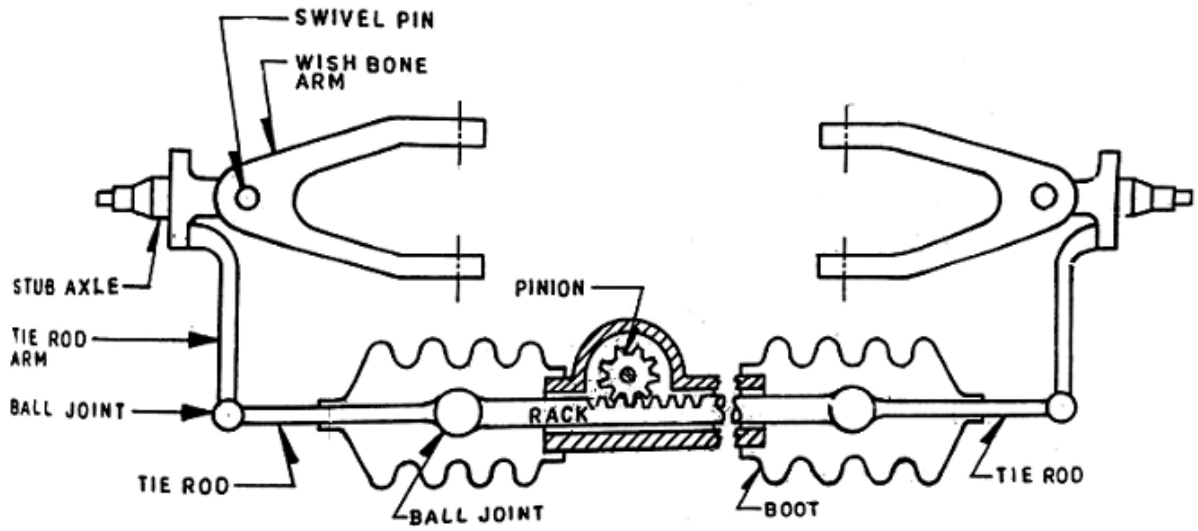
Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language 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.

……

Note: In question no.5, Assess only three sub questions- each carries 4 marks.

	Marks
1. A) Attempt any three:	**12**
i) State advantages and disadvantages of LPG /CNG engine over petrol engine.	04
Answer: *(Advantages 2 Marks, Disadvantages 2 Marks)* **Advantages of LPG & CNG operated engines:***(Any two)* 1. The fuel cost is less. 2. Less pollution and more efficiency. 3. It is safer for vehicle. The LPG/CNG fuel tank is made of thick wall so they can withstand dynamic explosion, crash test, and direct gunfire. 4. Increased life of lubricating oils, as LPG/CNG does not contaminate and dilute the crankcase oil. No need of oil change frequently which reduce vehicle maintenance. 5. Due to its antilock property, CNG can be used safely in engine with compression ratio as high as 12:1 compare to gasoline engine. Because CNG has a higher octane number than petrol, CNG engines operate at higher compression ratio without knocking. 6. CNG/LPG fuel systems are sealed, preventing fuel losses from spills or evaporation. **Disadvantages of LPG & CNG operated engines:***(Any two)* 1. Space Required for LPG/CNG Cylinder is more. 2. LPG/CNG tank is bulky. 3. More current rated battery is required. 4. Eats entire boots space of vehicle. 5. Easily not available in rural areas.	2 2
ii) State purpose and function of clutch in automobile.	04
Answer: *(Purpose 1 Mark, Function 3 Marks)* **Purpose of Clutch:** The clutch is a device located in between engine and gearbox which connects and disconnects the drive from engine to the transmission system. It provides a gradual engagement of rotary motion from engine (Flywheel) to gear box input shaft without any jerk.	1

Function of Clutch: 1. To permit engagement or disengagement of gears when the vehicle is stationary (the engine is running) and when the vehicle is in motion without damaging the gear wheels. 2. To transmit the engine power to the road wheels smoothly without shock to the transmission system while setting the vehicle in motion. 3. To allow the engine to take up load gradually without shock or jerk.	3
iii) Draw neat sketch of rack and pinion steering gear.	04
Answer:  Figure: Rack and Pinion steering gear	4
iv) State types of suspension system.	04
Answer: **Types of suspension system:** 1. **Rigid Axle** Suspension system: a) Leaf spring b) Air suspension system c) Torsion bar 2. **Independent** Suspension system: a) For Front Axle: i) Wishbone Type ii) Mac Pherson Strut Type iii) Vertical Guide Type iv) Trailing Link Type v) Swinging Half Axle Type b) For Rear Axle: i) De Dion Axle Type ii) Trailing Link Type iii) Link Trailing Arm Type 3. **Shock Absorber**: a) Single and Double acting b) Twin and Mono tube c) Hydraulic and Gas filled.	4
B) Attempt any one :	06
i) Draw car air conditioning system layout and explain in brief.	06
Answer: **Layout of car air conditioning system:** *(Layout - 3 marks, Description- 3 Marks)* Air Conditioning System in a Car works on Vapor compression cycle. It consists of compressor, condenser, evaporator, receiver, expansion valve, thermostat, blower fan and heating core. In compressor during suction stroke low pressure vapor in dry state is sucked from evaporator. It is then compressed to high pressure and temperature. These vapors are then passed into condenser where heat is removed by cooling medium which converts vapor into liquid. The liquid is stored into receiver. The liquid from receiver is then passed to evaporator through expansion valve. Expansion valve reduces pressure. The low pressure liquid refrigerant enters evaporator, where it absorbs the heat from	3

the warm air which is passed over the evaporator. The worm air gets cooled thereby cooling the passenger compartment. Due to heat absorption, liquid refrigerant gets converted into vapor and these vapors are passing to compressor.

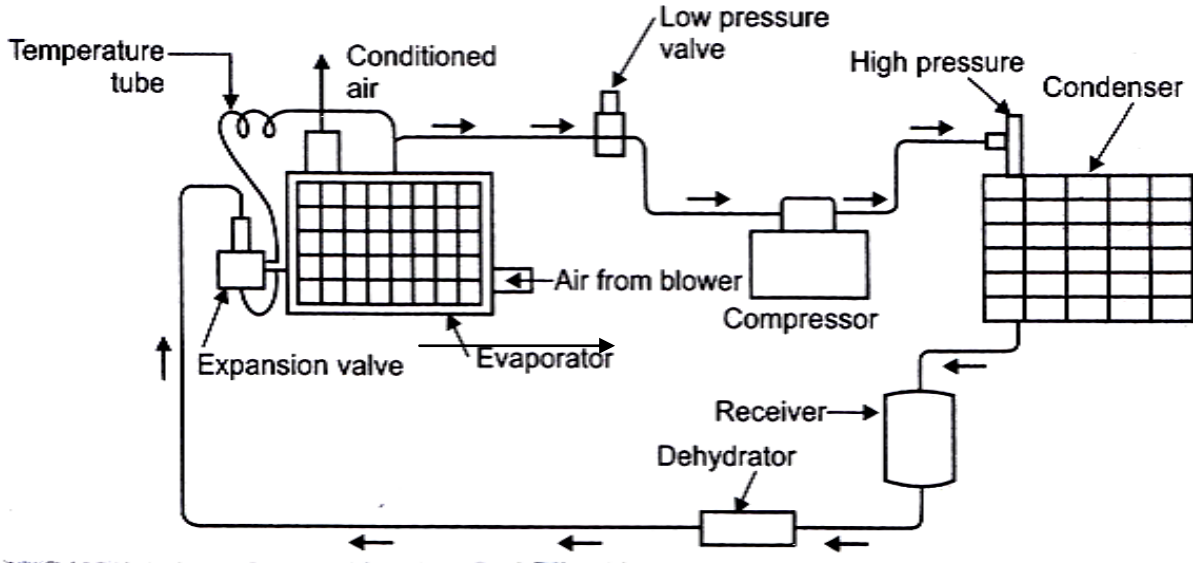


Figure: Layout of car air-conditioning system

3

ii) State function of battery. Explain its construction and working with neat sketch. 06

Answer:

Function of Battery:

1. Battery supplies the current for cranking motor and ignition system when the engine is being cranked for starting.
2. When the vehicle is stationary battery supplies electricity for operating the various electrical devices.

