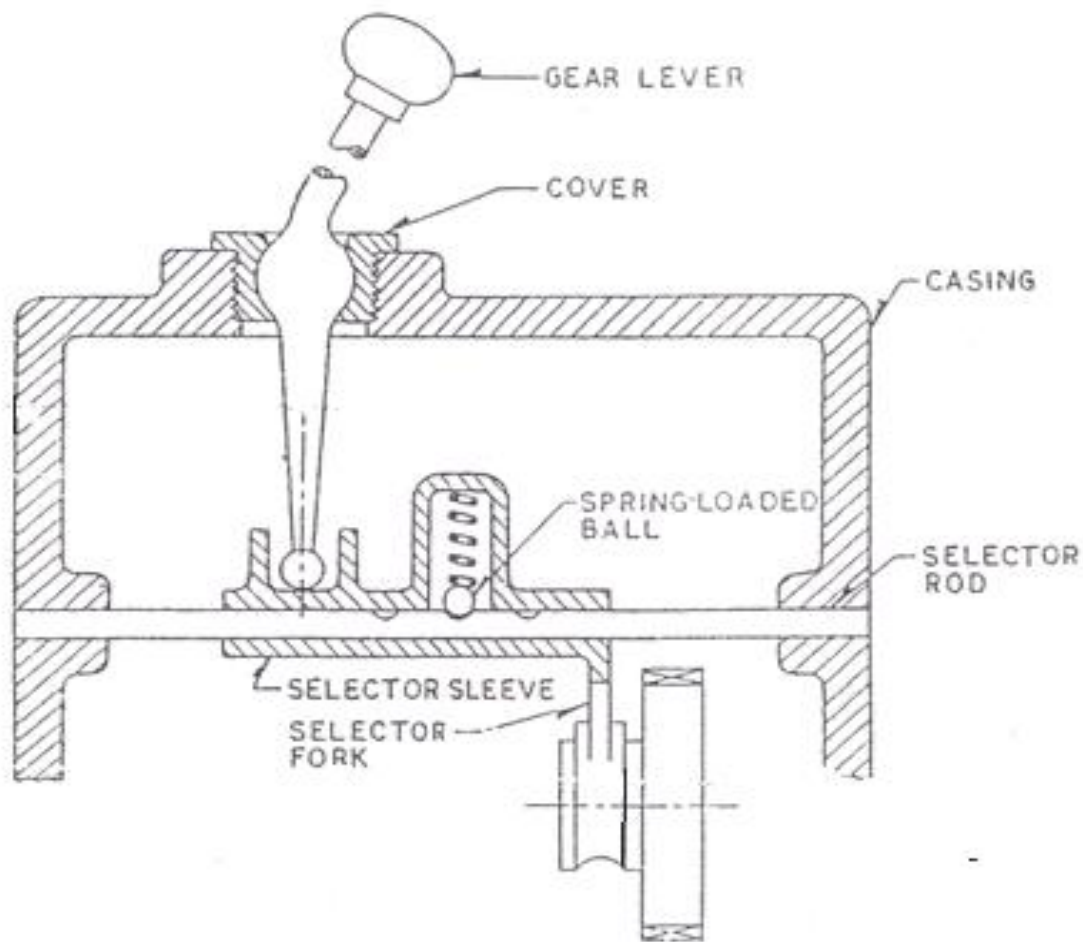
4

Answer: **Gear selector mechanism with gear lever on the top of gear box-**

A typical mechanism for a 4-forward speeds and reverse gear box where the gear lever is ball mounted in the gear box cover. This facilitates its movement in any direction. The lower end of gear lever fits into a slot in the selector sleeve. There are forks on the sleeves on three separate selector rods which are supported in the gear box casing. Each selector sleeve can slide on its rod, but just to avoid unwanted engagement of the gears, slots are made on the selector rods and the sleeves are provided with spring-loaded balls. These balls resist the movement of the forks until some force is applied to gear lever to overcome their resistance. In some cases the forks are fixed on the selector rods by means of pins and the assembly can slide.

2

Grooves are provided on the gear bosses where the selector forks can fit in. Transverse motion of the gear lever selects the forks which are to be engaged and the longitudinal movements then slides the fork and its gear to engage the selected gear.



2

Figure: Gear selector mechanism with gear lever on the top of gear box.

c) Write short note on lubrication of gear box.

4

Answer: **Lubrication of gear box-**

Proper lubrication of gear box is extremely important. The transmission gears operate in a bath of lubricating oil to prevent metal-to-metal contact.



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Lubrication of gear box is done by putting oil of specification given by the manufacturer (the gear oil is thicker than the engine oil), in the gear box to ensure that at least one gear dips in the oil. With the clutch engaged the gears will rotate and splash the oil. The bearings located in transmission case are lubricated with grease periodically as and when it is required.

Different design of the gear boxes have different requirements. Some car makers recommend engine oil for gear boxes, with overdrive. Synchromesh gear box and some overdrive units require fluid gear oil of SAE 80 and 90 viscosity. The lubricant level in the gear box should be inspected every 1000 miles and filled if necessary. If the lubricant should be contaminated, the gear box should be drained, flushed and refilled with fresh lubricant.

d) What is transfer case? Explain with neat sketch.

Answer: **Transfer case:**

Transfer case also called as a transfer box or an auxiliary gear box is used in four wheel drive vehicle. It enables the driver to drive the vehicle in two wheel drives on highways or shift to four wheel drive for rough, muddy roads i.e. for cross country applications. It also enables to drive the vehicle in high gear or low gear whenever required.

Working: When the shifter-A is at the central position as shown in fig. here neither the gear G1 and nor the gear G2 is connected to the input shaft, it is known as neutral position. When the shifter-A connects the input shaft with big input gear G2, and the shifter-B disconnects the front output shaft from the rear output shaft. In this position, rear two wheel drives with the high gear is obtained. Similarly when the shifter-A connects the input shaft with small input gear G1, and the shifter-B connects the front output shaft from the rear output shaft. In this position, four- wheel drive with the low gear is obtained.

