



Winter – 15 EXAMINATION  
Model Answer

Subject Code: 17409

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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 of the following-	<b>12</b>
i) Define King-pin inclination and toe in.	2
<b>Answer : Definition:</b>	
<b>King-pin inclination:</b> It is the angle between vertical line and centre line of king pin or steering axis when viewed from the front of the vehicle.	1
<b>Toe in:</b> It is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary.	1
ii) Draw a neat labeled sketch of reverse elliot type stub axle.	2
<b>Answer:</b>	
	2
Figure: Reverse elliot type stub axle.	

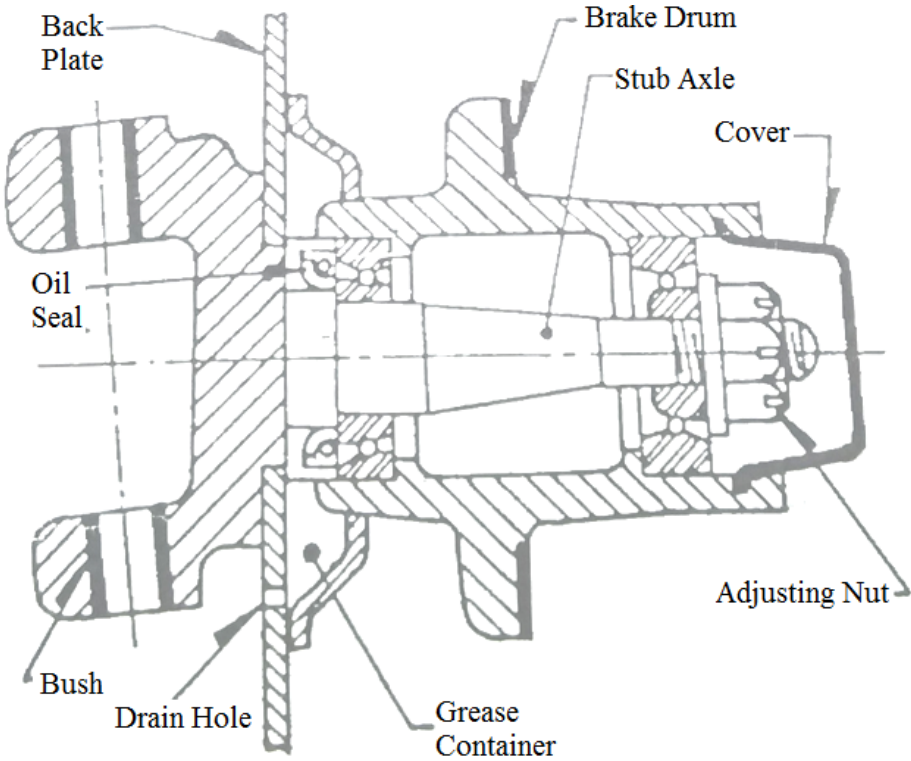


iii) List friction materials used for brake shoes and pads.	2
<b>Answer:</b> <b>Material used for brake shoes:</b> Sheet Steel, Cast Aluminum Alloy. <b>Material used for brake shoes and pads:</b> Asbestos, Semi-Metallic, Non-Asbestos Organics, Low steel, Ceramic materials	2
iv) Define the term air-conditioning.	2
<b>Answer: Air-conditioning:</b> It is a system or process for controlling the temperature, humidity, and sometimes the purity of the air in an interior, as of an office, theatre, laboratory, or house, especially one capable of cooling. OR It is the process of altering the properties of air (primarily temperature and humidity) to more comfortable conditions, typically with the aim of distributing the conditioned air to an occupied space such as a building or a vehicle to improve thermal comfort and indoor air quality.	2
v) Define drawbar pull and gradeability.	2
<b>Answer:</b> <b>Drawbar pull:</b> If the extra load attached to the vehicle is pulled by fully utilizing the excess power, then, maximum drawbar pull = Tractive effort – Road resistance. <b>Gradeability:</b> It is the maximum percentage grade negotiated by a vehicle under full rated condition.	1 1
vi) List any four advantages of disk brake system.	2
<b>Answer: Advantages of disc brake system: (Any 04, 1/2 mark each)</b> 1) It has comparatively better anti-fade characteristic. 2) Better heat dissipation as braking surface is directly exposed to air. 3) The linings of disc brakes brush lightly against the rotating disc, even when the brakes are not applied therefore no brake adjustment is required. 4) It is possible to check condition of pad wear without dismantling the brake system.	2
vii) Define turning radius.	2
<b>Answer: Turning radius:</b> It is the radius of circle on which the outside front wheel moves when the front wheels are turned to their extreme outer position.	2
viii) List types of suspension springs.	2
<b>Answer: Types of suspension springs: (Any 04, 1/2 mark each)</b> 1) Leaf spring a. Semi elliptical leaf spring b. Quarter elliptical leaf spring c. Three Quarter elliptical leaf spring d. Transverse spring e. Full elliptical leaf spring f. Platform type spring 2) Coil spring 3) Torsion spring 4) Air spring 5) Rubber spring	2