1

Battery Construction:

Battery consists of – Container, Positive and negative plates, Separators, Cell cover, Electrolyte, Grids, Cell connectors, Taper terminals, sealing compounds etc. Positive and negative plates are arranged alternately and separated by separators. Negative plates are surrounded by spongy lead paste and positive plates are surrounded by lead peroxide. The entire container of battery is filled with an electrolyte. All positive plates are connected to positive terminal and all negative plates are connected to negative terminal.

1

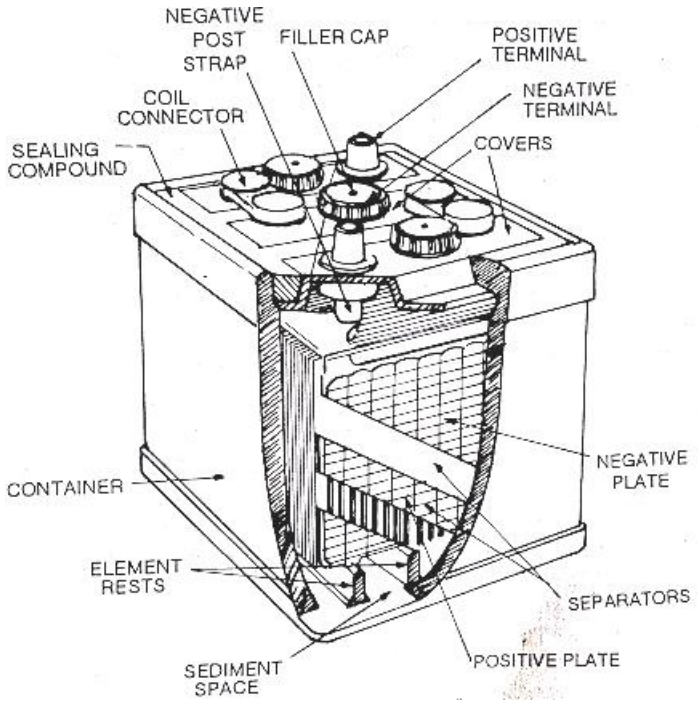
Working:

In the charged state, each cell contains a lead peroxide (PbO_2) on positive plate and spongy Lead (Pb) on negative plate. The chemical changes that takes place during discharging and charging processes are shown by the equation

2

$$\underset{\text{(Positive Plate)}}{PbO_2} + \underset{\text{(Electrolyte)}}{2H_2SO_4} + \underset{\text{(Negative plate)}}{Pb} \rightleftharpoons \underset{\text{(Positive Plate)}}{PbSo_4} + \underset{\text{(Electrolyte)}}{2H_2O} + \underset{\text{(Negative plate)}}{PbSO_4}$$

On discharging both PbO2 and Pb are converted to Lead Sulphate ($PbSO_4$) and the electrolyte losses its dissolved Sulphuric acid and becomes primarily water. During recharging the electrodes are converted

back to lead peroxide on positive plate and spongy lead on negative plate. The chemical activity inside the battery depends on the temperature of electrolyte. At higher temperatures, the activities are faster while at lower temperature are slower.  Figure: Cut section of Lead acid battery	2
2. Attempt any four :	16
a) State importance of aerodynamic body of car.	04
Answer: Importance of aerodynamic body of car: The body of vehicle is designed to protect the passenger as well as various components of the vehicle from the air. An aerodynamic shape of car body is the external shape of car body which will offer least resistance to air motion. Whenever car is moving there is an air resistance to motion of car. This air resistance depends on (i) Size of car (ii) frontal shape and area (iii) speed and (iv) wind velocity. This air resistance is given by $Ra = Ca.A.V^2$ Where, Ra - Air Resistance, Ca - coefficient of air resistance and V= Velocity of vehicle (speed) Now as frontal projected area of vehicle increases then vehicle air resistance increases & vice-versa. Figure shows the use of curved surfaces in modern vehicles instead of flat surfaces. Frontal area of car body is designed in such a way that front portion is made inclined & body is given smooth curves. This offers a least resistance to air and called as an aerodynamic shape. Thus, Aerodynamic shape of car body – 1. Reduces fuel consumption. 2. Air eddies are not formed behind the body. 3. Increases road traction. 4. Good on-road stability	4

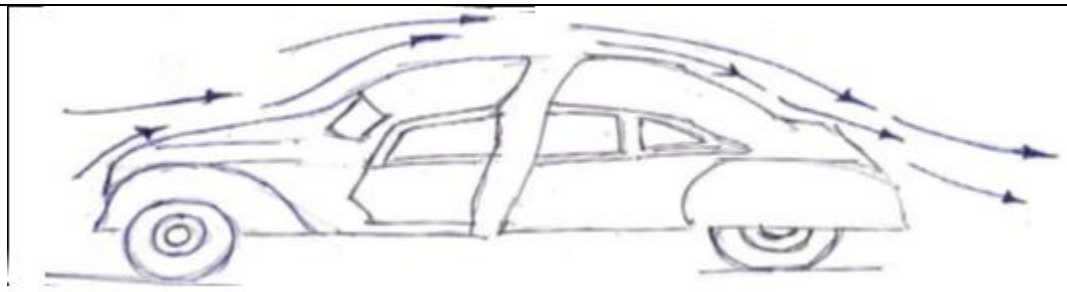


Figure: Streamlined car body

b) Explain need of double declutching. 04

Answer: Need of double declutching:

It is the most common operation associated with constant mesh gear box.In this type of gear box, for the smooth engagement of the dog clutches it is necessary that the speed of main shaft gear and the sliding dog must be equal. Therefore to obtain lower gear, the speed of the clutch Shaft, lay shaft and main shaft gear must be increased. This is done by double declutching. As the clutch is disengages twice in this process, it is called double declutching. 4

For changing to higher gear however, reverse effect is desired that means the driver has to wait with the gear in neutral till the main shaft speed is decreased sufficiently for a smooth engagement of the higher gear. Double declutching is necessary for noise free gear shifting of constant mesh gear box.

c) Define TOE- IN and TOE OUT, state its effects and its normal range. 04

Answer:

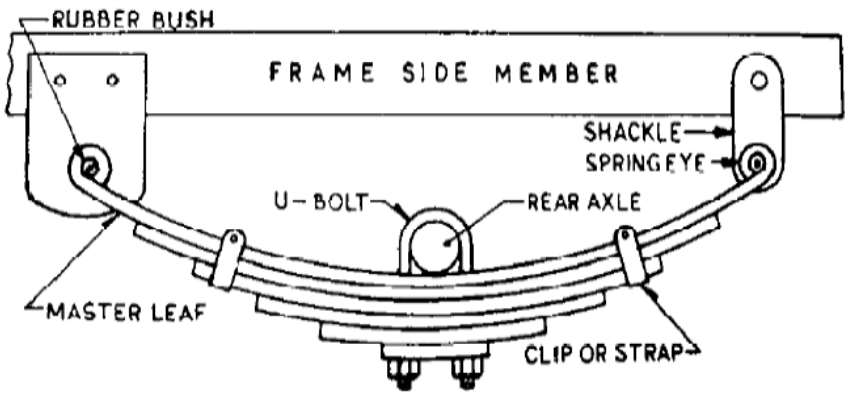
1. **Toe – in:** Toe-in is the amount by which the wheels are set closer together at the front than the rear when the vehicle is stationary. It should not exceed 3 mm. 1
2. **Toe – out:** Toe- out is the amount by which the wheels are set closer together at the rear than the front when the vehicle is stationary. 1

Effects of Toe – in and Toe - out:

Increasing Toe in would result in decreased oversteer and increased directional stability at high speed, whereas increase in Toe out would result in reduced understeer and greater ease in steering during cornering. 2