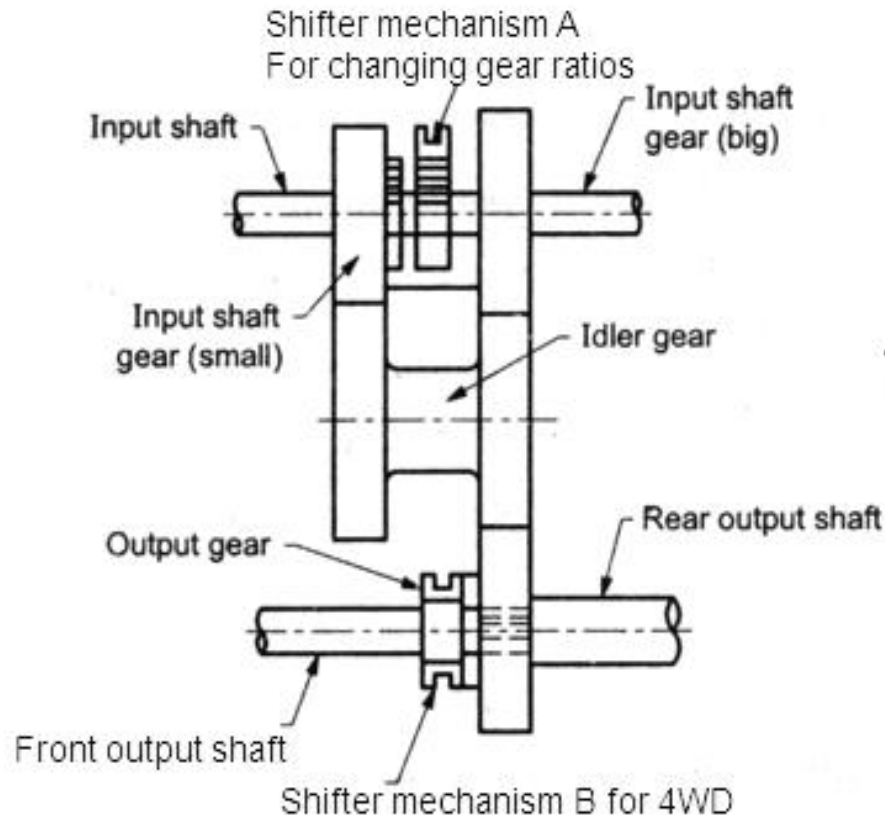


Figure –Transfer case



e) Why synchromesh gear box is preferred to sliding mesh gear box in a car?	4																								
<p>Answer:</p> <p>Synchromesh gearbox works in the same way as that of sliding mesh gear box, the only difference is that instead of a sleeve, a synchromesh unit is fixed. The main purpose of this unit is to synchronize the speed of the two gears before they are engaged. We know that in running vehicle, when we press the clutch & put the gear in neutral position, till the gears are revolving. All the gear do not revolve at the same speeds & when we have to engage two gears running at different speeds by shift lever there will be some sound due to clashes of gears and very hard to engage and disengage the gears. To avoid said problems the synchromesh devices are used.</p> <p>While in sliding mesh gear box, gear ratio is obtained by sliding the main shaft gears to engage with lay shaft gears. it is troublesome to synchronize the input and output speeds during shifting the gears. This result into noise, vibration and wear while changing the gears at higher speeds. Since the synchromesh gear box facilitates smooth gear shifting at higher speeds and less wear and noise, these are preferred to sliding mesh gear box in a car.</p>	4																								
f) Compare Torque tube drive and Hotchkiss drive (4 Points each)	4																								
Answer: Comparison of Hotchkiss drive and Torque tube drive: (Any four points - 4 marks)																									
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%; padding: 5px;">Sr.</th> <th style="width: 45%; padding: 5px;">Hotchkiss Drive</th> <th style="width: 45%; padding: 5px;">Torque Tube Drive</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 5px;">1.</td> <td style="padding: 5px;">Open type propeller shaft is used.</td> <td style="padding: 5px;">Propeller shaft is housed in a tube called torque tube.</td> </tr> <tr> <td style="text-align: center; padding: 5px;">2.</td> <td style="padding: 5px;">Two universal joints is used one at front & second at rear end of the propeller shaft.</td> <td style="padding: 5px;">Only one universal joint is used at the front end of the propeller shaft.</td> </tr> <tr> <td style="text-align: center; padding: 5px;">3.</td> <td style="padding: 5px;">Slip joint is used to accommodate change in length.</td> <td style="padding: 5px;">No slip joint is used.</td> </tr> <tr> <td style="text-align: center; padding: 5px;">4.</td> <td style="padding: 5px;">Torque reaction, driving thrust, side thrust, weight of the body & braking torque all are taken by leaf spring.</td> <td style="padding: 5px;">Weight of the body & side thrust are taken by leaf spring. Torque reaction, driving thrust, braking torque are taken by the torque tube.</td> </tr> <tr> <td style="text-align: center; padding: 5px;">5.</td> <td style="padding: 5px;">Leaf spring is shackled at the rear and bracketed at front end.</td> <td style="padding: 5px;">Both end of the leaf spring are shackled.</td> </tr> <tr> <td style="text-align: center; padding: 5px;">6.</td> <td style="padding: 5px;">The centre axis of propeller shaft and bevel pinion shaft is not coinciding when axle moves up and down.</td> <td style="padding: 5px;">Axis of propeller shaft and bevel pinion shaft coincide always.</td> </tr> <tr> <td style="text-align: center; padding: 5px;">7.</td> <td style="padding: 5px;">It is used in heavy vehicles like bus, truck.</td> <td style="padding: 5px;">It is used in light vehicles like cars.</td> </tr> </tbody> </table>	Sr.	Hotchkiss Drive	Torque Tube Drive	1.	Open type propeller shaft is used.	Propeller shaft is housed in a tube called torque tube.	2.	Two universal joints is used one at front & second at rear end of the propeller shaft.	Only one universal joint is used at the front end of the propeller shaft.	3.	Slip joint is used to accommodate change in length.	No slip joint is used.	4.	Torque reaction, driving thrust, side thrust, weight of the body & braking torque all are taken by leaf spring.	Weight of the body & side thrust are taken by leaf spring. Torque reaction, driving thrust, braking torque are taken by the torque tube.	5.	Leaf spring is shackled at the rear and bracketed at front end.	Both end of the leaf spring are shackled.	6.	The centre axis of propeller shaft and bevel pinion shaft is not coinciding when axle moves up and down.	Axis of propeller shaft and bevel pinion shaft coincide always.	7.	It is used in heavy vehicles like bus, truck.	It is used in light vehicles like cars.	4
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4. Solve any four:	16																								
a) State with brief explanation loads acting on the rear axle.	4																								
Answer: Loads acting on the rear axle: (Any 04 points - each carry 01 mark)																									
<p>1. Driving thrust:</p> <p>Driving torque produced in the engine causes the thrust to be produced in the road wheels, which has to be transmitted from the axle casing to the chassis frame and the body of the vehicle.</p> <p>2. Torque Reaction:</p> <p>If the rear axle is held rigidly when the road wheels are prevented from rotation, (due to driving needs or road conditions) the bevel pinion of the final drive tends to rotate around the crown wheel. It produces a tendency in the whole vehicle to rotate about the rear axle, or to lift off the front of the vehicle. This effect is known as torque – reaction.</p>	4																								