b) Attempt any TWO of the following:	08
i) Explain anticorrosive treatment for vehicle.	4
<b>Answer: Anticorrosive treatment for vehicle:</b> It consist of following steps - <b>1. Surface preparation:</b> a. Degreasing: It is a process by which organic deposits such as oil, grease, metallic soaps and inorganic matters like soil, dirt, shop dust are removed from metal surface. b. Descaling: The process of removing scales on the ferrous surface. c. Derusting: If the metal is exposed to atmosphere or water, the oxides of iron are formed on the metal surface; these oxides are called as rust. This process of removing the rusting on the surface. <b>2. Rinsing:</b> To remove all acids and acid salts, the work is passed through 2 or 3 successive rinse baths. <b>3. Phosphate coating:</b> Phosphate coating is secondary metallic phosphate of iron, zinc or manganese deposited on steel surfaces. They provide a good anchorage to the paint film and prevent rust creep underneath the paint film. <b>4. Passivation:</b> After Phosphate coating and rinsing, surfaces are given a final passivation rinse with solution of chromic acid to improve their corrosion resistance. <b>5. Sealing:</b> After passivation and drying, the sealant is to be applied within 2 hours during monsoon and 6 hours during winter and summer months.	4
ii) Define 1) Air Resistance 2) Gradient Resistance 3) Rolling 4) Pitching	4
<b>Answer:</b> <b>Air or wind resistance:</b> It is resistance offered by air to the forward movement of vehicle. This resistance has an influence on performance, ride and stability of the vehicle. <b>Gradient Resistance:</b> It is force that opposing forward motion of vehicle on the gradient. <b>Rolling:</b> While cornering, the centrifugal force produces a movement of the vehicle about a longitudinal axis through centre of gravity and is known as rolling. <b>Pitching:</b> It is rocking chair action or rotating action about a transverse axis through the vehicle parallel to ground is known as pitching.	1 1 1 1
iii) List two advantages and two disadvantages of central locking system.	2
<b>Answer: Advantages of central locking system: (Any 02, 01 mark each)</b> 1. All the doors and luggage compartments can be locked or unlocked simply by operating one key. 2. It Indicates open door with flash 3. Locking/ unlocking can be done by remote 4. In case of failure of electronic system, the manual locking is still possible.	2
<b>Disadvantages of central locking system: (Any 02, 01 mark each)</b> 1. It is not convenient in case of accident because occupant may not open the door in emergency since all doors are centrally locked. 2. It's initial and maintenance cost is high.	2



2. Attempt any <u>FOUR</u> of the following	16
a) State effects of castor and camber.	4
<b>Answer :</b> <b>Effects of castor:</b> Directional stability i.e. straight line tracking is improved by castor. However positive castor increases the effort required to turn the vehicle and high negative castor causes abnormal wobble. Too little or too much castor causes wheel to wander and shimmy resulting in spotty wear of tyre. <b>Effects of camber:</b> Tyre wears on only one side. Unequal camber results in excessive wear by pulling the wheel to one side. Camber increases the straight ahead recovery.	2
b) Draw neat sketch of front wheel assembly and label it.	4
<b>Answer : (03 marks for figure, 01 mark for label)</b>  <p>Figure: Front wheel assembly.</p>	4
c) Explain rack and pinion type steering gear box with sketch.	4
<b>Answer:</b> <b>Rack and Pinion type of steering gear box:</b> The rotary motion of the steering wheel is transmitted to the pinion of the steering gear through the universal joints. The pinion is in mesh with rack. The circular motion of the pinion is transferred to the rack and rack moves linearly and this linear movement of rack is transmitted to the stub axle and wheel gets steered. The rack has ball joints at each end to allow for rise and fall of the wheels.	2

