



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 types of frames.		2
Answer: The types of frames are: 1. Conventional Frame 2. Half Integral and Half frame 3. Integral or Unitised frame		2
b) Classify the vehicle layout with respect to i. Arrangement of engine ii. application		2
Answer: Classification of vehicle layout with respect to- i) Arrangement of engine: 1. Front engine front wheel drive. 2. Front engine rear wheel drive. 3. Four wheel drive. 4. Rear engine rear wheel drive. 5. Central engine all wheel drive. ii) Application: 1. Cars 2. Vans 3. Heavy commercial vehicle 4. Rigid / non articulated vehicle 5. Articulated vehicle		1 1
c) Write various loads acting on chassis frame.		2
Answer: Loads acting on the chassis Frame (any four points (Names only)- 1/2 mark each) 1. Static Loads - Loads due to chassis parts, weight of vehicle and passengers etc. 2. Inertia Loads - While application of braking torque and engine torque. 3. Impact loads - When a vehicle or wheel collides with any other object on the road or road obstacle. 4. Short Duration Loads - While crossing a broken patch of a road or speed breakers. 5. Momentary Duration Loads - Combined loads -while negotiating curves, applying brakes and striking a pot hole. 6. Overloads - Overloading a vehicle beyond its designed capacity.		2



d) State materials used for clutch lining.	2
Answer: The materials for clutch lining are: (<i>any four materials- 1/2 mark each</i>) 1. Leather 2. Cork 3. Fabric 4. Asbestos 5. Reybestos and Ferodo 6. Non- asbestos clutch lining material.	2
e) State necessity of gear box.	2
Answer: Necessity of gear box: The engine delivers its full power at high speed and its direction of rotation is not reversible. When a vehicle starts from rest, hill climbing, accelerating and meeting other road resistances, high torque (tractive effort) is required at driving wheels. Hence a gear box is used to permit the engine crankshaft to revolve a relatively high speed, while the wheels turn at slower speeds. The vehicle speed is also changed with the help of gear box keeping the engine speed same with certain limit. This is the main purpose of gearbox to provide speed variations in road wheels by keeping engine speed constant.	2
f) Write function of propeller shaft.	2
Answer: Function of propeller shaft: (<i>Any two</i>) 1. To transmit rotary motion and power to the differential. 2. To transmit power at varied angle. 3. To absorb the shocks coming on the transmission system when the vehicle starts from rest. 4. To accommodate change in length when the rear axle moves up and down.	2
g) State function of differential.	2
Answer: Function of differential: 1. To transmit the power from propeller shaft at right angle to the axle shafts for moving the wheel. 2. To differentiate the speed of two rear wheels when vehicle takes a turn, i.e. the outer wheel has to travel more distance than inner wheel or the outer wheel has to run faster than the inner wheel.	2
h) List load acting on rear axle.	2
Answer: The various loads acting on the rear axle are- (<i>Any 02 points each carry 01 mark</i>) 1) Driving thrust 2) Torque Reaction. 3) Braking torque or thrust. 4) Side thrust 5) Weight of the body	2
(B) Attempt any TWO:	8
a) Draw layout of rear engine rear wheel drive.	4

Answer: **Layout of rear engine rear wheel drive:**

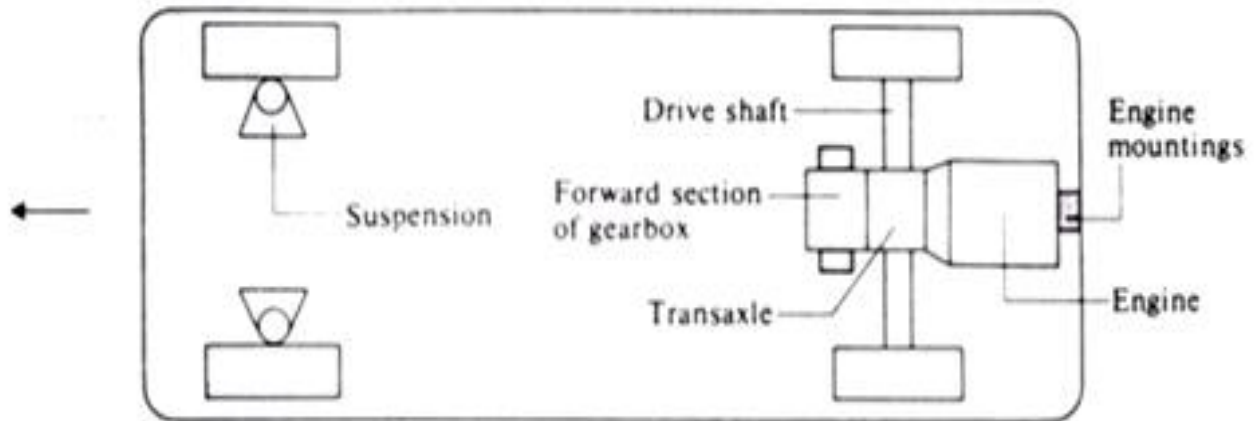


Figure: Layout of rear engine rear wheel drive

b) State and explain working principle centrifugal clutch.

Answer: **Working principle 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.

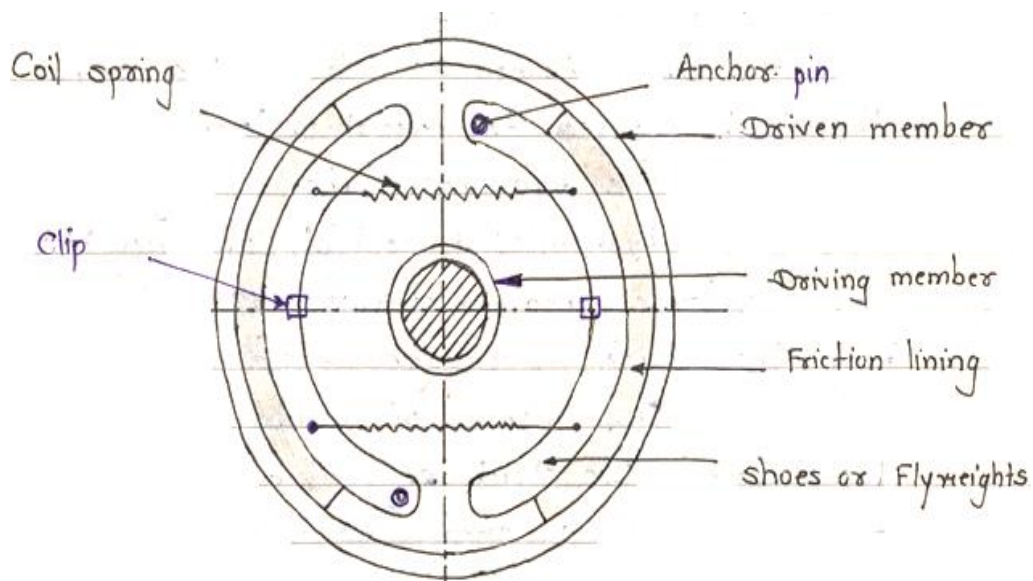
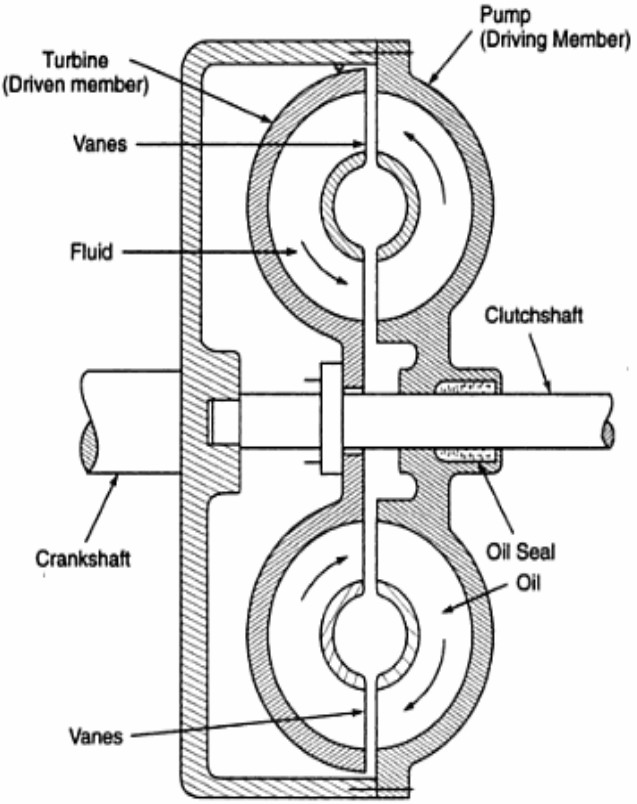