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3. Braking torque or thrust:

The axle casing experiences the brake torque when the brakes are applied to the vehicle.

4. Side thrust:

When the vehicle is taking the turn, the rear axle subjected to the side thrust or pulls due to any side load on the wheel.

5. Weight of the body:

The rear axle may be considered a beam supported at ends loaded. This weight causes bending and shears force in the axle shaft.

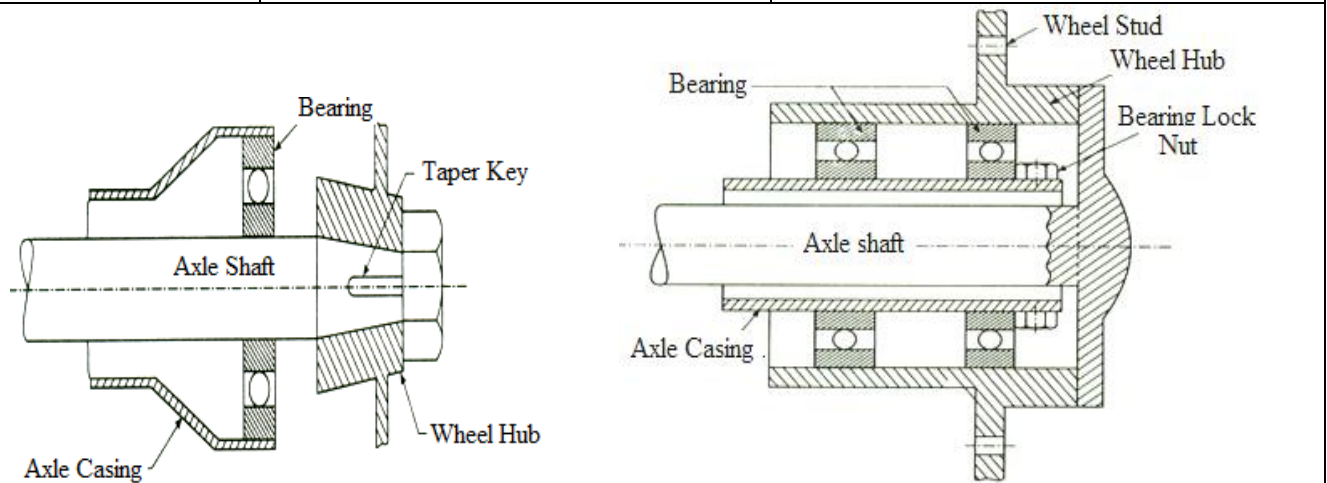
b) Differentiate full floating and semi-floating types of rear axles.

4

Answer: Difference between semi-floating and Full floating type rear axle: (Any 4 points- 4marks)

Description	Semi-floating rear axle	Full floating rear axle
1) Bearing location	Single bearing between shaft and casing.	Two bearings widely spaced between hub and casing.
2) Size of shaft	For same torque transmission size of shaft is bigger.	For same torque transmission size of shaft is smaller.
3) Stress acting on axle shaft	Stress acts on shafts are Torsional, bending, shear, tension, and compression stress.	Stresses acting on shaft are Torsional stresses.
4) loads acting on axle shaft	Loads acting on axle shafts are vehicle weight, side thrust, driving torque, and braking torque.	Loads acting on axle shafts are driving torque, and braking torque.
5) Vertical load taken	Yes, taken by the half shaft bearings.	Nil
6) Side load	Present	Nil
7) Driving torque to the wheels	Yes	Yes
8) Application	In medium vehicles-Tata Sierra, Tata Estate, standard 20 van, Fiat 1100 car etc.	In heavy vehicles-Tata truck, Mahindra jeep Ford truck