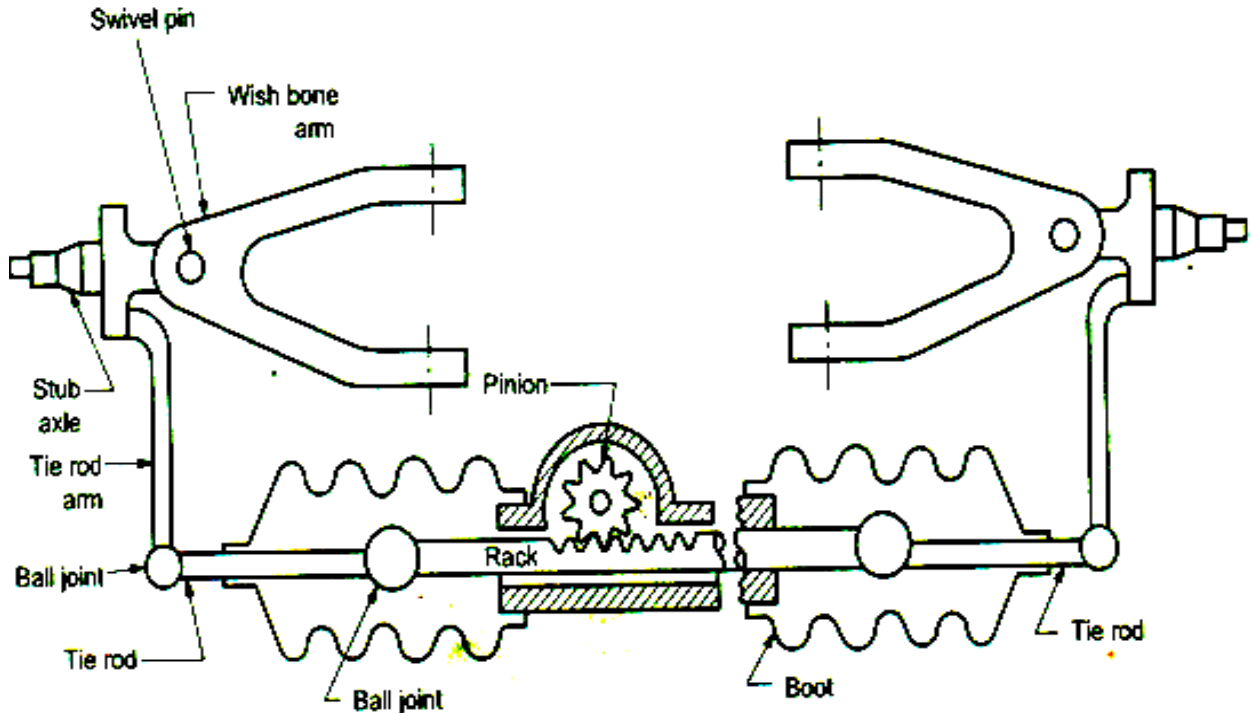


Figure: Rack and Pinion type of steering gear box.

2

d) Classify the brakes on the basis of Purpose, Location, Construction and method of actuation.

4

**Answer: Classification of brakes according to following consideration:**

- 1) On the basis of purpose:
  - a) Primary brake or Service brake
  - b) Parking brake or Secondary brake
- 2) On the basis of location: The brake may be located either at
  - a) the Wheels or
  - b) at the Transmission
- 3) On the basis of construction:
  - c) Drum brake
  - d) Disc brake
- 4) On the basis of method of actuation:
  - a) Mechanical brakes
  - b) Hydraulic brakes
  - c) Air brakes
  - d) Vacuum brakes
  - e) Electric brakes

1

1

1

1

e) Explain types of materials used in body construction.

4

**Answer: Materials used for body construction:** (Explain any 04 material, 01 mark each)

1. **Steel sheets and high-strength, low-alloy steels:** The main factors of selecting material especially for body is wide variety of characteristics such as thermal, chemical or mechanical resistance, ease of manufacture and durability. Steel sheets are used for paneling over a timber frame work and also for press work such as roof, scuttle, door and wings.