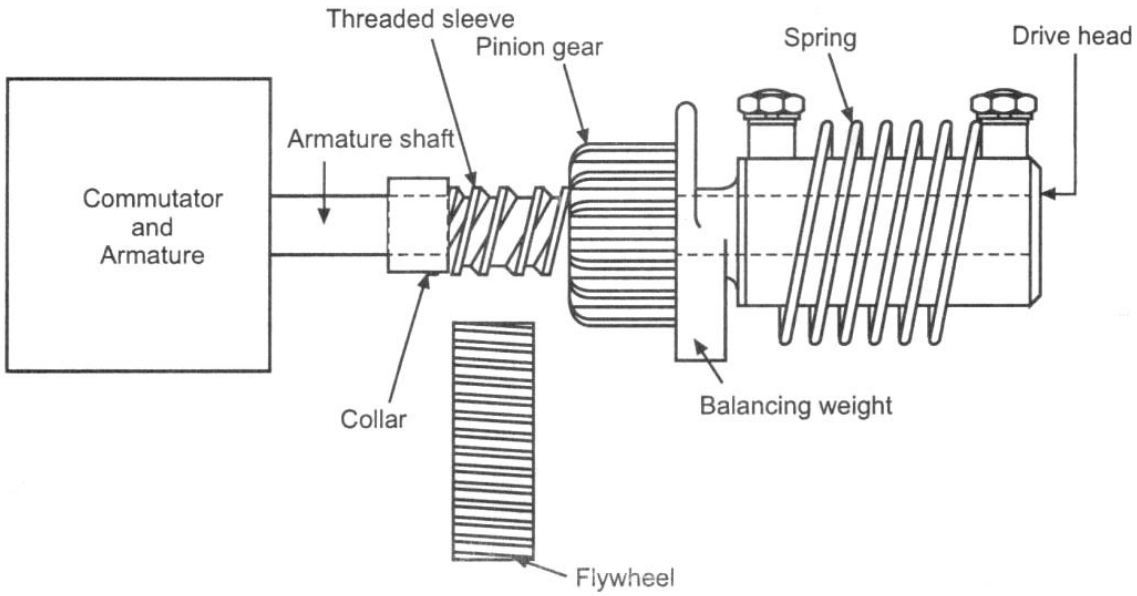
d) Draw neat labeled sketch of rear leaf spring suspension and explain its working. 04

Answer: Rear leaf spring suspension: *(2 Marks for Figure, 2 Marks for Explanation)*



2

Figure: Rear leaf spring suspension

When the vehicle comes across a projection on the road surface, the wheel moves up deflecting the spring. This changes the length between the spring eyes. If both ends of the leaf are fixed, then it will not able to accommodate this change in length. Hence a shackle is provided at one end and another end is bracketed to frame. Since the front end is fixed, the leaf spring has a center of rotation at the front fixed end. Also the propeller shaft is connected to the universal joint near the front end. Thus, leaf spring and propeller shaft (with rear axle) swivel around the front end while the shackle permits this swiveling of the rear eye of the leaf. When the leaf spring deflects, the upper side of each leaf rubs against adjacent surface of the other leaf. This provides the damping effect.	2
e) Explain neat sketch of Bendix drive used in starting system with neat sketch.	04
Answer: **Bendix drive used in starting system:** *(2 Marks for diagram, 2 Marks for Working)*  Figure: Bendix drive Bendix drive is an inertia based drive in which the pinion on the starter motor armature engages and disengages with the flywheel depending on the inertia of motor and flywheel. When the ignition switch is turned 'ON', the starter motor armature starts spinning. This causes the sleeve to rotate while the pinion is stationary due to the unbalanced weight. The pinion hence moves axially towards the collar until it engages with the flywheel ring gear. Since the pinion cannot move further axially, its starts to rotate along with the sleeve thereby also rotating the flywheel. When the flywheel starts rotating at above 100 rpm the engine gets starts. After the engine has started the pinion gear is turned by the engine much faster than rotated by starting motor. This causes, the pinion gear to turn back on the threaded sleeve, making it disengaged with the flywheel.	2 2
3. **Attempt any two:**	16
a) Draw neat labeled sketch of constant mesh gear box and explain working.	08
Answer: **Working of constant mesh gear box:** In this type of gear box, all the gears are in constant mesh with the corresponding gears on the lay shaft. The gears on the main shaft which is splined are free. The dog clutches are provided which are free to slide on the main shaft. The gears on the lay shaft are fixed.	4

When the left dog clutch is slide to left by means of the selector mechanism, its teeth are engaged with those on the clutch gear & we get the direct gear. The same dog clutch when slide to right makes contact with the second gear & second gear is obtained. Similarly movement of the right dog clutch to the left results in low gear & towards right in reverse gear. — 4

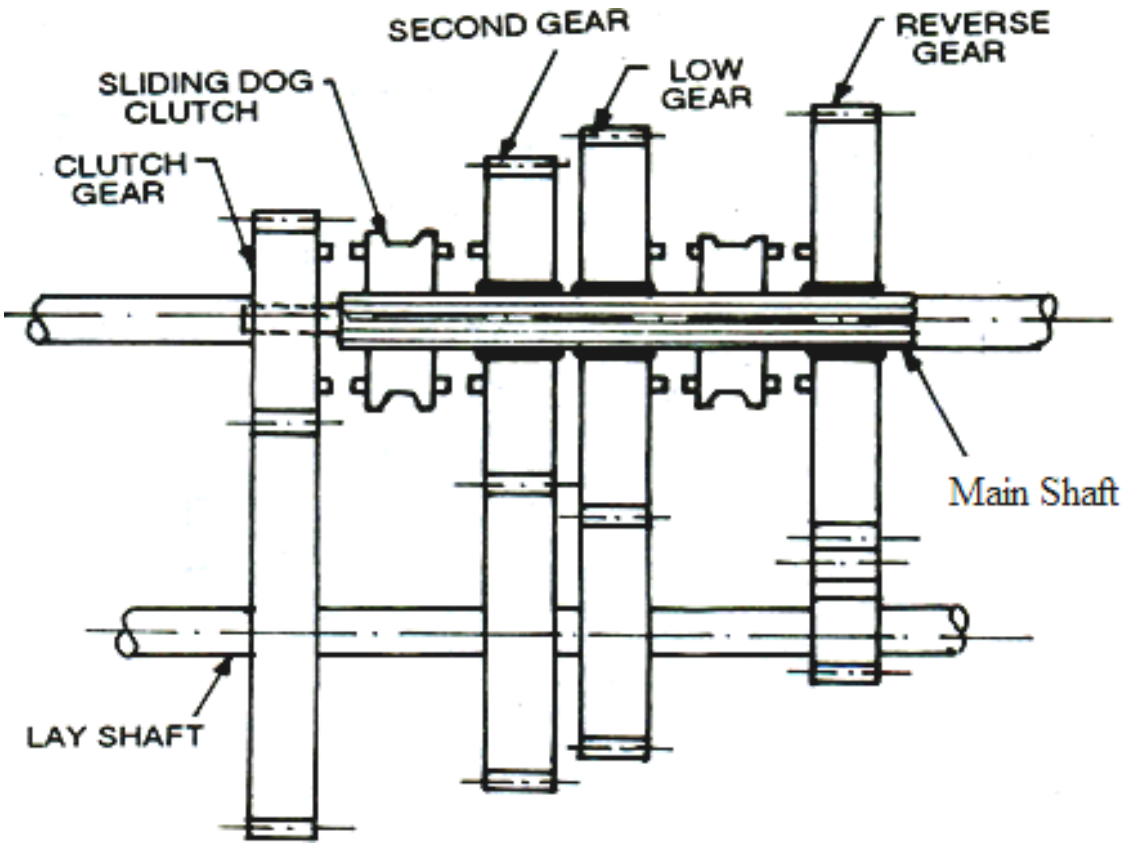


Figure: Constant mesh gear box (Neutral position)

b) Draw neat sketch of master cylinder of Hydraulic brake and explain working. — 08

Answer: **Working of master cylinder of Hydraulic brake:** — 4

1) Brakes applied: When the brake pedal is operated, the push rod moves the piston against the action of spring force. When sufficient pressure is built up, the rubber cap of fluid check valve deflects and the high pressure fluid enters the wheel cylinder through fluid lines and operates the brake shoe against the revolving drum.