4



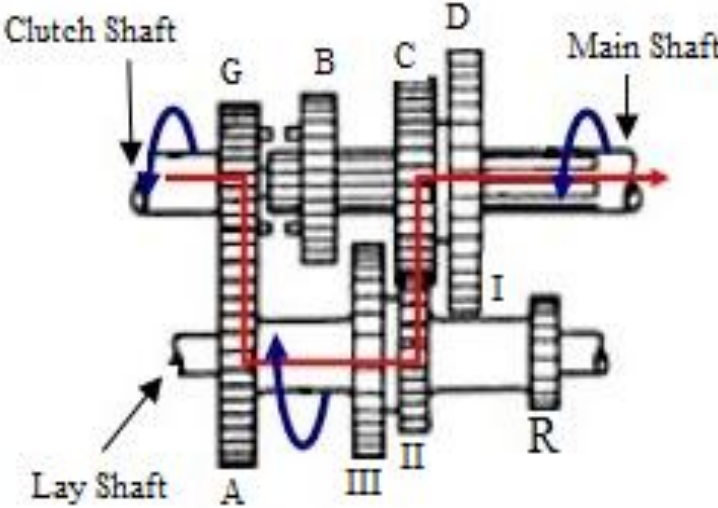


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c) Write the function of universal and slip joints.	4
<p>Answer: Function of – Universal Joints: In front engine rear wheel drive vehicles, the transmission rigidly fixed to the frame or body is normally at higher level than wheels. The rear axle is suspended to the frame through springs. The driveshaft hence requires some flexibility at the bend near the transmission and at the axle. So the universal joints are used at front and rear end of propeller shaft which transmit the power to the wheels even if the heights of transmission and rear axle are different. Also whenever the axle moves up and down due to road irregularities, the angle of drive changes continuously and universal joint allows transmission of power and rotary motion at a varied angle.</p> <p>Slip Joints: When the rear wheel comes across a bump, the spring compresses or expands as the differential with the rear axle housing and the wheel moves up and down. This not only changes the angle but also varies the length of propeller shaft. So the slip joint permits the effective length of propeller shaft depending upon the road conditions. If there is no slip joint, the propeller shaft will buckle or brake.</p>	2
d) Draw a neat sketch of sliding mesh gear box (3 forward and 1- reverse) engaged in second gear and show power flow for the same.	4
<p>Answer:</p>  <p>G: Clutch gear, A: Countershaft Gear, B: Top gear/third gear, C: Second gear, D: First gear, I, II, III, R: - counter shaft First, Second, Third, and Reverse gear.</p> <p>Figure: Power flow when sliding mesh gear box engaged in second gear</p>	4
e) Explain tyre inflation and its effect.	4
<p>Answer: Tyre inflation: The inflation pressures are recommended by the vehicle manufacturer depending upon tyre size, speed and load. Although tires are made up of more or less airtight materials, they still allow minute quantities of air to gradually leak away over time. Therefore, the tire inflation pressure must be checked regularly and adjusted as necessary whenever it differs from the specified pressure. While inflating the tyres, there are chances of under inflation or Over inflation which will highly affect the tyre performance. These conditions must be avoided and always correct tyre pressure should be maintained.</p>	2

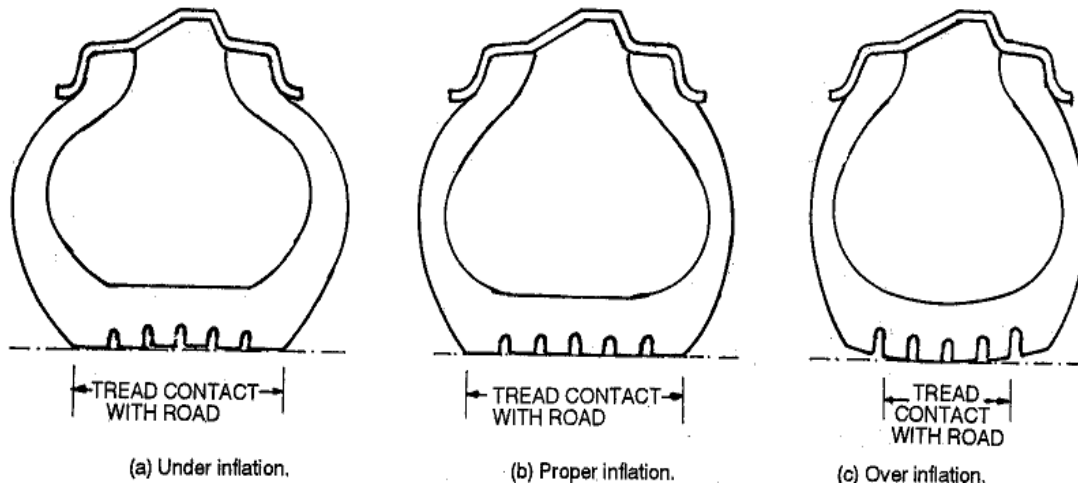


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Effects of Under-inflation: (Any two)

1. Uneven tread wear, more wear at tyre sides.
2. Lack of directional stability.
3. Increased rolling resistance leading to increased fuel consumption.
4. Excessive flexing of sidewall causes build up.
5. Vehicle will roll on curves.

1

Effects of Over-inflation: (Any two)

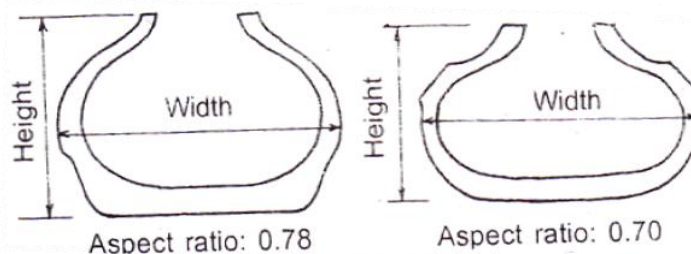
1. Reduced tread contact area with road surface.
2. Reduced tyre grip.
3. Increased vibration resulting in uncomfortable ride.
4. Increased stresses may causes tread separation and crack in the side wall.
5. The centre of tyre will be worn rapidly.

1

f) Write a short note on aspect ratio.

4

Answer: **Aspect Ratio:**



4

The aspect ratio of a tyre is the height of the tyre sidewall expressed as a percentage of the tyre's width. For example, a tyre with a profile/aspect ratio of 65, is a tyre whose height is equal to 65% of its width. Low profile tyres have lower profile/aspect ratio numbers.