Figure: Working principle of Centrifugal Clutch



<p>c) Explain construction of fluid coupling with neat labeled sketch</p>	<p>4</p>
<p>Answer: Construction of fluid coupling:</p>  <p style="text-align: center;">Fig. Fluid Coupling</p> <p>Fluid coupling or hydraulic coupling is used as clutches in cars employing automatic transmissions. It consists of two members, the driving and driven as shown in fig. The driving member is attached to the engine flywheel and the driven member to the transmission shaft. The two members do not have any direct contact with each other. The driven member is free to slide on splines on the transmission shaft. The two rotors are always filled with fluid of suitable viscosity. These are provided with radial ribs to form number of passages which avoids the formation of eddies and as guide to flow in desired direction.</p>	<p>2</p> <p>2</p>
<p>2. Attempt any TWO :</p>	<p>16</p>
<p>a) Draw neat labelled sketch of variator drive and explain its operation.</p>	<p>4</p>
<p>Answer: Operation of Variator Drive:</p> <p>Vario-drive provides various drive ratios between the engine and rear wheel according to the engine speed and load. It consists of two set of split pulleys – drive and driven pulley and drive belt between the pulleys. The drive pulley is attach to the crankshaft and driven to rear wheel. The variator (drive pully) consists of a fixed face and a movable face. The movable face is capable of sliding axially on the boss of the fixed face. The ramp plate is fixed by a nut and is pushes in the weight rollers against the drive face.</p> <p>As the speed of the engine increases, centrifugal force on the weight roller is also increased. This pushes the movable drive face inward. The unit then acts with a reduced drive ratio by allowing the drive belt to run on a pulley of greater diameter. The driven pulley and clutch weights are attached over the drive shaft. The force of the driven face spring is increased, the driven pulley turns and the clutch connects automatically. The effective diameter of the drive pulley is increased. The movable</p>	<p>2</p>



face is forced outward by means of the belt until equilibrium is reached between the torque tension of the belt and force of the spring. When this occurs, the drive ratio decreases and less torque is delivered to the final reduction.

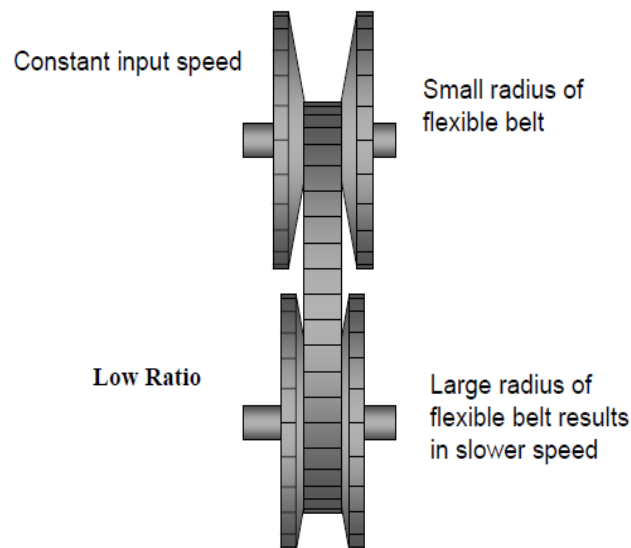


Figure: Variator Drive

(Note: equivalent credit should be given to any other suitable diagram)

2

b) Where and why do we use multiplate clutches and explain working of multiplate clutch.

4

Answer: **Multiplate Clutch:** (Note: Diagram not necessary)

Use:

Multiplate dry clutch is used in heavy duty transport vehicles for example tractor trailer in which requirement of power and torque is more or higher.

2

OR

Multiplate wet clutch is used in motorcycles and racing cars because space available to locate the clutch is very small and natural cooling is not possible.

Working:

Multiplate clutch consist of a number of clutch plates. The plates are alternately fitted to the engine and gear box shaft. They are firmly pressed by strong coil springs and assembled in a drum. Each of the alternate plate slides in the groves on the flywheel and the other slides on splines on the pressure plate.

2

To disengage the clutch, pressure will be applied on the clutch pedal; due to this the pressure plate moves to right and against the spring force. The movement of the pressure plate to the right makes the clutch plates free which mean that torque will not be transmitted from the engine shaft to the transmission. When the clutch pedal is released, because of spring force the pressure plates move forward and keeps the pressure on the clutch plates holding them against the flywheel. Now the torque is transmitted to the transmission.