2) **Brakes released**: When the pedal is released, the piston return towards its initial position due to the spring force and closes the fluid check valve for a short time to avoid entry of any air. The fluid from the lines also comes back in the compression chamber by lifting the check valve off its seat.

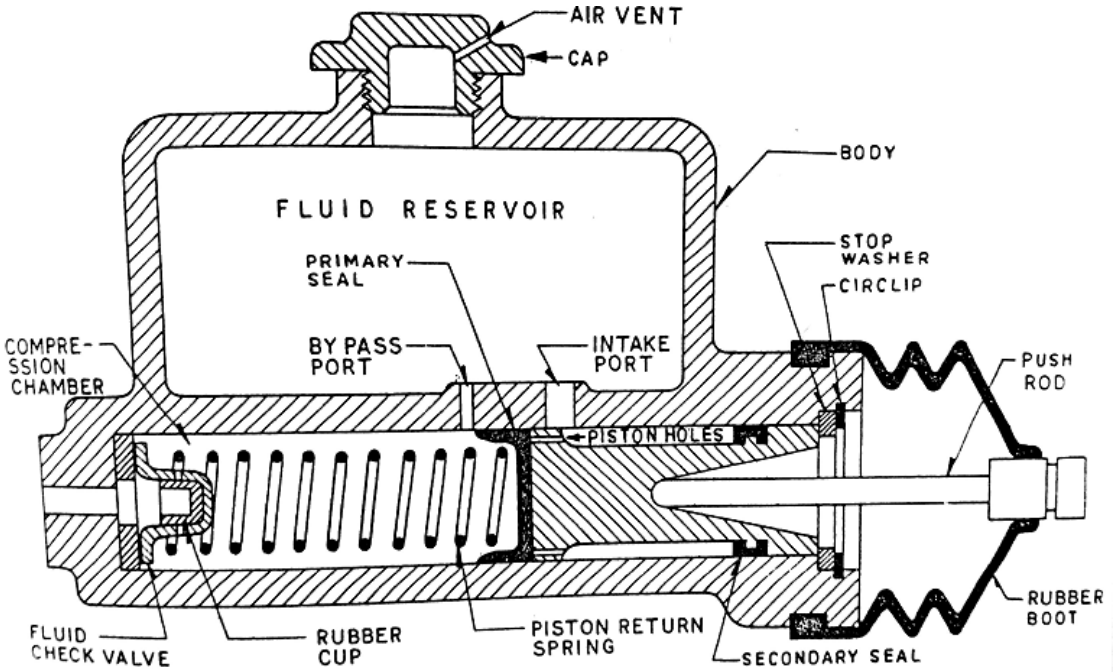


Figure: Master cylinder — 4

c) Explain construction and working of Wishbone type suspension with neat sketch. — 08

Answer: **Wishbone type suspension:**

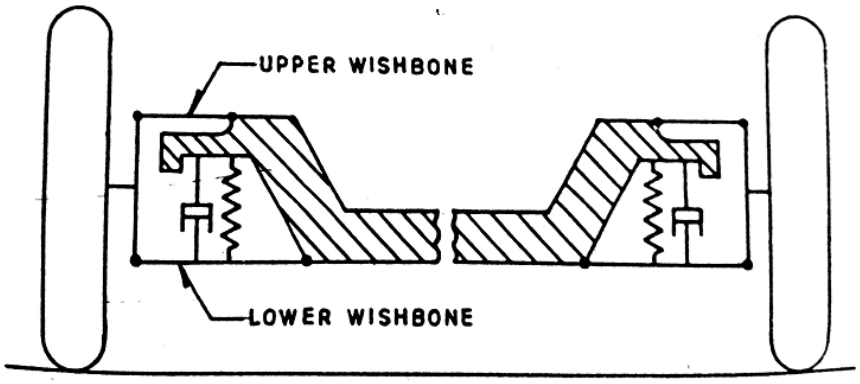


Figure: Wishbone type suspension (Schematic) — 2

(Note: Equivalent credit shall be given to any other suitable sketch if drawn)

Construction: It consists of upper and the lower wishbone arms provided to the frame. These arms resemble letter 'A'. The spring is placed in between the lower wishbone and the underside of the cross member. The vehicle weight is transmitted from the body and the cross member to the coil spring through which it goes to the lower wishbone member. A shock absorber is placed inside the coil spring and is attached to the cross member and to lower wishbone member. — 3

Working: When the vehicle came across a bump and wheel is tended to move up the lower and the upper arm moves up and the coils spring is compressed, so shock absorber (Damper) damps the vibrations setup in the coil spring due to road irregularities. After passing over a bump the lower arm comes to its original position with upper arm. This type of suspension resists up and down forces that develop after bump, acceleration, braking and cornering. — 3

4. A) Attempt any three: 12

i) Compare two wheel and four wheel drive vehicle. 04

Answer: **Comparison of two wheel and four wheel drive:** *(Any four parameters – 1 mark each)* 4

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 the front and rear wheels, hence spinning of drive wheels on loose roads are not possible and vehicle can be taken out from ditch safely.
2	Engine location and drive	Engine is located either at the front or rear and drive is given to either to front wheels or rear wheels.	Engine is located at the front or at 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. Fuel efficiency is more.	Off road performance of 4WD is better where higher torque and slow speeds are desired. Fuel efficiency is less.
4	Merits , demerits *(Any one)*	• Initial cost is less as compare to 4WD. Running cost is less due to lower fuel consumption. • Weight is concentrated only on driving wheels. • Aerodynamic design is possible. • Floor height can be reduced hence lower ground clearance can be kept. • It is applicable in high speed, light motor vehicles and cars.	• Higher initial cost as well as running cost because of extra fuel consumption. • Weight is uniformly distributed on all the wheels. • Aerodynamic design isn't possible. • Floor height cannot be reduced hence ground clearance is more. • It is used in heavy duty motor vehicles as well as in off road / cross country vehicles.

ii) Draw neat labeled sketch of single plate coil spring clutch of automobile. 04

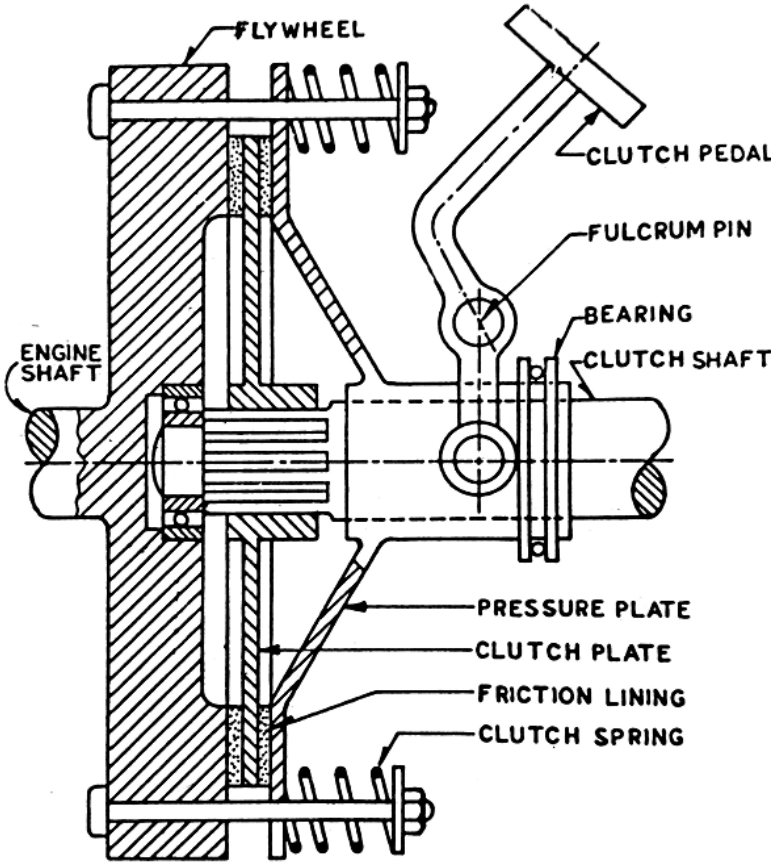


Figure: Single plate coil spring clutch — 4

iii) Define caster and camber angle, state effects on steering and give approximate range of angle. — 04