However, with the advancement of research on the various tyre characteristics the lower aspect ratios became increasingly popular. Usually lower the aspect ratio, the wider and flatter is the tyre section. The advantages of lower aspect ratio are, better load-carrying capacity, less wear, higher cornering power, quicker steering response & greater stability at high speeds, whereas the main disadvantage is the uncomfortable ride, because of less vertical flexibility. However with better designed suspension systems it has now been possible to use aspect ratio as low as 50%. Rather in racing cars, aspect ratios down to 27% have been already employed.



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pinion. So the cage rotates with crown gear. The bevel pinion mounted on the propeller shaft end gives power to the crown gear. The cage and crown gear are free on the left rear axle. The two planet pinions are supported in the cage and are always in mesh with the sun gears. When the cage rotate, both the sun gear rotates which causes both rear wheels to rotate as the rear wheels are attached to outer end of rear axle.

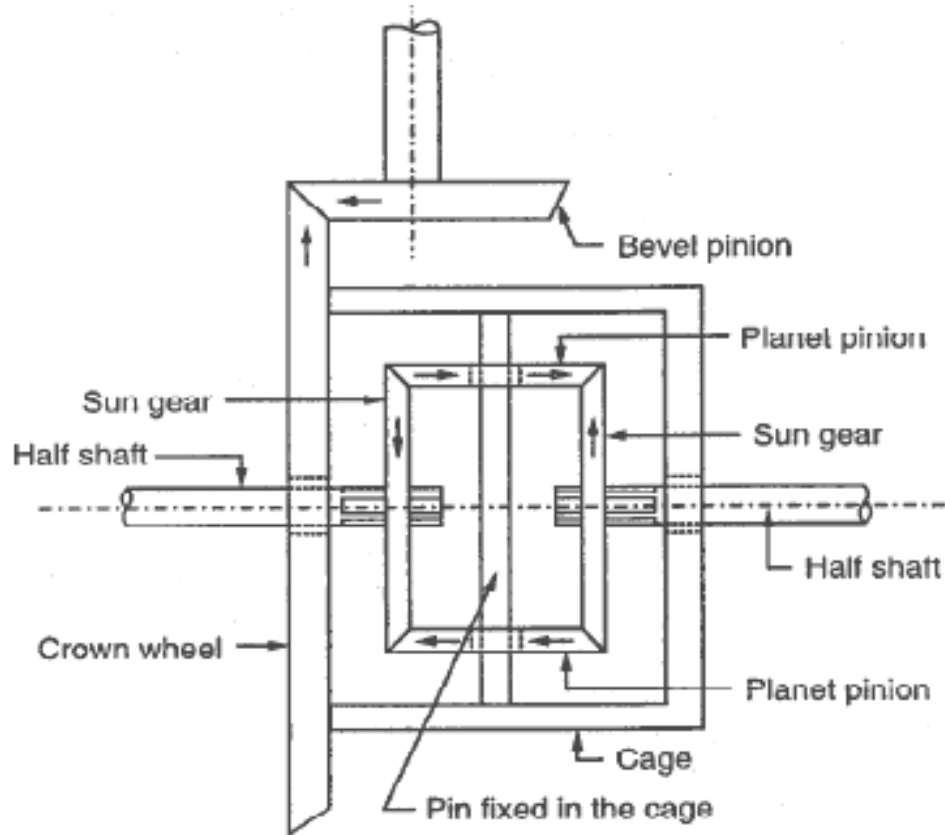


Figure- Differential

Working of differential:

When vehicle moves in a straight line, the power comes from propeller shaft to the bevel pinion which drives the crown wheel. Then it is carried to the differential cage in which a set of planet pinions and sun gears are located. From the sun gear it is transmitted to the road wheels through axle half shafts. In this case, the crown wheel, differential cage, planet pinions and sun gears all turn as a single unit and there is no any relative motion between the sun gear and planet pinion. The planet pinions do not rotate about their own axis. Both the road wheels turn at the same speed. When vehicle takes a turn, the inner wheel experiences a resistance and tends to rotate in opposite direction. Due to this the planet pinions starts rotating about their own axis and around the sun gear and transmit more rotary motion to the other side sun gear. So that outer sun gear rotates faster than the inner sun gear. Therefore the outer road wheel runs faster than the inner road wheel and covers a more distance.

c) Explain the construction and operation of hollow tube propeller shaft.

Answer: **Construction and operation of hollow tube propeller shaft:**

Propeller shaft is the shaft which transmits the drive from the transmission to the bevel pinion or worm of the final drive in front engine rear wheel drive vehicles and from the transfer box to the front and rear axles in the all-wheel drive vehicle. It is also called as drive shaft.



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It consists mainly of three parts :

a) Shaft: As the shaft has to withstand mainly torsional loads, it is usually made of tubular cross-section. The shaft has to be well balanced to avoid whirling at high speeds. Shaft is made of steel, aluminium or composite materials

b) Slip joint: Single slip joint is used at front end of hollow tube near the front universal joint. This serves to adjust the length of the propeller shaft when demanded by the rear axle movement. Slip joint is formed by the internal splines on the sleeve attached to the left universal joint and external splines on the propeller shaft as shown

c) Universal joints: In hollow tube propeller shaft arrangement, two universal joints – one at front end and other at rear end are used. The universal joints account for the up and down movements of the rear axle when the vehicle is running.

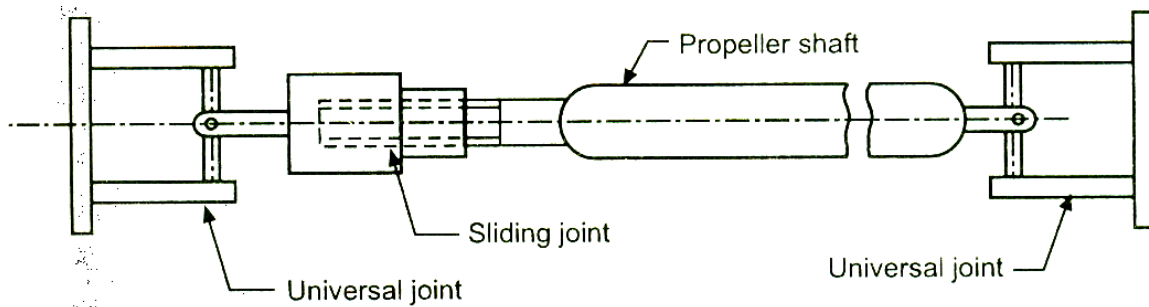


Figure: Propeller shaft.