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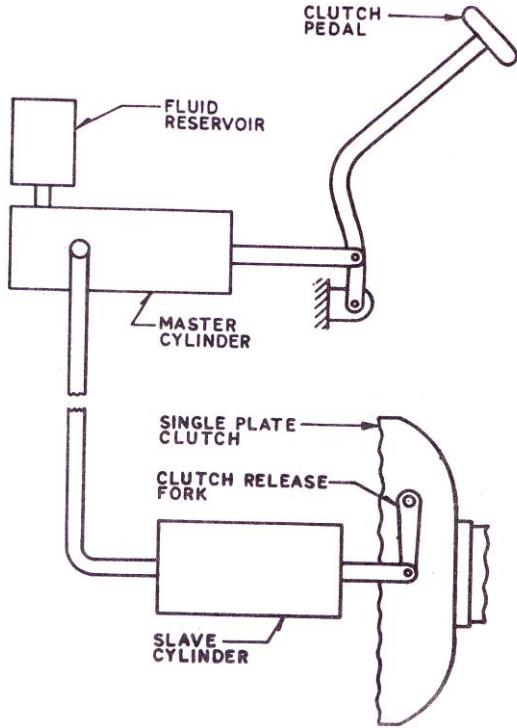
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	c) Differentiate between single plate clutch and multiplate clutch. (any four points)	4																											
	Answer: Difference between single plate clutch and multiplate clutch: (Any 4 points)																												
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%;">Sr</th> <th style="width: 45%;">Single Plate clutch</th> <th style="width: 45%;">Multi-plate clutch</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>It consists of only one clutch plate.</td> <td>It consists of two or more number of clutch plates.</td> </tr> <tr> <td>2</td> <td>Number of pairs of friction surfaces in contact are two.</td> <td>Number of pairs of friction surfaces in contact are more than two.</td> </tr> <tr> <td>3</td> <td>It does not ensure smooth engagement.</td> <td>It ensures smooth and gradual engagement.</td> </tr> <tr> <td>4</td> <td>It requires more space.</td> <td>It requires less space.</td> </tr> <tr> <td>5</td> <td>For same power transmission, larger in size.</td> <td>For same power transmission, smaller in size.</td> </tr> <tr> <td>6</td> <td>For same size, torque transmission capacity is less.</td> <td>For same size, torque transmission capacity is more.</td> </tr> <tr> <td>7</td> <td>Frictional power loss is less.</td> <td>Since it has number of friction plates instead of single, frictional power loss is more.</td> </tr> <tr> <td>8</td> <td>Application- Trucks, Jeeps, cars etc.</td> <td>Application- Two wheelers, racing cars, some heavy duty trucks.</td> </tr> </tbody> </table>	Sr	Single Plate clutch	Multi-plate clutch	1	It consists of only one clutch plate.	It consists of two or more number of clutch plates.	2	Number of pairs of friction surfaces in contact are two.	Number of pairs of friction surfaces in contact are more than two.	3	It does not ensure smooth engagement.	It ensures smooth and gradual engagement.	4	It requires more space.	It requires less space.	5	For same power transmission, larger in size.	For same power transmission, smaller in size.	6	For same size, torque transmission capacity is less.	For same size, torque transmission capacity is more.	7	Frictional power loss is less.	Since it has number of friction plates instead of single, frictional power loss is more.	8	Application- Trucks, Jeeps, cars etc.	Application- Two wheelers, racing cars, some heavy duty trucks.	4
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	d) Give the classification for friction and non-friction type clutches.	4																											
	Answer: Classification of friction and non-friction type clutches: <div style="text-align: center; margin-top: 20px;"> <pre> graph TD Clutch --> FrictionClutch[Friction Clutch] Clutch --> nonFrictionClutch[non Friction Clutch] FrictionClutch --> ConeClutch[Cone Clutch] FrictionClutch --> DiscOrPlateClutch[Disc Or plate Clutch] FrictionClutch --> SemiCentrifugalClutch[Semi centrifugal clutch] FrictionClutch --> CentrifugalClutch[Centrifugal clutch] ConeClutch --> InternalCone[Internal Cone] ConeClutch --> ExternalCone[External Cone] DiscOrPlateClutch --> SinglePlateClutch[Single plate Clutch] DiscOrPlateClutch --> MultiPlateClutch[Multi plate Clutch] MultiPlateClutch --> WetClutch[Wet Clutch] MultiPlateClutch --> DryClutch[Dry Clutch] nonFrictionClutch --> FluidClutch[Fluid Clutch or flywheel] </pre> </div>	4																											



e) Explain hydraulic clutch linkage with sketch.	4
<p>Answer: Operation of hydraulic clutch mechanism:</p> <p>When the clutch pedal is pressed fluid under pressure from the master cylinder reaches the slave cylinder which is mounted on clutch itself. The fluid under pressure actuates slave cylinder push rod and plunger permits the seal spring to press the valve shank and seal against its seat. This disconnects the cylinder from the reservoir. Further movement of the plunger displaces the fluid through the hydraulic lines to the slave cylinder and disengages the clutch.</p>  <p>Figure: Hydraulically operated clutch.</p>	2
f) Describe the working of synchromesh gear box.	4
<p>Answer: Working of synchromesh gear box.</p> <p>In fig. the gear A is fixed with clutch shaft, Gear A, B, C, and D are free to rotate on the main shaft. Member S_1 & S_2 (hub) are free to slide on splines on the main shaft. Ring shaped members N_1 & N_2 having internal teeth can fit on the external teeth of sliding members S_1 & S_2 respectively. L_1 & L_2, and R_1 & R_2 are dog teeth on gear A, B, C, D. M_1 & M_2 are the forks and T_1 & T_2 are the balls supported by springs. $A_1, A_2, B_1, B_2, C_1, C_2$ and D_1, D_2 are the frictional surfaces.</p> <p>Working:</p> <p>For obtaining second gear, slide (move) the member S_1 to the right till cones B_1 and B_2 rub and the friction makes their speed equal. Now push the member N_1 to the right, by overcoming the force of the spring loaded balls and be engaged with teeth R_1. In this way the drive to the main shaft is transmitted from A to G_1 and G_2 to B and then B_2 to the main shaft through member S_1.</p> <p>Similarly for obtaining direct (top) gear, slide (move) the member S_1 to the left till cones A_1 and A_2 come in contact and the friction makes their speed equal. Now push the member N_1 to the left and get engaged with teeth L_1. In this way the drive to main shaft will be direct from A through member S_1.</p>	2

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For obtaining first gear, move N_2 and S_2 to the left. Then the drive will be from A to G_1 and G_3 to C and then C_2 to the main shaft through member S_2 . For obtaining reverse gear, slide N_2 and S_2 to the right. In this way the drive will be from A to G_1 and G_4 to G_5 and G_5 to D and then D_2 to the main shaft through member S_2 .

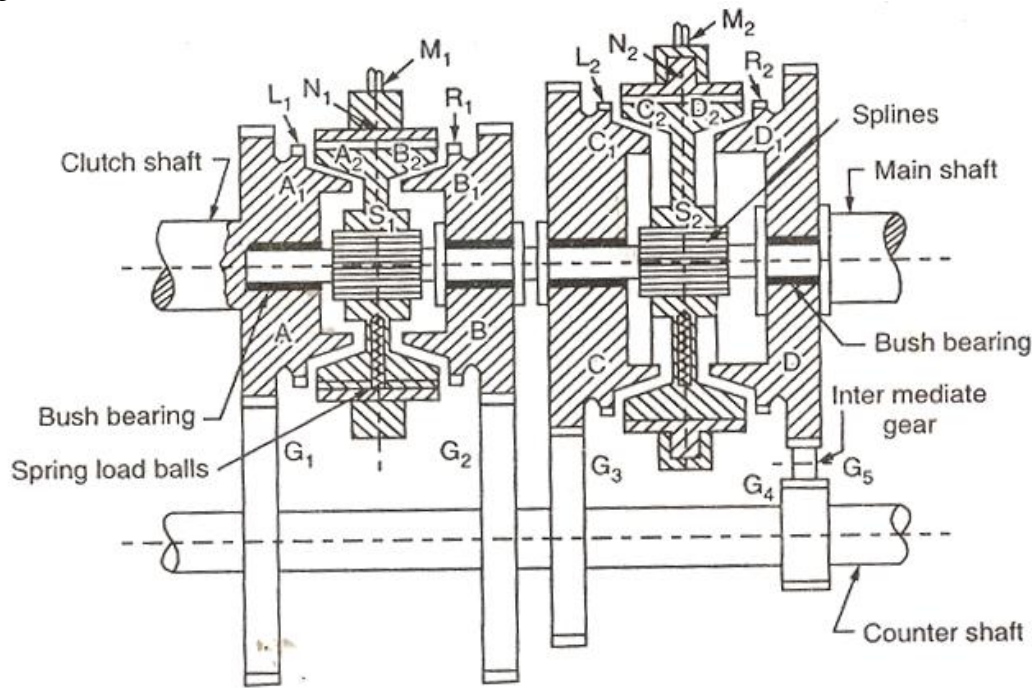


Figure: Synchromesh Gear Box

2

3. Attempt any FOUR

16

- a) Explain construction and working of gear selector mechanism with gear lever on top of gear box.