Answer :

1. **Camber:** It is the tilt of car wheels from the vertical when viewed from the front of vehicle.
   Effects: Tyre will wear more on one side than the other side
   Range (Amount): Camber should not exceed 2 degree. — 2

2. **Castor:** It is the angle between king pin Centre line and the vertical, in plane of wheel **OR** It is forward or backward tilt of the wheel from true vertical when viewed from the side of wheel. — 2
   Range (Amount): About 3 degree of castor gives good results.
   Effects: Positive castor on the wheels provides directional control and good road holding capacity.

iv) Explain battery ignition system for four cylinder engine. — 04

Answer: Battery ignition system for four cylinder engine:

- When the ignition switch is in the ON Position, current flows from the battery to the primary winding of ignition coil.
- The current in the primary circuit goes on increasing exponentially during the period that the contact breaker points are connected. — 2
- The laminated core of the ignition coil stores the electromagnetic energy generated on account of this current built up in the primary circuit.
- When the contact breaker points open, the electromagnetic field built up in the primary circuit

collapses and the energy is projected in the secondary circuit.

- As the break period of contact breaker is very short, the EMF voltage induced in secondary circuit is very high and is proportional to the rate of change of flux in winding.
- This sudden high voltage generated is directed to specific spark plug as per the firing order with the help of distributor.
- The condenser stores energy during this break period of contact breaker and releases it during the make period, thereby avoiding acting at contact breaker point.
- The voltage multiplication is dependent on the number of turns of primary and secondary winding of ignition coil.

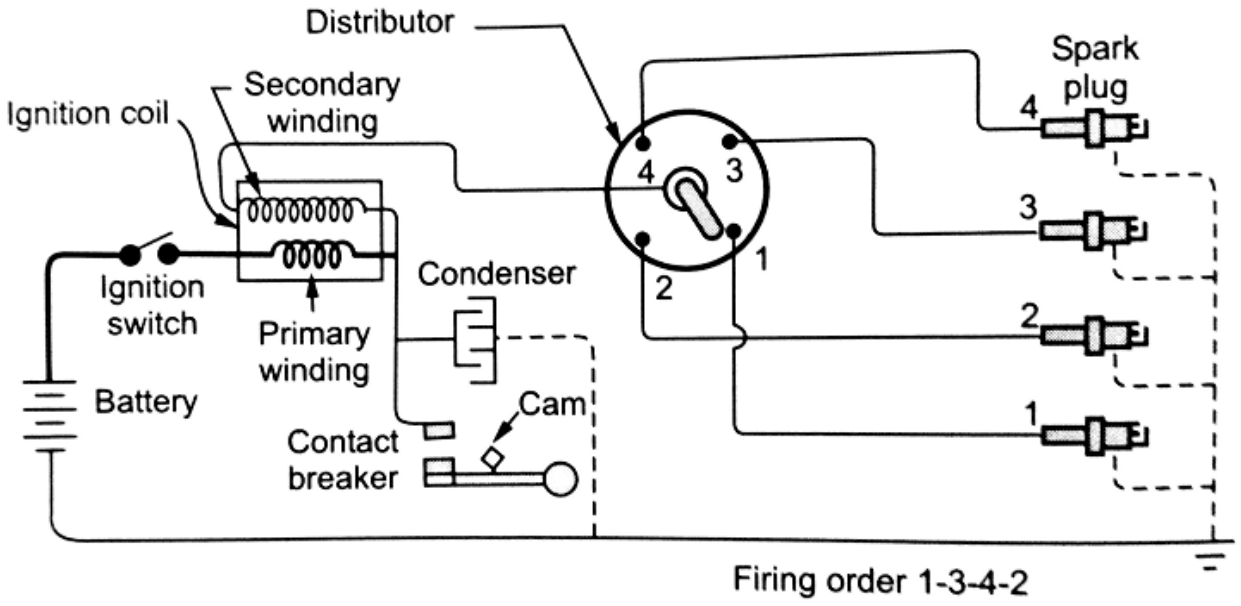


Figure: Battery ignition system for four cylinder engine. — 2

B) Attempt any one: — 06

i) State need of power steering and explain general layout of power steering. — 06

Answer :

Need of Power Steering:

1. To reduce the effort needed to turn the steering wheel.
2. To achieve higher degree of steering response.
3. To achieve driving comfort by absorbing road shocks
4. To reduce driver's fatigue.
5. Higher control over the vehicle is possible which leads to greater safety of vehicle. — 2

General Layout of Power Steering:

Power steering provides hydraulic or electric assistance to the turning effort applied to the manual steering. When the manual effort at the steering wheel exceeds, a predetermined value, the power steering become operative.

1. Hydraulic Power Steering (Linkage Type):

The hydraulic power assisted steering system as shown in figure consists of hydraulic pump, hydraulic ram, hydraulic control valve, fluid reservoir, rack & pinion gear box, steering shaft, & steering wheel. The hydraulic fluid is stored into a reservoir to which a pump is connected. This pump — 2

lifts the fluid from reservoir & sends it to hydraulic control valve through the feed line. The steering wheel is connected to hydraulic control valve through the steering shaft.

When the steering wheel is at rest & the vehicle is going in straight ahead, at that time the both high pressure lines are open in position. So fluid exerts the same pressure on both sides of piston. So the rack does not operate the front wheels to turn in either side. As soon as the driver turn the steering wheel, the contact control valve operates hydraulic control valve which closes one of the port or pressure line, while the other remains open. So high pressure fluid from the pump goes to one side of the piston & operates the rack which in turn to operate the front wheels to turn in desired direction. 2