Working:

The propeller shaft transmits the torque from transmission main shaft to the rear axle at an angle by means of universal joint provided at the front end. Due to the torque reactions the suspension spring gets deflected, thus torque reaction is taken up by the springs. Similarly to take up the braking torque, the springs would deflect in opposite direction. When the spring deflects in this manner, the bevel pinion shaft also changes its position. So, the universal joints provided at the rear end of the propeller shaft take care of rear axle movement due to spring deflection.

When the rear axle moves up and down, it has to move in circle with front spring support at the frame as centre. But for the propeller shaft motion, the centre is at the front universal joint. This means that during this movement of rear axle, length of propeller shaft has to vary. This is provided by means of sliding joint in propeller shaft.

6. Attempt any two:

a) State the types of vehicle layout. Explain four wheel drive in detail with a neat sketch.

Answer: **Types of vehicle layout:-**

- 1) Front engine front wheel drive
- 2) Front engine rear wheel drive
- 3) Front engine all wheel drive
- 4) Rear engine rear wheel drive
- 5) Central engine all wheel drive

Four Wheel Drive: As shown in the figure, in this layout engine is located at front and drive is given to all the four wheels so that whole weight of the vehicle is available for traction. A transfer case (also called as an auxiliary gear box) is used in addition to the main gear box which gives same torque to front and rear axle. Two propeller shafts are used to transmit the power from engine to front and rear axle. For each propeller shaft two universal joints are used. In this, power from engine is transmitted to transfer case through clutch and gear box and from the transfer case it is transmitted to both the

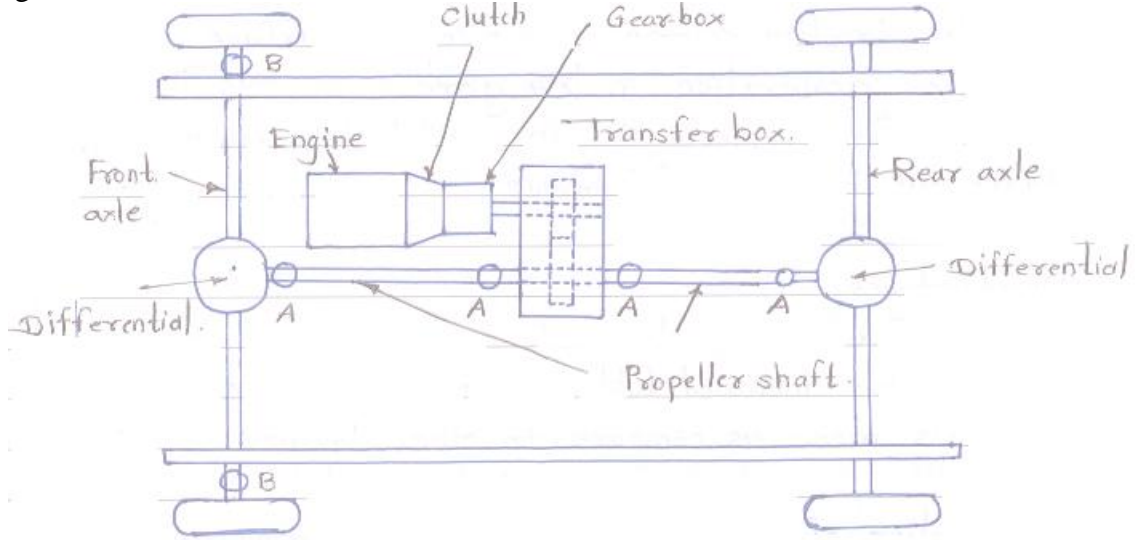
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propeller shafts and differential. There is a provision in the control of transfer case so that front wheel drive or rear wheel drive may be disengaged when it is not required. The upper lever in the driver's cabin is gear box control lever and the lower one is transfer box control lever.

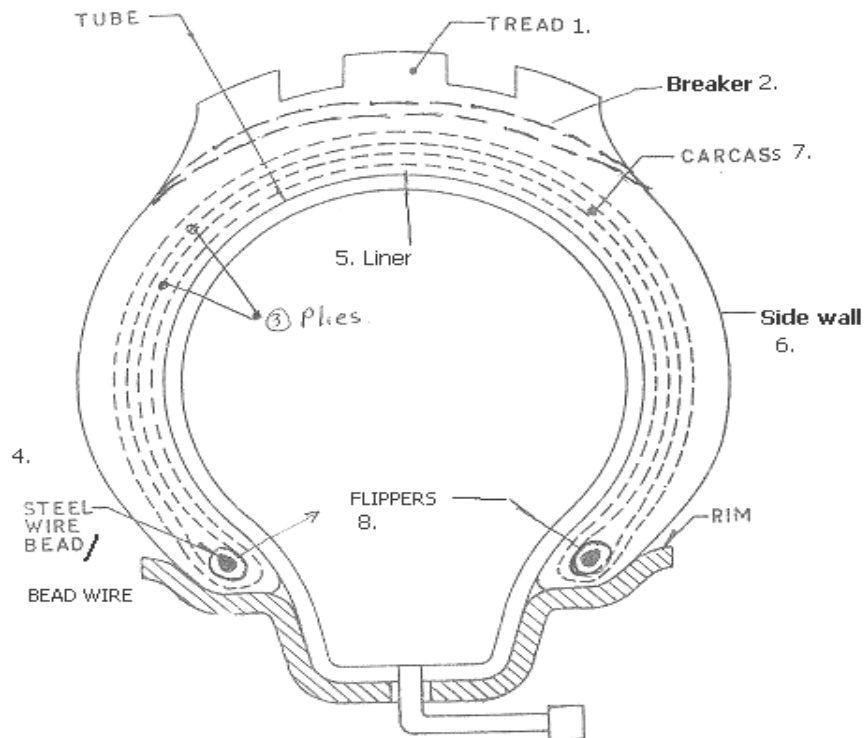


A^s - Universal Joint
B^s - Constant velocity joint

Figure: Layout of four wheel drive vehicle

b) Draw a neat sketch showing tyre – tube construction. Explain tyre rotation procedure for a four wheeler.