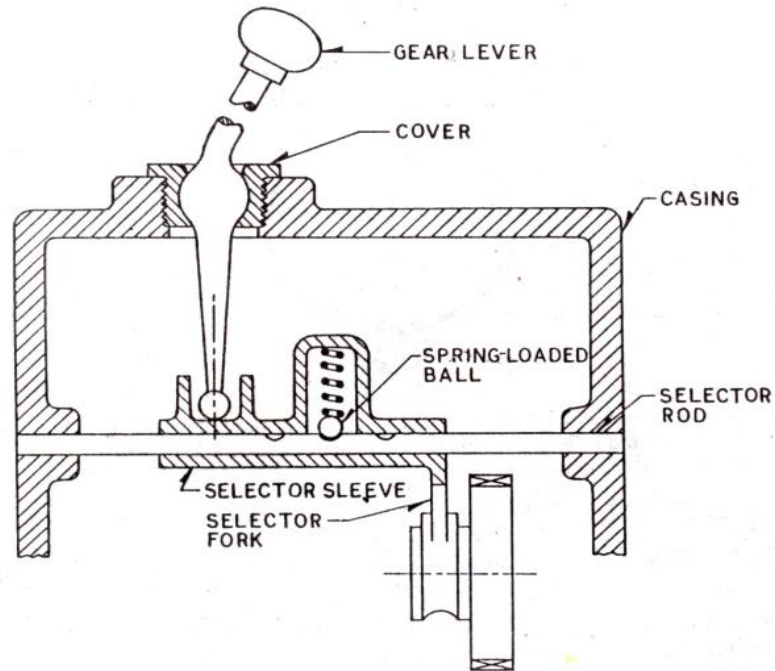
4

Answer: Construction & working of gear selector mechanism with gear lever on top of gear box.

A typical 4-forward and a reverse speed floor mounted mechanism is shown in the figure. The gear lever is ball mounted in the gear box cover, the lower end of the lever fits into a slot in the selector sleeve. The sleeve has a fork by which it can move the gears. There are three selector rods supported in the gear box casing. On the selector rods the sleeve can slide. The slots are cut on the rod and the sleeves are provided with spring loaded balls to avoid unwanted engagement of gears. These balls resist the movement of the forks until some force is applied to the gear lever to overcome their resistance. A suitable interlocking mechanism is provided to ensure that at any time no two gears are engaged. This can be possible by a mechanism which ensures that any gear can be engaged only after the neutral has been obtained. Further a provision is also made to prevent accidental engagement of the reverse gear instead of a forward gear. This may be done by means of a stiff spring which has to be overcome by applying extra force.

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 is to be engaged and the longitudinal movements then slides the fork and its gear to engage the selected gear.



OR

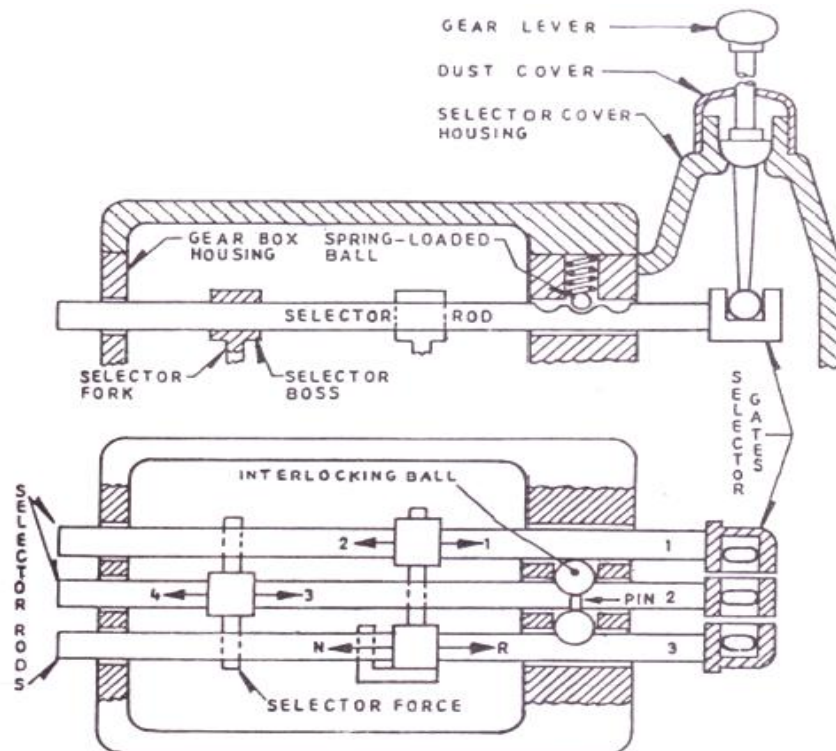
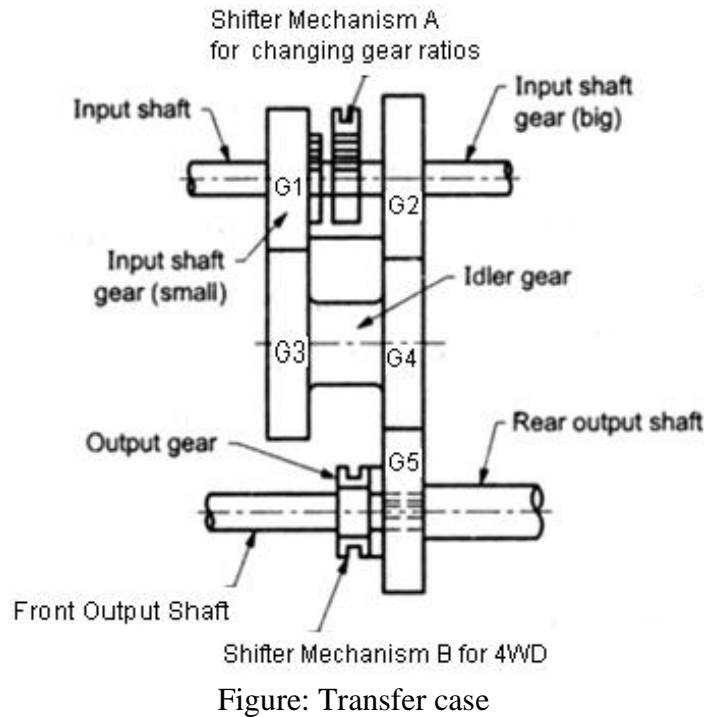


Figure: Gear selector mechanism with gear lever on top of gear box.

b) Describe the construction and working of transfer case.

4

Answer: **Transfer case:**



2

Construction:

It consists of three shafts- input shaft, counter shaft and two output shafts. The input shaft takes power from the main gear box. The two gears gear1 and gear 2 on input shaft are free to rotate on it. These two input shaft gears have bosses on the inner side having axial teeth, which can be meshed with central member. The input shaft carries on central member C.M. having axial teeth on both, side faces. The gear G1 is smaller in diameter than G2.

1

Working:

When the shifter-A is at the central position as shown in fig. here neither the gear G_1 and nor the gear G_2 is connected to the input shaft, it is known as neutral position. When the shifter-A connects the input shaft with big input gear G_2 , 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.

1

Similarly when the shifter-A connects the input shaft with small input gear G_1 , 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.

c) Describe the working of four speed sliding mesh gear box with power flow diagram.

4

Answer: **Working of four speed sliding mesh gear box with power flow diagram:**

Neutral: In neutral main shaft gear is not meshed with any of the lay shaft gears. Hence only clutch shaft and lay shaft rotates. Power is not transmitted to main shaft.

First gear: The selector fork (A) moves bigger gear (6) on main shaft to mesh with gear (5) on the lay shaft. The power flow is 1-2-5-6--→ main shaft. This ratio provides the greatest torque increase and greatest speed reduction.