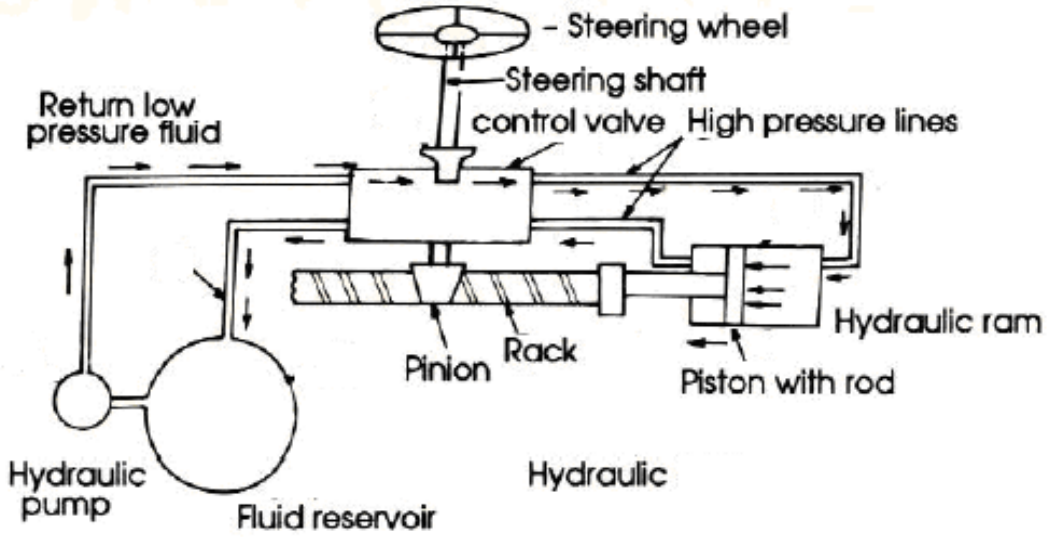


Figure: Hydraulic Power Steering

OR

2. Electronic Power Steering:

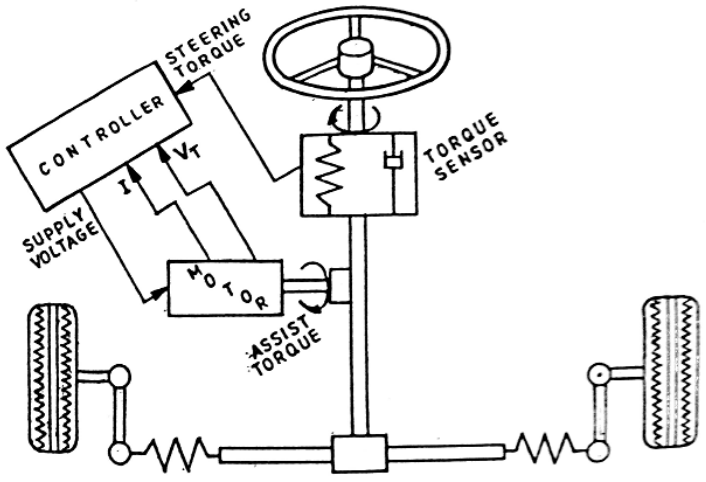
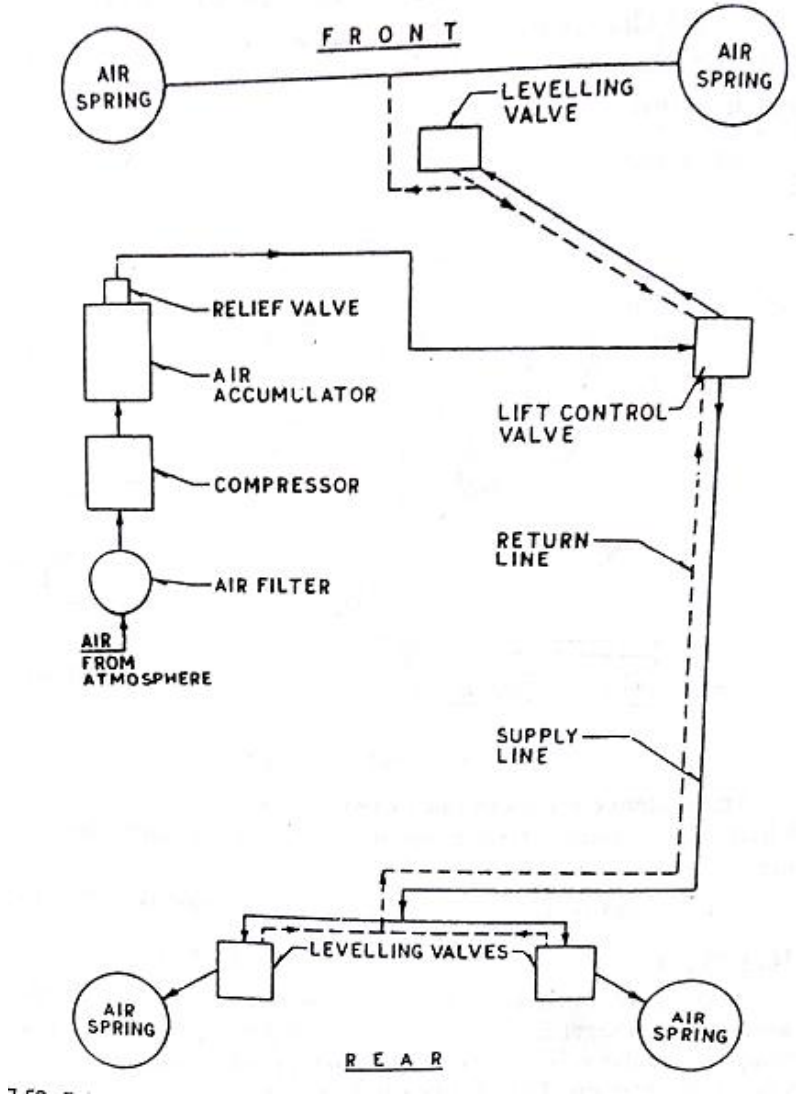


Figure: Electronic Power Steering

In an electronic power steering system, steering sensor consisting of in fact two sensors, viz, a torque sensor that converts the steering torque input and its direction into voltage signals and rotational sensor that converts the rotational speed and direction into voltage signals is located on the input shaft of the steering gear box. Input from the steering sensor and the vehicle speed sensor are fed to a microprocessor control unit where these are compared with a programmed force assist map. The control unit then sense out the appropriate command signals to the current controller with supplies the appropriate current to the electric motor. The motor pushes the rack to the right or left depending on which direction the current flows. Increase the current to the motor, increase the amount of power assist and thus turning of wheels takes place. *(Note- Equivalent credit shall be given to appropriate sketch and explanation of any other type)*	
ii) Sketch layout of an air suspension system and name the components	06
Answer :*(Sketch-4 marks, correct labeling – 2 marks)*  Figure: Air suspension system layout	6

5. Attempt any **Three:**	16
a) Classify automobiles.	4
Answer: *(Any four purpose – 1 mark each)* **1. According to Purpose (Use)** a) Passenger Cars b) Goods Carriage c) Special Purpose d) Earth Moving e) Motor Cycle (Bikes) f) Mopeds **2. According to Fuel Used:** a) Petrol Vehicles b) Diesel Vehicles c) LPG/CNG Vehicles d) Electric Cars e) Hybrid Cars f) Solar Cars g) Fuel Cell **3. According to Load Carrying Capacity:** a) Heavy Motor Vehicle b) Medium Motor Vehicle c) Light Motor Vehicle **4. According to Drive Used:** a) Left and Right Hand Drive b) Two Wheel and Four Wheel Drive **5. According to Engine Location and Mounting:** a) Front Engine Front Wheel Drive b) Rear Engine Rear Wheel Drive c) Front Engine Rear Wheel Drive d) Bus Chassis e) Full Forward Chassis f) Semi Forward Chassis **6. According to Body Styles:** **A. Passenger Cars:** **a)** Sedan/Saloon **b)** Hardtop **c)** Lift back (Hatchback) **d)** Station Wagon **e)** Coupe **f)** Limousine **g)** Convertible **h)** Estate Car **B. Heavy Vehicles/Trucks:** a) Truck Punjab Body b) Truck Half Body c) Truck Platform Type	4

d) Truck with Trailer e) Dumper f) Tanker **7. According to Wheel and Axle:** a) Two and Three Wheeler b) Four Wheeler and Six Wheeler c) Single and Multi Axle	
b) i) State functions of propeller shaft: ii) State requirement of good steering system.	4
Answer: **i) Functions of propeller shaft**: *(Any two*) 1. It transmits rotary motion and power from gear box to the differential at varied angle. 2. It accommodates change in length when the rear axle moves up and down. 3. It absorbs the shocks coming on the transmission system when the vehicle starts from rest. **ii) Requirement of good steering system:** 1. The steering mechanism should be very accurate and easy to handle. 2. It should multiply the turning effort applied on the steering wheel by the driver. 3. It should be to a certain degree irreversible, so that the road shocks encountered by the wheel are not transmitted to the driver's hand. 4. The Steering mechanism should have self rightening effect, so that when the driver released the steering wheel after taking a turn, the wheel should try to achieve straight ahead position.	2 2
c) Draw labeled neat sketch of telescopic type shock absorber and explain working.	4
Answer: Working of Telescopic Shock Absorber: Below figure shows a simple Telescopic Shock absorber. There is a fluid in space above valve assembly (A), below (A) & also in annular space between cylinder (C) & tube (D), which is connected to the space below valve assembly (B). (H) is gland in head (J) & any fluid scrapped off by rod (G) is brought down into annular space through inclined passage shown in head. Eye (E) is connected to axle, while eye (F) is attached to chassis frame. Fluid generally used in shock absorbers is a mixture of 60 per cent Transformer oil & 40 per cent Turbine oil. When car has come across a bump**,** Eye (E) would move up & thereby the fluid will pass from lower side of valve assembly (A) to its upper side.Due to pressure of fluid through rod (G) fluid will be go to underside of valve (B). This passing of fluid through valve openings provides damping. Similarly for downward motion of eye (E), fluid will pass upper side of valve assembly (A) to lower side & also from lower side of valve assembly (B) to its upper side.	2