Answer: **Tyre tube construction:**



Section of a conventional tyre with tube



Tyre rotation procedure for a four wheeler:

Tyre rotation is the practice of moving the wheels and tyres of an automobile from one position to another, to ensure even tire wear. Even tyre wear is desirable to extend the useful life of a set of tyres. The weight on the front and rear axles differ which causes uneven wear. The pattern of tyre rotation differs for the front wheel drive vehicles and rear wheel drive vehicles. A good example is Front Wheel Drive vehicles which places braking, steering and driving forces on the front axle tyres. Rear axle tyres only receive braking forces resulting in a much faster wear rate for the front axle tyres. Tyre rotation for these vehicles therefore becomes very important for optimum tyre life.

Tyre rotation should be undertaken every 5,000 to 8,000 kilometers, even if there is no sign of uneven wear. The "Cross Pattern" provides the best results and can be performed on any Front or Rear Wheel Drive vehicle equipped with 4 non-unidirectional tyres. (Unidirectional tyres must be rotated front to rear only). Free rolling axle tyres are crossed and installed to the drive axle, while the drive axle tyres are brought straight to the free rolling axle (without crossing). The rotation patterns of tyres for different vehicles are shown in figure.

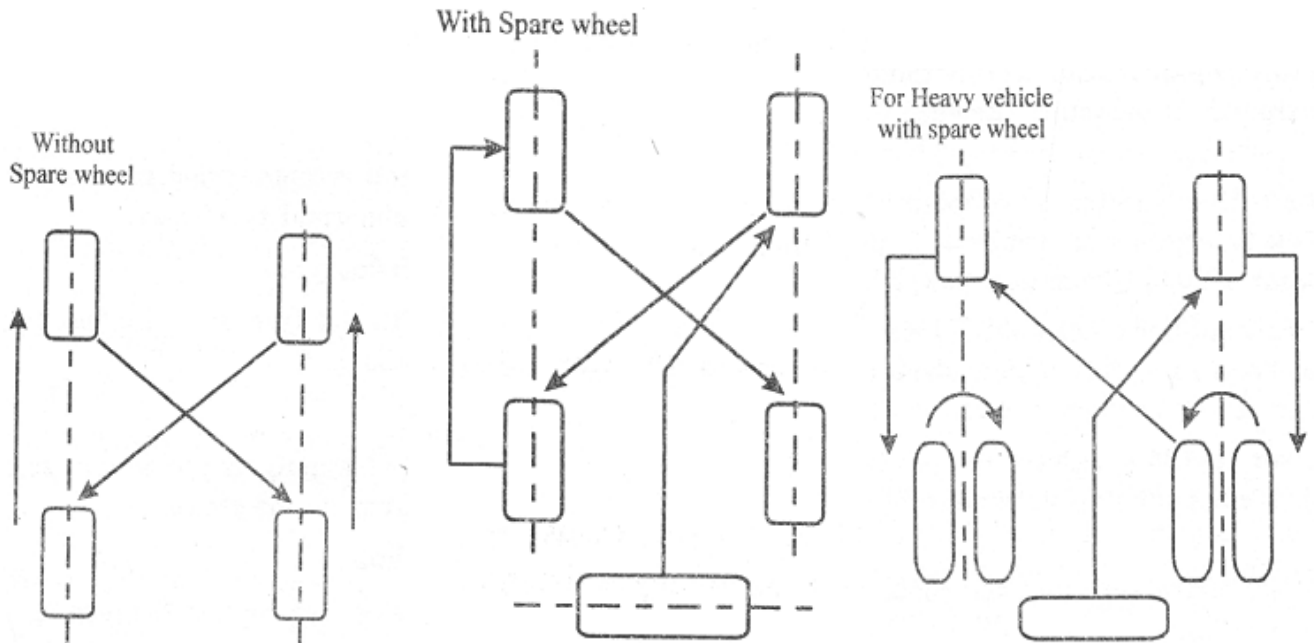


Figure 1

OR

Figure2

OR

Figure3

c) Give classification of wheels. Explain in brief any one type of wheel with neat sketch.

Answer: **Classification of wheels:**

- 1) Wire wheel
- 2) Disc wheel
- 3) Light alloy cast or forged wheel

(Explain any one type of wheel: Explanation - 3 marks, Sketch – 3 marks)

1. Wire Wheel:

Wire wheels are light weight, high strength and provide much better cooling of the brake drum. Wire wheels have separate hub, which is attached to the rim through number of wire spokes. Components of wire wheels are – Spoke, Hub and Rim

i) Spokes: Each spoke is individually hooked at one end of the hub while its other end is pushed through a hole in the wheel rim, where tapered nut called nipple, is screwed down pulling the spoke tight. If a spoke is too loose or too tight, the rim will distort. Spokes are mounted in complicated criss-cross fashion in all the three planes. Spoke carries weight of vehicle and passengers. It transmits driving & braking torque as well as withstands side forces while cornering (i.e. cornering load and side thrust).

ii) Hub: Hub is provided with internal splines and is mounted on the axle shaft.

iii) Rim: Rim has holes at the centre for attaching spokes. The only disadvantage of this rim is that tubeless tyre cannot be mounted on it because of holes on the rim.