2



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Second gear: The selector fork (A) moves back to neutral and the fork(B) moves the gear (4) of main shaft to right to mesh with gear (3) of lay shaft. The power flow is 1-2-3-4-→ main shaft. The output torque is more than that of first gear but the output speed is increased.

Top gear: The selector fork (B) is moved in opposite direction to engage gear (4) with clutch gear (1) by means of dog clutch. This connects the two shafts firmly and main shaft is directly driven at crank shaft speed.

Reverse: The selector fork (A) is moved in opposite direction to engage gear (6)to mesh with reverse idler (8). The power flow is 1-2-7-8-6-→main shaft. The idler changes the rotation of main shaft opposite to that of first gear, this provides reversal of direction of drive.

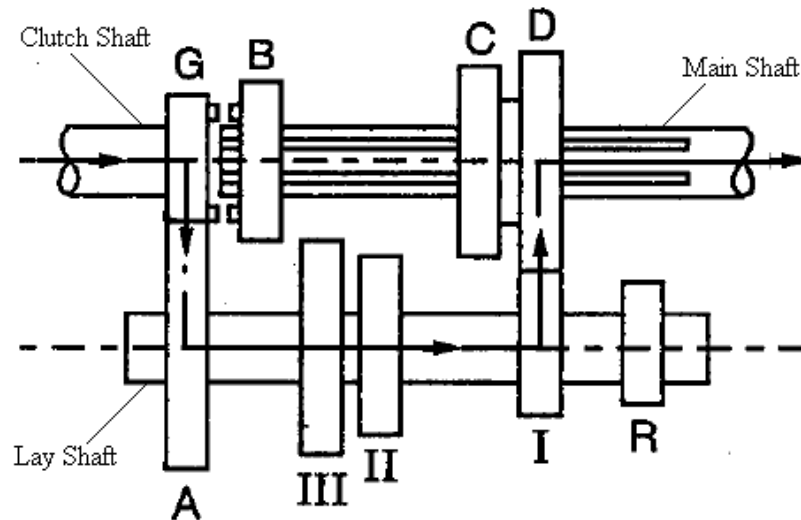


Figure: Sliding Mesh gear box with power flow when I gear is engaged.

(Note: Equivalent credit should be given to power flow diagram with any one gear is in engaged position)

d) Draw a proportionate sketch of 4 speed constant mesh gear box.

Answer:

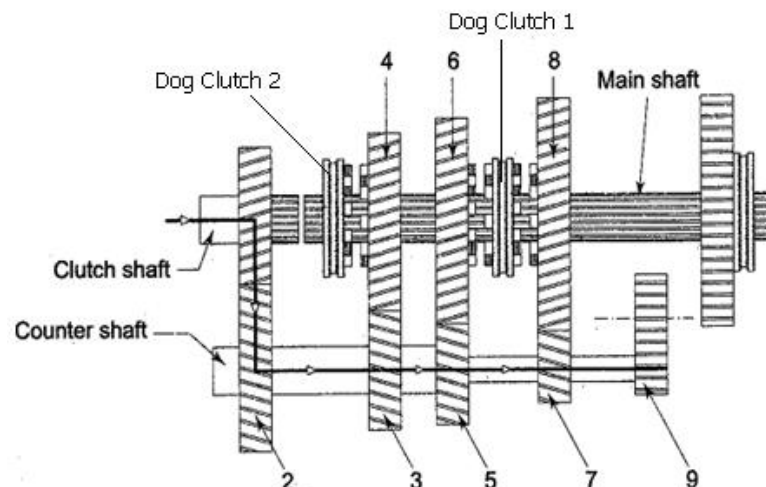


Figure: 4 Speed Constant Mesh Gear Box.

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Answer: Functions of Constant Velocity Joint:

1. To transmit the power when angle of drive is more than 30° as in front wheel drive car.
2. To allow shafts to slide in and out at large operating angles, when there is irregularity of rotation angle at more torque and fluctuation cause steering control problem.
3. To maintain constant speed even at corners.

2

Types of inboard and outboard type CV Joints: (Any two)

1. Rzeppa joint
2. Tripod joint
3. Bendix-weiss joint
4. Thomson coupling
5. Double carden joints

2

b) State various types of rear axle casing and explain any one with neat sketch.

4

Answer: Types of rear axle casing: (Types-1 mark, Explanation of any one with sketch-3 marks)

1. Banjo or separate carrier type (or one piece) casing
2. Split (or two piece) casing
3. Salisbury or Integral Carrier type casing

1

1) **Banjo type (or one piece) casing:** It is named so, because its shape like the musical instrument banjo. It is also called separate carrier type casing because the complete differential unit is carried in a separate carrier which is bolted to the axle casing. The two half shafts are put-in or taken-out from the sides during assembly or repairs. In majority cars the propeller shaft lies along the centre line of the car, and the rear axle gearing is enclosed in banjo at the centre of the axle casing. However, in certain cases the banjo may be offset to one side or the other.

2



1

Figure: Banjo type Casing

OR

2) **Split (or two piece) casing-**The casing is made in two-pieces which are bolted together to form a casing. This type is obsolete now because in case of a fault, the whole rear axle unit has to be taken out before its dismantling.



Figure: Split type casing

OR

3) **Salisbury or Integral carrier type:** This is similar in construction to the banjo type except that in this the carrier i.e. differential housing has permanent housing tubes pressed and welded in its sides. According to SAE nomenclature, it is called the unitized carrier housing.



c) Explain the concept of differential lock.	4
<p>Answer: Concept of Differential lock:</p> <p>The torque transmitted by the bevel gear differential to each of the rear wheels remains equal when they are rotating at different speeds. Due to this, if one of the rear wheel lying on soft, mud, loose dirt sand or slippery surface and the other is on the solid ground, at that time, the wheel which is on the soft mud is having less resistance. The wheel lying on the soft ground spins or rotates around its own axis due to differential action, whereas the other wheel lying on the solid ground is not driven and remains stationary. It causes not only the loss of traction but also does not enable the vehicle to move.</p> <p>Therefore to drive out the vehicle from such situations or conditions differential locking is provided. When the differential lock is applied, the differential action is stopped and the whole torque is then applied to the wheel which is gripping on the road.</p>	4
d) How a torque converter differs from a gear box?	4
<p>Answer:</p> <p>A torque converter is a device which performs a function similar to that of a gear box, i.e. to increase the torque while reducing the speed. But whereas gear box provides only a small number of fix ratios, the torque converter provides a continuous variation of ratio from the lowest to the highest. It provides maximum gear ratio starting from the rest and gradually decreases that ratio as the vehicle gains speed.</p> <p>In torque converter no shifting mechanism is required as torque increases along with the engine speed. No gear train is used as in the gear box. It does not require frequent maintenance as compared to gear box and is compact in design. The efficiency of torque converter is maximum within a very narrow speed range. It is used along with the epicyclic gear train.</p>	4
e) Discuss with the help of simple sketch the construction of various types of disc wheels.	4
<p>Answer: Types of Disc Wheels: (Any two types- 02 marks , sketch-02 marks)</p> <p>Disc wheels are classified according to the method of their manufacture and the materials out of which they are made. Two types are in common use at present: pressed steel and cast light alloy.</p> <p>a) Pressed-Steel Disc Wheel - This type consists of a rim welded to a disc stamped from sheet steel, a construction well suited for mass production. Most automobiles now use the pressed-steel disc type because of its higher durability and uniform quality levels.</p> <p>b) Cast Light-Alloy Disc Wheel - This type, cast from a light alloy consisting mainly of aluminum or magnesium, is widely used not only for vehicle models requiring lighter weight, but also to add an accent to the vehicle's appearance.</p> <p>c) Inset, zerset and outset: Disc wheels are classified according to the position of the rim in the relation to the attachment face of the disc.</p> <p>Zerset - the rim center line coincides with the attachment face of the disc.</p> <p>Outset- the centerline of the disc is located to the outboard of the attachment face of the disc.</p> <p>Inset - the centerline of the disc is located to the inboard of the attachment face of the disc.</p> <p>Reversible wheel- the wheel whose disc can be mounted in either face to provide inset or outset, thus decreasing or increasing the wheel track.</p> <p>d) Divided wheel: wheel constructed in two parts which when securely fastened together combine to form a rim having two fixed flanges.</p>	2