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2. **Aluminum:** Aluminum is used as a body material because of its better formability, lightness and anti rusting qualities, though its main disadvantage is lesser stiffness and rigidity.  
e. g. Pillars, frame work and paneling are all made out of aluminum sections and sheets.
3. **Plastic:** Plastic is also popular material in body work. Thermoplastics are often used for components like boot coves, grills etc., where as thermosetting plastics are used for the body shells. The latest type of plastic used for body work is reinforced carbon fiber which is stronger than steel.
4. **Glass - fiber composites:** It is lighter than steel and aluminum, easy to be shaped and rust-proof. It is cheap to be produced in small quantity.
5. **Wood:** Timber in common forms like Log, balk, billet, plank, board, batten, pillars etc are used for commercial body building. Plywood also largely used due to its property like uniformity in strength along and across the grain.
6. **Glass:** The wind screens and window panels, doors are made up of glass sheet. Toughened glass sheet, if broken into pieces in case of accident cause injury, but now a days laminated glass sheets are used which do not break into pieces.
7. **Rubber:** Natural and synthetic rubbers are used in upholstery work as well as internal trimming of door and window panels.
8. **Carbon-fibre epoxy composite:** It is because the composite structures are the high strength/low weight ratio. The most common materials used for racing cars are carbon (graphite), Kevlar and glass fibres.
9. **Magnesium:** Magnesium is another light metal that is becoming increasingly common in automotive engineering. It is 33% lighter than aluminium and 75% lighter than steel/cast iron components.

f) Explain with neat sketch construction of disc brake.

4

**Answer: Construction of disc brake:**

These brakes consist of a metal disc instead of a drum and a pair of pads, instead of the curved shoes. The disc is attached to the wheel hub by bolts. The caliper is connected to the axle casing or stub axle. When the brakes are applied, the caliper cannot move. Such disc brake is called fixed caliper disc brake.

2

The caliper is cast in two parts, each part containing a piston. There is a friction pad in between each piston and the disc. The passages are drilled in the caliper for the fluid to enter or leave the housing. These passages are also connected to another one for bleeding. There is a rubber sealing ring between each cylinder and the piston.

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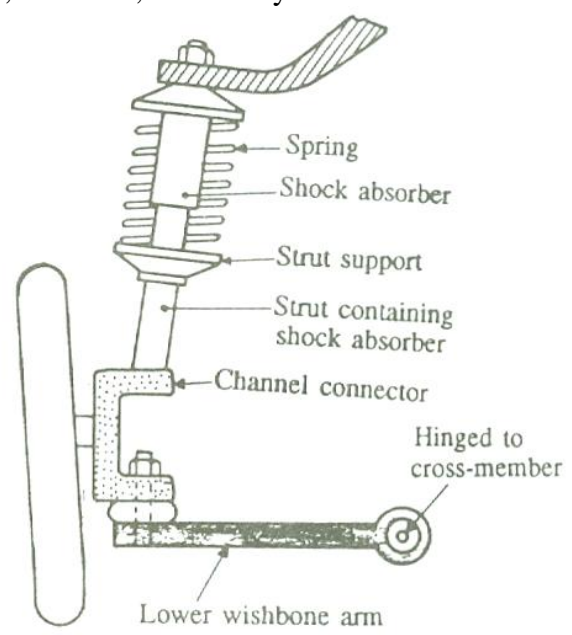