Application: Two wheelers & bicycles.

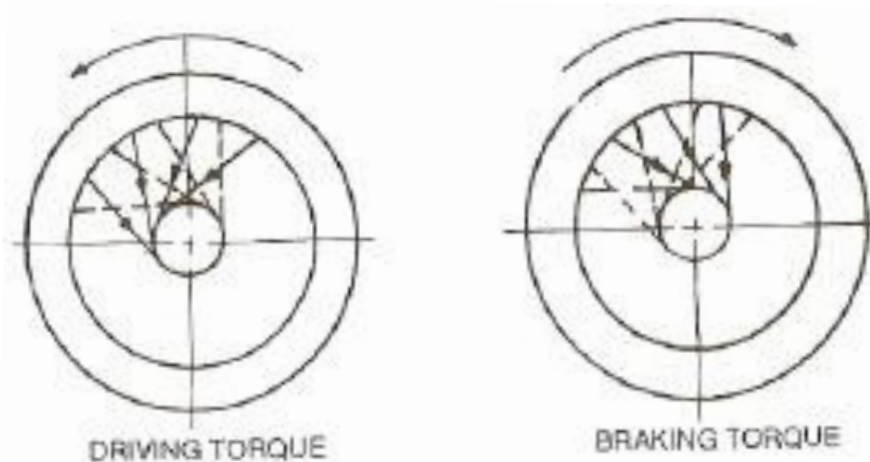


Figure: Wire Wheel

2. Disc wheel:

Disc type of wheel consists of two parts, a steel rim which is generally well-based to receive the tyre & a pressed steel disc. The rim & the disc may be integral, permanently attached or attachable, depending upon design.

In disc wheel the pressed steel disc is welded to the rim. When the bead of the tyre is resting in the well, it is possible to pass the tyre over the possible edge of the rim. Without the well it would not be possible to mount or remove the tyre from the wheel. The seat of the rim where the tyre rests usually has a 5° or 15° taper so that the tyre is inflated; the beads are forced up the taper to give a wedge fit. With tubeless tyres, the taper helps to make a good seal. Some slots are provided in the wheel disc to allow the air to the inner side for better cooling of the brake drum inside. A separate cover is also provided on the wheel disc. A hole in the rim serves to accommodate tube valve.

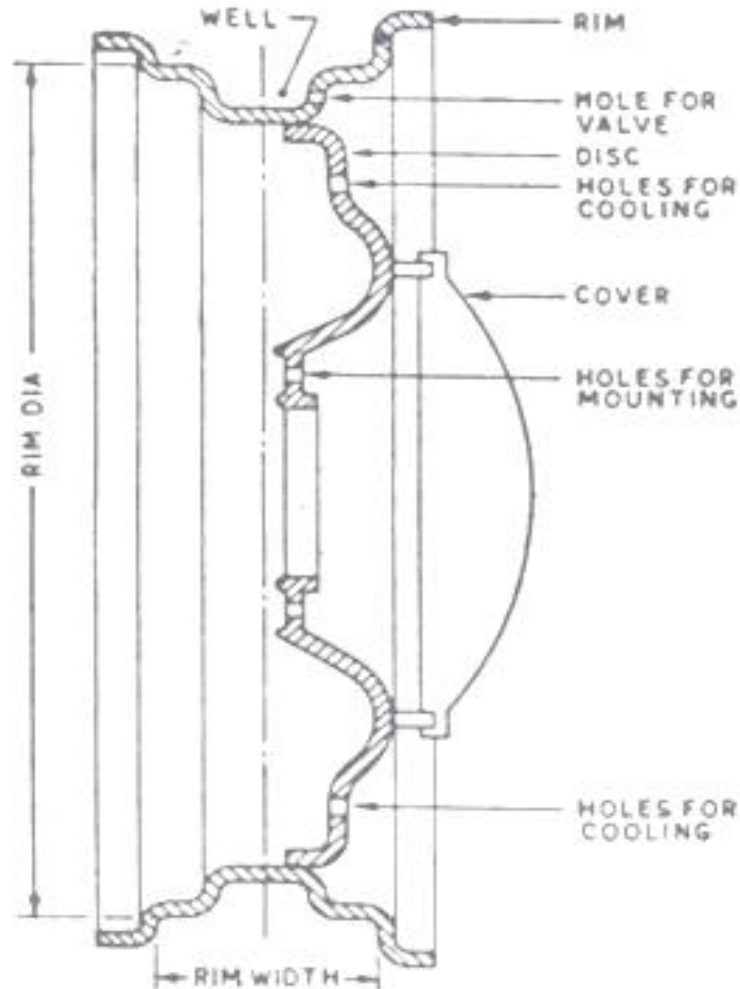


Figure: Disc type wheels

3. Light Alloy cast or forged wheel :

Light weight wheels are made from aluminum or magnesium alloys. Alloy wheels are manufactured by casting & forging processes. It consists of central hub & outer rim. The hole is provided in the body to accommodate rubber sealed valve. Sometimes wheels are made in composite form means that the wheel body with cast aluminum alloys & rim with steel.

Light alloys are better conductors of heat which helps the wheels dissipate any heat generated by tyres or brakes and thereby run cooler. Since the wider rims are possible, light alloy cast wheel improves stability on cornering. Only disadvantage of it is higher costs.

Application: Cast alloy wheels are generally used for cars while forged wheels are preferred for heavier vehicles.

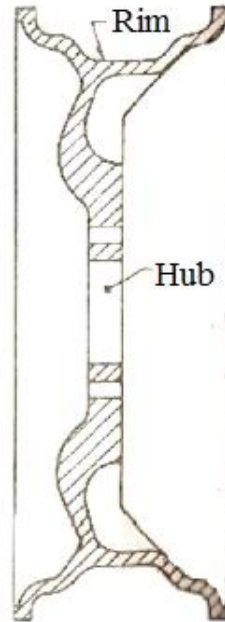


Figure: Construction of alloy wheel