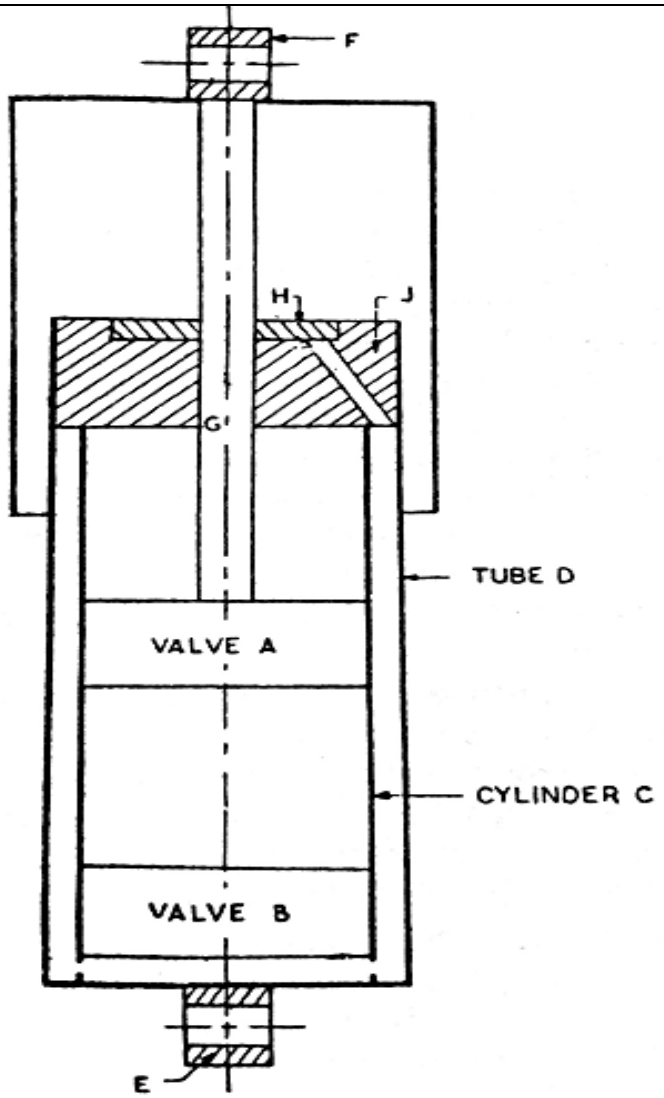


Figure: Telescopic type shock absorber

2

d) Explain battery capacity and rating. 4

Answer:

Battery Capacity: It can be defined as the maximum amount of current the battery can deliver.

Maximum amount of current that a cell can furnish depends up on the following factors- 2

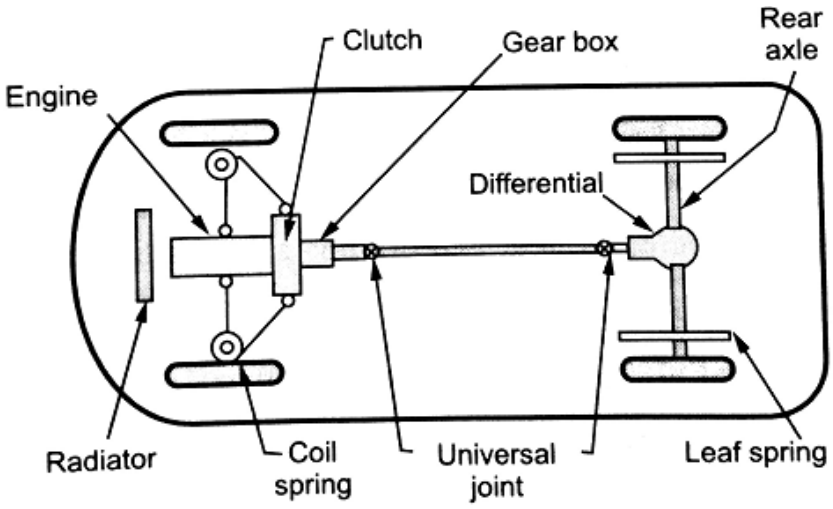
1. Numbers of plates
2. Area of plates
3. Temperature of electrolyte
4. Quantity of electrolyte

About 1/10 m^2 of the surface plate must be in contact with an electrolyte to produce 40 to 60 ampere of current.

Battery Rating:

Battery rating is recommended by (SAE) and is defining as lighting ability of a full charge battery.

1. **20 Hours rating** (in Ampere- hours): It is also known as ampere-hour capacity and represents a lasting power of a battery on small load. It is obtain by discharging of battery at a current rate equal to 1/20 of the manufacture's ampere hours rating. The current rate that battery delivers 2

continuously for 20 hours after which cell voltage should not drop below 1.75 and battery temperature is 80^0 F. 2. **Cold rating**: It gives an indication of cold weather of starting ability of battery. Numbers of minutes of a 6 volt battery can deliver 300 Ampere at 0^0 F before cell voltage drops below 1 volt. 3. **25 Ampere rating:** Measures battery performance at a moderate constant current output at 80^0 F to final limiting voltage 1.75 Volt/ Cell 4. **Twenty minutes rate**: Amount of current a battery can deliver continuously during 20 minutes without dropping the cell voltage below 1.5. A temp of 27^0C is maintained at the start of the test.	
e) State importance precaution while using air conditioning system of car.	4
Answer: **Important precautions for using A/C system in automobile:** *(Any 4 Points-1Mark each)* 1. Do not use A/C with fresh air mode open. 2. Never operate a/c with heater on. 3. Never run a/c without refrigerant. 4. Do not leak test a/c with more than 2 MPa pressure. 5. Donot leave a/c joint open. 6. Do not charge refrigerant in a/c system before flushing.	4
6. Attempt any two:	16
a) Explain rear wheel drive vehicle with front and rear engine. State relative advantages and disadvantages.	08
Answer: **1. Rear wheel drive vehicle with engine at front:**	
 Figure: Front engine rear wheel drive vehicle layout	1
It is the most conventional type of layout and as the name suggests the engine is mounted in the front part of vehicle and the drive is transmitted to the rear axle. e.g.- Bolero XL The drive chain in this layout is Engine – Clutch – Gearbox - Universal joint - Propeller shaft – Differential-Rear axle - Wheels.	1

Advantages: *(Any two)*

1. Balanced weight distribution in vehicle.
2. Simple front axle design with steering mechanism.
3. Better engine cooling by taking full benefits of natural airstream flowing across the radiator
4. Accessibility to various engine component is easier

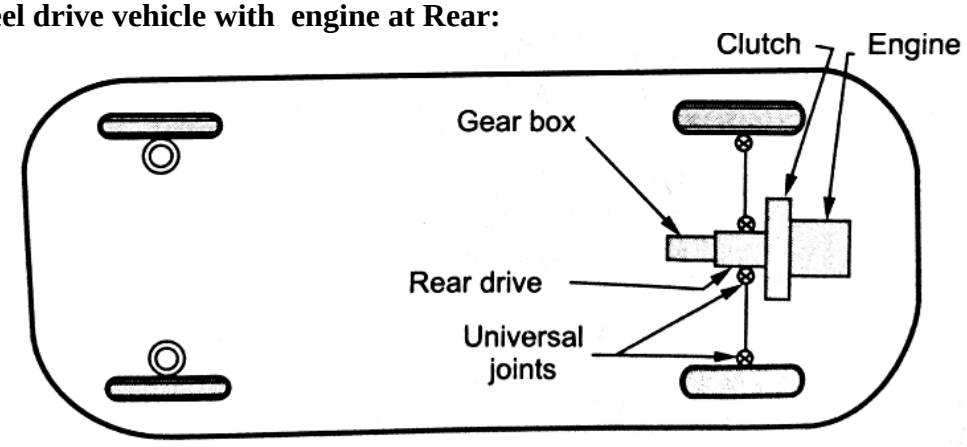
1

Disadvantages:*(Any two)*

1

2. It requires long Propeller shaft to transmit the power from gearbox to differential.
3. Higher noise transmitted from front engine to driver cabin
4. The rear floor houses the propeller shaft and hence rear legs space is limited.
5. It requires larger brake pads at front wheels because of higher weight being transmitted on front wheels while deceleration.