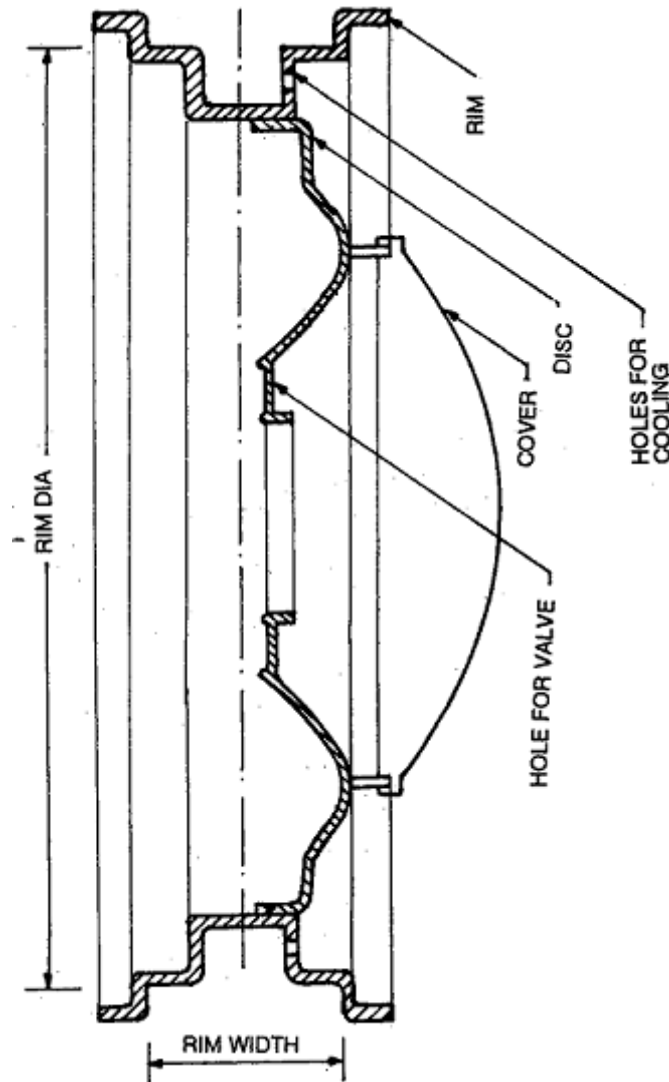


Figure: Disc Wheel

2

f) Explain tyre terminology with sketch.

4

Answer: **Tyre Terminology:** (Any four terms- 2 marks, Sketch -2 marks)

1. Tread: That portion of a tire that comes into contact with the road. It is distinguished by the design of its ribs and grooves. Provides traction in a variety of conditions, withstands high forces, and resists wear, abrasion, and heat.

2. Tread Depth: The depth of usable tread rubber, the distance from the top of the tread to the grooves in a tire. The measurement is taken at the centerline of a tire.

3. Tire Size: The combination of tire width, construction type, aspect ratio, and rim size used in differentiating tires.

4. Sidewall: That portion of a tire between the tread and the bead. Protects the tire against impacts with curbs, etc. This is also where the sidewall markings can be found which tell you important information regarding the tire.

2

5. **Section height:** The height of a tire, measured from its rim to its outer tread.
6. **Section width:** The distance between the outside of a tire's sidewalls, not including any lettering or designs.
7. **Ribs:** A pattern of tread features aligned around the circumference of a tire. There are usually multiple ribs across the tread area of a tire.
8. **Carcass:** The supporting structure of the tire consisting of plies anchored to the bead on one side and running in a radius to the other side and anchoring to the bead.
9. **Bead:** The part of the tire that sits on the wheel made of steel wires, reinforced by body ply cords, shaped to hold firmly the tire against the wheel rim.
10. **Aspect Ratio:** The relationship of a tire's sidewall height to its section width. In a tire size designation, it is 65 in "195/65R15". It is also referred to as the tire's profile or the series.
11. **Load Index:** Is a number that corresponds to the maximum load in kilograms that a tyre can support when properly inflated.

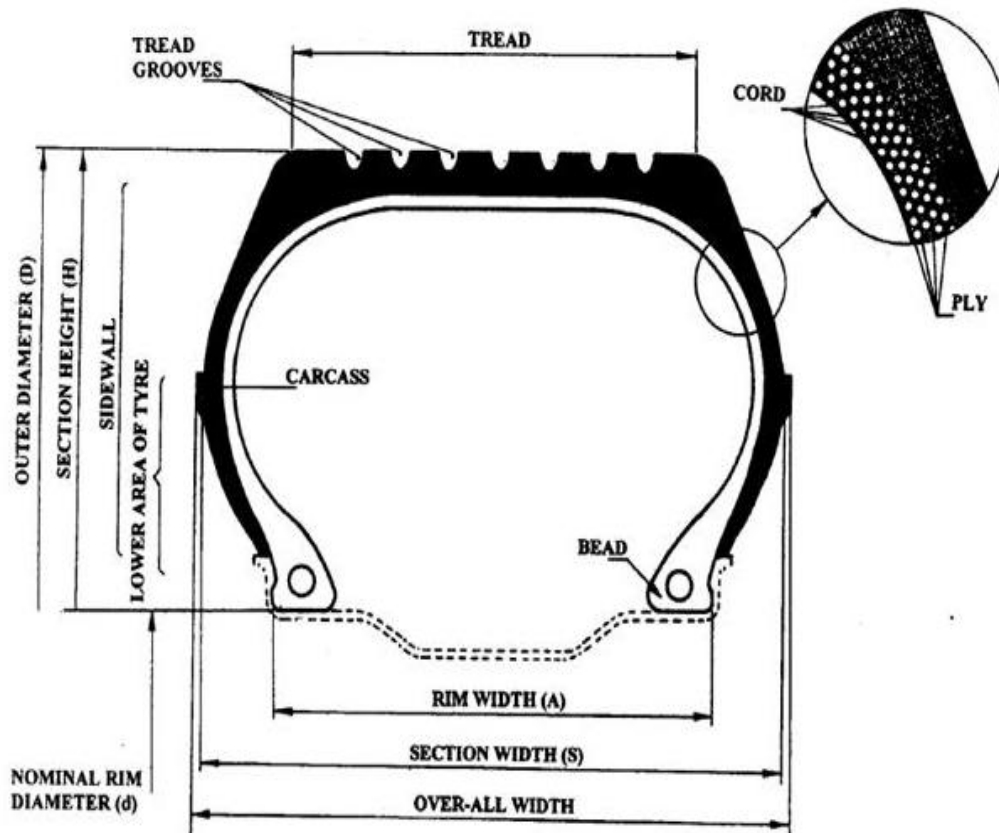


Figure: Tyre Terminology

5. Attempt any **TWO**:

- a) Differentiate between Hotchkiss and torque tube drive with the help of suitable sketches (any four points)