2. Rear wheel drive vehicle with engine at Rear:



1

Figure: Rear engine rear wheel drive vehicle layout

This type of layout eliminates the necessity of propeller shaft. The engine is mounted at the rear and drive is also transmitted to the rear axle. e.g.- Nano

1

The drive chain for this layout is –

Engine – Clutch – Gearbox-Differential - Universal joint - Rear drive shafts - Wheels.

Advantages: *(Any two)*

1. The front axle consists of a very simple design and houses the steering mechanism only.
2. Because of high weight on the driving axle, it provides excellent traction and grip on steep hills.
3. The rear floor can be made flat due to absence of propeller shaft
4. The driver cabin is well isolated from engine noise.
5. Because of elimination of front engine packaging constraints, the front body can be design as per styling

1

Disadvantages:*(Any two)*

1. Natural air cooling of engine is not possible, hence it requires a powerful radiator fan
2. The clutch and gear shifting mechanism is long and complex.
3. Because of higher weight concentration at rear, the vehicle has a tendency to oversteer while taking a sharp turn.
4. Luggage space at front is restricted due to small compartment that houses the fuel tank and spare wheel.

1

b) Draw neat labeled sketch of differential and explain working.	08

Answer: **Working of differential:**

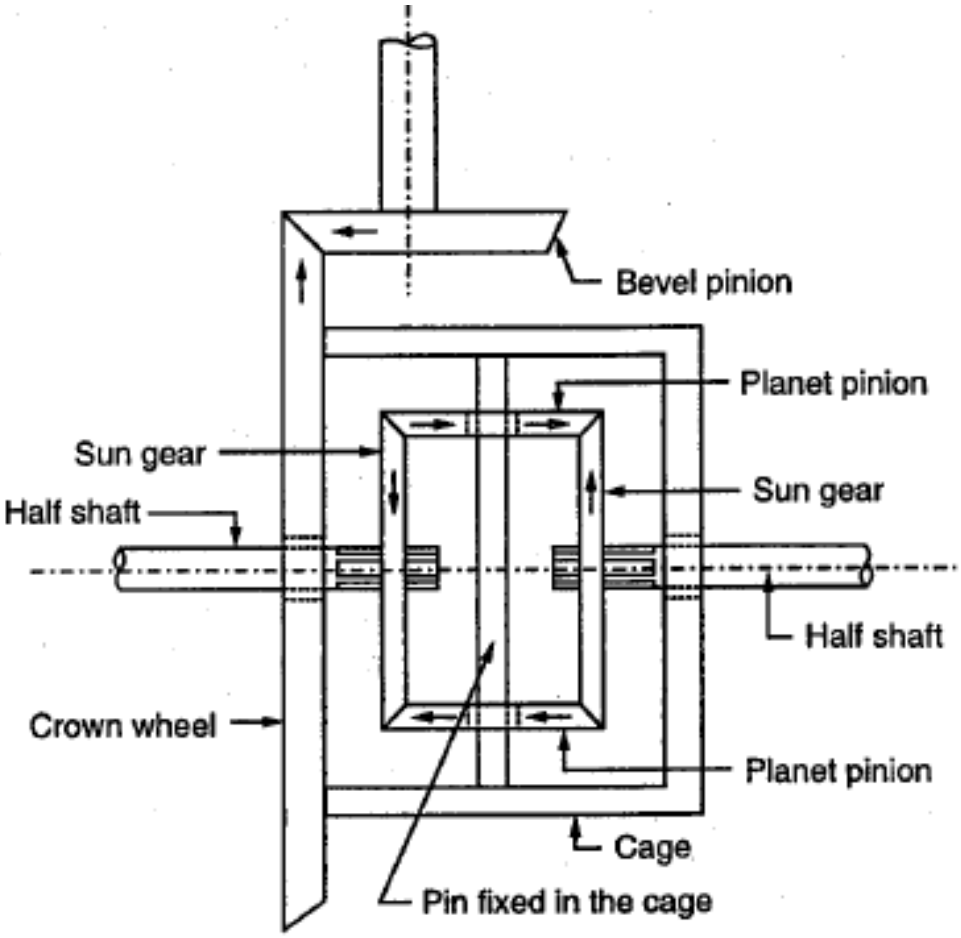
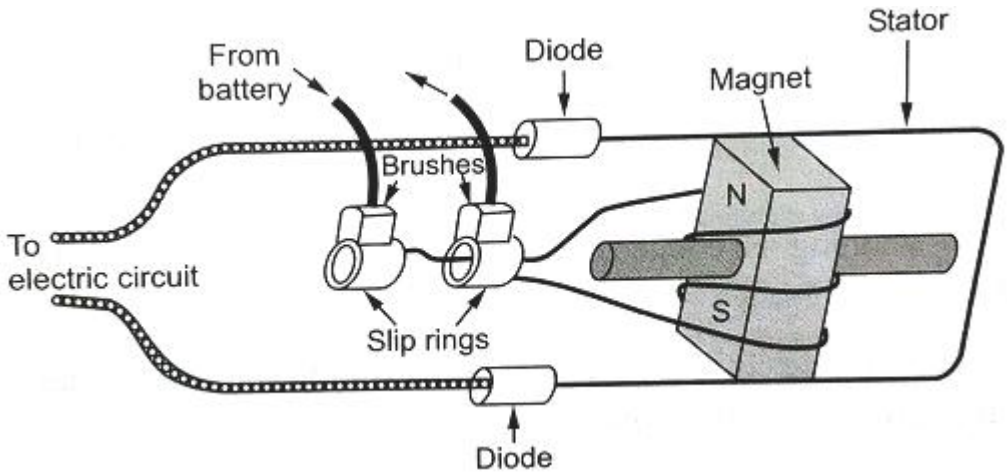


Figure: Working of differential — 4

1. **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

2. **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 to negotiate a turn safely. — 2

c) Explain construction and working of alternator, state its advantages.	08
Answer**: C****onstruction and working of alternator:**  Figure: Alternator *(Note: Equivalent credit shall be given to any other suitable sketch if drawn)* **Construction**: It consists of fan, rectifier, diode, spacer, stator, drive and housing, slip rings, rotors, drive and bearing, regulator, pulley etc. The operation of alternator is improved by placing the stator and rotor assembly inside the iron frame of housing which provide a conducting path for the magnetic line of force. Voltage increase by increasing stator winding in to number of coil. Alternators consist of rotor assembly, stator assembly and rectifier mounted in housing. Housing near of two piece of die cast aluminium which is light and weight. Stator is clamp in housing. **Working:** It consists of an electromagnetic rotor which is energized form the current of the battery through brush and slip ring assembly. Rotor is rotated by belt and pulley arrangement get power form engine stator winding is wound around the rotor. The rectifier circuit consisting of diodes is connected to the stator winding. Diodes are electronic device that allows current to flow only in one direction. When the electromagnetic rotor is turned its magnetic lines of force cut the stationary stator loop. This induces a current in the stator winding. Through the electromagnetic rotor reverses its polarity the alternating current produces in the stator winding is converted to direct current by the diodes. **Advantages:*****(****Any two)*** 1. Alternator is generator that produces the alternating current. 2. Use on vehicle to charge the battery and operate the electrical circuits 3. Much smaller, light in weight.	2 2 2 2