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Answer: **Difference between Hotchkiss and torque tube drive:** (Sketches-4 marks, Any four remaining points-4marks)

Hotchkiss Drive	Torque Tube Drive
<p>1)</p>	<p>1)</p>
2) Open type propeller shaft is used.	2) Propeller shaft is housed in a tube called torque tube.
3) Two universal joints is used one at front & second at rear end of the propeller shaft.	3) Only one universal joint is used at the front end of the propeller shaft.
4) Slip joint is used to accommodate change in length.	4) No slip joint is used.
5) Torque reaction, driving thrust, side thrust, weight of the body & braking torque all are taken by leaf spring.	5) Weight of the body & side thrust are taken by leaf spring. Torque reaction, driving thrust, braking torque are taken by the torque tube.
6) Leaf spring is shackled at the rear and bracketed at front end.	6) Both end of the leaf spring are shackled.
7) The centre axis of propeller shaft and bevel pinion shaft is not coinciding when axle moves up and down.	7) Axis of propeller shaft and bevel pinion shaft coincide always.
8) It is used in heavy vehicles like bus, truck.	8) It is used in light vehicles like cars.

b) Explain working of differential with neat sketch.

Answer: **Working of differential with neat sketch:**

1. **When Running Straight:** 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. The road wheels, half shafts and sun wheels offer the same resistance to being turned and the differential gearing does not therefore operate. Both the road wheels turn at the same speed.

2. **When taking a turn:** 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 outer 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.

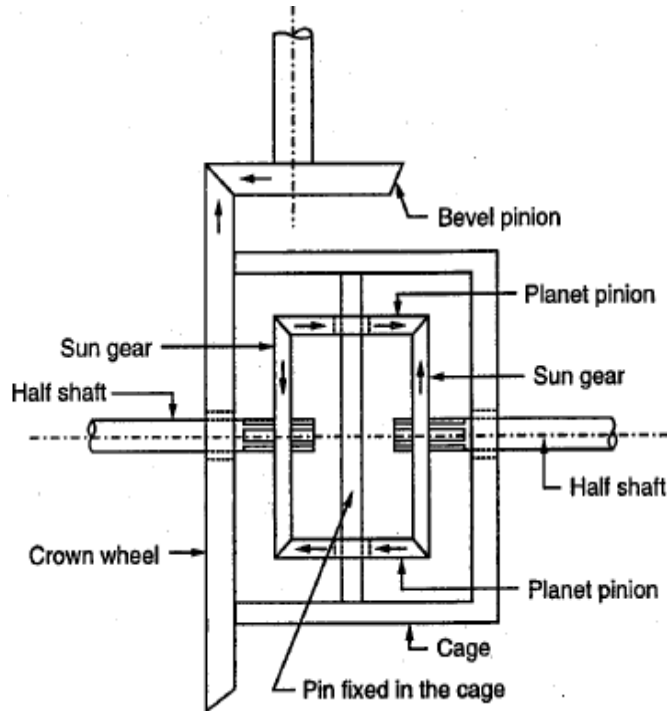


Figure: Working of differential

4

- c) Explain with neat sketch following type of rear axle.
a) Semifloating
b) Three quarter floating.

8

Answer: **Type of rear axles:**

a) Semifloating: The figure shows a schematic diagram of the semi floating rear axle. A single ball bearing is inside the axle casing. The axle of the wheel is at the centre of the axle casing and the wheels are fitted at the end of the axle. This is done by means of key, bolt and nut. The whole weight of the vehicle is first transmitted to the suspension spring. From there it is transmitted to the axle casing from there to the axle and wheel. Finally it is transmitted to the ground. The axle can be removed by first placing a support below the axle casing.

2

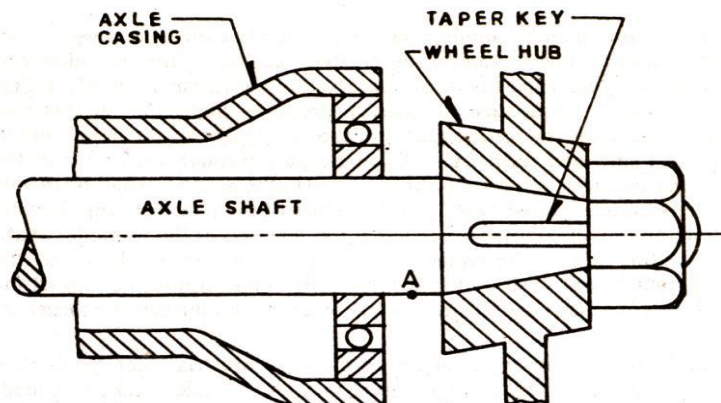


Figure: Semifloating type rear axle

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b) Three quarter floating: This is a compromise between the more robust full floating type and simplest semi-floating type of rear axle. In this bearing is located between the axle casing and the hub instead of between the axle casing and the shaft as in the case of semi-floating axle. As shown in the figure, the axle shafts do not have to withstand any shearing or bending actions due to weight of the vehicle. The axle transmits the torque from differential to road wheels. Driving and cornering torque is carried by the axle half shafts. Braking torques, shearing and bending loads, and side thrust are taken up by the axle casing through the hub and the bearing, provided the bearing lies in the plane of the road wheel.

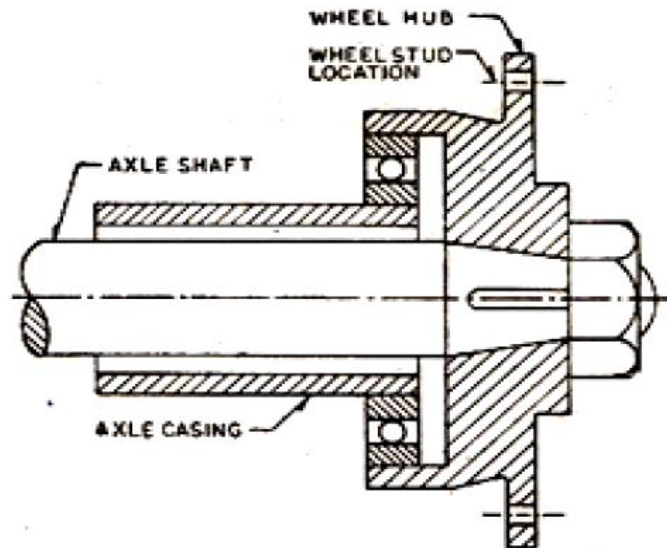


Figure: Three quarter floating type rear axle

6. Attempt **any TWO** of the following:

- a) Differentiate between 2WD and 4WD on the basis of the following parameters.
- i. Torque and power transmission
 - ii. Engine location and drive
 - iii. Performance and efficiency
 - iv. Merits, demerits.

Answer: Difference between 2WD and 4WD on the basis of: *(Each parameter carry 2 marks)*

Sr.	Point	2 Wheel Drive	4 Wheel Drive
1	Torque and power transmission	Torque and power is transmitted to only front or rear wheels, hence spinning of drive wheels on loose roads is possible	Torque and power is transmitted to both front and rear wheels, hence spinning of drive wheels on loose roads is not possible.
2	Engine location and drive	Engine is located either at the front or rear and drive is given to either only to front wheels or rear wheels.	Engine is located at the front or center and the drive is given to all the four wheels.
3	Performance and efficiency	On road performance of 2WD is better where moderate torque and higher speeds are desired. Efficiency is more.	Off road performance of 4WD is better where higher torque and slower speeds are desired. Efficiency is low



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4	Merits, demerits (Any two points)	<p>1. Initial cost is less. 2. Since fuel economy is more, running cost is also less. 3. Floor height can be reduced and lower ground clearance can be kept, hence aerodynamic design is possible. 4. Weight is concentrated only on driving wheels. 5. It is used in light motor vehicles and cars where higher speeds are desired.</p>	<p>1. Initial cost is more. 2. Running & maintenance cost is more since fuel economy is less. 3. Floor height cannot be reduced much and ground clearance is more, hence aerodynamic design is not possible. 4. Weight is uniformly distributed on all the wheels. 5. It is required in heavy duty motor vehicles as well as in off road / cross country vehicles. It is not applicable in high speed vehicles.</p>																					
<p>b) Differentiate between cross ply and radial ply type on the basis of</p> <ol style="list-style-type: none"> Construction/trade pattern Materials / constituents Performance / efficiency Application / purpose. 				8																				
<p>Answer: Difference between cross ply and radial ply type tyres: (Each point carry 2 marks)</p>																								
<table border="1"> <thead> <tr> <th data-bbox="180 1121 269 1163">Sr.</th> <th data-bbox="269 1121 558 1163">Point</th> <th data-bbox="558 1121 1013 1163">Cross Ply</th> <th data-bbox="1013 1121 1495 1163">Radial Ply</th> </tr> </thead> <tbody> <tr> <td data-bbox="180 1163 269 1276">1</td> <td data-bbox="269 1163 558 1276">Construction/trade pattern</td> <td data-bbox="558 1163 1013 1276">Piles are running diagonally opposite from bead to bead.</td> <td data-bbox="1013 1163 1495 1276">Piles are running radially (i.e. in the direction of tyre axis) straight from bead to bead.</td> </tr> <tr> <td data-bbox="180 1276 269 1425">2</td> <td data-bbox="269 1276 558 1425">Materials / constituents</td> <td data-bbox="558 1276 1013 1425">It consists of cord ply woven at an angle. Breaker strips are not provided, thus continuous grip on road surface is not possible.</td> <td data-bbox="1013 1276 1495 1425">It consists of cord ply woven in radial direction. Breaker strips are provided to make continuous flat contact with road surface.</td> </tr> <tr> <td data-bbox="180 1425 269 1719">3</td> <td data-bbox="269 1425 558 1719">Performance and efficiency</td> <td data-bbox="558 1425 1013 1719">Stiffness of tyre is more, so less comfortable. Steering is easy. Tyre has lesser grip with road. More rolling resistance as compare to radial ply tyres. Also it has less trade life. It has wobbling characteristics.</td> <td data-bbox="1013 1425 1495 1719">Stiffness of tyre is less, so it gives ultimate comfort at high speed. Steering is harder at low speeds. Tyre has firm grip with road. This tyre has low rolling resistance, hence better fuel efficiency. Also it has more trade life. It provides better directional stability.</td> </tr> <tr> <td data-bbox="180 1719 269 1835">4</td> <td data-bbox="269 1719 558 1835">Application/ purpose.</td> <td data-bbox="558 1719 1013 1835">Motorcycles, agricultural purpose vehicles</td> <td data-bbox="1013 1719 1495 1835">Passenger cars</td> </tr> </tbody> </table>	Sr.	Point	Cross Ply	Radial Ply	1	Construction/trade pattern	Piles are running diagonally opposite from bead to bead.	Piles are running radially (i.e. in the direction of tyre axis) straight from bead to bead.	2	Materials / constituents	It consists of cord ply woven at an angle. Breaker strips are not provided, thus continuous grip on road surface is not possible.	It consists of cord ply woven in radial direction. Breaker strips are provided to make continuous flat contact with road surface.	3	Performance and efficiency	Stiffness of tyre is more, so less comfortable. Steering is easy. Tyre has lesser grip with road. More rolling resistance as compare to radial ply tyres. Also it has less trade life. It has wobbling characteristics.	Stiffness of tyre is less, so it gives ultimate comfort at high speed. Steering is harder at low speeds. Tyre has firm grip with road. This tyre has low rolling resistance, hence better fuel efficiency. Also it has more trade life. It provides better directional stability.	4	Application/ purpose.	Motorcycles, agricultural purpose vehicles	Passenger cars				8
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<p>c) i) Explain tube less tyre and its features. ii) Explain tyre inflation and its effect.</p>				8																				

Answer:

i) **Tube less tyre & its features:**

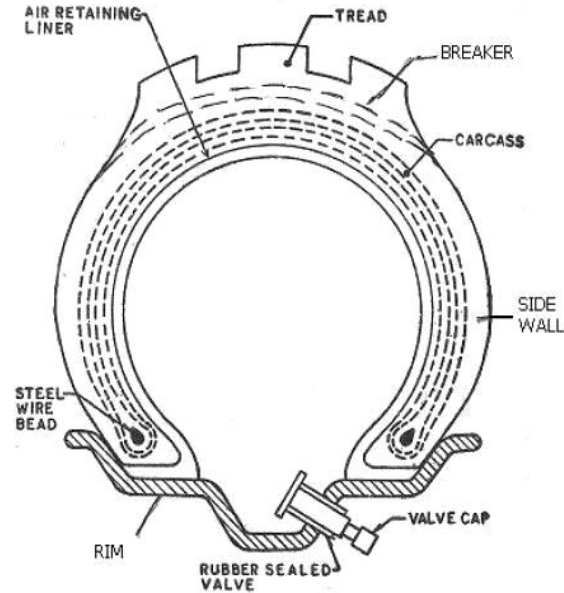
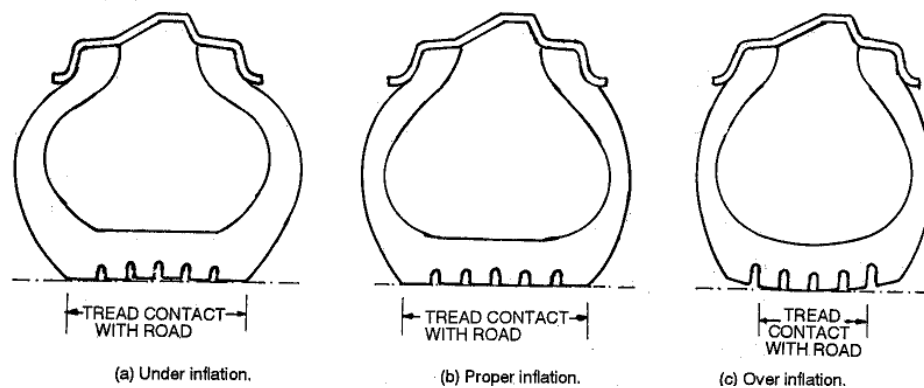


Fig. Tubeless tyre

The material & design of carcass & tread remains similar to tubed type tyre. In this no tube is placed inside the tyre. The inside of casing is lined with soft rubber lining which forms an air tight seal with rim, it is known as “air-retainer liner”. This lining retains the air & seals itself on being puncture. A “non return valve” is fitted to rim through which the air is forced inside the tyre. The rim used for such tyres is specially designed.

ii) **Tyre inflation & its effect:**

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 tyre inflation pressure must be checked regularly and adjusted as necessary whenever it differs from the specified pressure. Three different conditions of tyre inflation are shown in the following figure.





Effects of Under-inflation:

- 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.

Effects of Over-inflation:

- 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.