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b) List four properties of brake fluid.	4
<p><b>Answer: Properties of brake fluid:</b> (Any 04, 01 mark each)</p> <ol style="list-style-type: none"><li>1) <b>Boiling point:</b> Boiling point of fluid must be high because due to continue operation of brakes, generates the heat inside the drum, which increases the temperature of fluid in the wheel cylinder and lastly generates the vapour, which decreases the effectiveness of brakes. Therefore the boiling point should be high i.e. 2500 C to 3000 C.</li><li>2) <b>Viscosity:</b> Viscosity of brake fluid should be such that the fluid should not lose its fluidity in any atmospheric condition. i.e., too cold or too hot temperature. Therefore, it is necessary that the viscosity of brake fluid should change adequately with the change in temperature to maintain its fluidity.</li><li>3) <b>Lubrication properties:</b> The brake fluid should provide proper lubrication to the pistons in the master cylinder, wheel cylinder. Otherwise these components wear out quickly.</li><li>4) <b>Effect on rubber:</b> A number of rubber seals are used in the hydraulic braking system, therefore the brake fluid should not have any effect on these seals. Otherwise it leads to leakage of fluid, loss of pressure in lines.</li><li>5) <b>Corrosive action:</b> The brake fluid should not corrode the metal components with which it comes into contact.</li><li>6) <b>Storage stability:</b> Brake fluid should have sufficient stability at least 3 years. During this period the fluid should not be spoiled.</li></ol>	4
c) Explain with sketch working of suspension system used in MARUTI 800.	4
<p><b>Answer: Mc-pherson strut type independent suspension system used in MARUTI 800:</b></p> <p>In this type, only lower wishbones are used as shown in fig. A strut containing shock absorber and the spring carries also the stub axle on which the wheel is mounted. The wishbone is hinged to the cross member and positions the wheel as well as resists accelerating, braking and side forces. This system is simple, lighter and keeping the unsprung weight lower. Further the camber also does not change when the wheels move up and down. This type of suspension provides the maximum area in the engine compartment and is, therefore, commonly used on front wheel drive cars.</p>  <p>Figure: Mc-pherson strut type independent suspension used in MARUTI 800.</p>	2





d) Write the functions of following components of car HVAC system. (i) Condenser (ii) Expansion valve (iii) Evaporator (iv) Blower fan	4
<b>Answer: Functions of-</b>  <b>i. Condenser:</b> High pressure and temperature vapors from compressor are then passed into condenser where heat is removed by cooling medium which converts vapor into liquid.  <b>ii. Expansion Valve:</b> The refrigerant goes from the receiver-drier to the expansion valve where a sudden expansion to a much lower pressure occurs. The refrigerant changes back to vapor state and this cause a big chilling effect.  <b>iii. Evaporator:</b> The evaporator unit where the cooling effect is obtained usually located inside the passenger compartment below the dash board. A high capacity blower circulates the air in the car interior across the evaporator coils, and this drops the temperature of the air inside the passenger compartment. It also helps in dehumidification, as warmer air travels through the evaporator coil; the moisture containing the air condenses on its surface.  <b>iv. Blower fan:</b> The air from blower motor fan is passed over the heating core thus passenger compartment gets warm.	1 1 1 1
e) Describe repainting procedure for old vehicle.	4
<b>Answer: Repainting procedure for old vehicle.</b> <b>1.</b> Remove dent using denting tools and dent removing procedure. <b>2.</b> Preparing the Surface: Begin by sanding the car's surface with a dual action sander and 120 grit sandpaper to remove old paint and primer. <b>3.</b> Carryout any necessary masking so that paint remover may not fall on the finished surface. <b>4.</b> Wipe the surface down with a proprietary sprit. <b>5.</b> Primer coat: Spray a coat of primer on the entire car and allow it to dry for 30 minutes. Use a long block sander and 120 grit sandpaper to slowly sand the entire car, keeping the sanding block flat and level. Repeat the primer and block sanding steps until the body is smooth. <b>6.</b> Painting: Wipe the car with wax and grease remover. Spray the car with automotive spray paint, starting at the roof and work your way to the hood, trunk and then the sides of the car. Spray a total of four thin coats of paint on the car, allowing 30 minutes of dry time between each coat. <b>7.</b> Polishing: Inspect the painted finish for runs and other imperfections. Use 800 grit sandpaper and water to sand the entire car. Once the car is sanded and looks dull, use a mildly abrasive liquid rubbing compound and a dual action orbital polisher to polish the car. Use circular and back and forth motions until the entire car has been polished.	4
f) Name four denting tools and write purpose of each.	4
<b>Answer: (Any 04, 01 mark each)</b> <b>1) Hammer:</b> These are special purpose hammer used for roughing out heavy dent. <b>2) Dolly blocks:</b> These are small set of anvils which are to be held in hand underneath while dent While dent is being hammered. <b>3) Spoons:</b> Used for same purpose as that of dolly blocks but they are made small for dents which are difficult to access. <b>4) Files:</b> These are used to smoothen the rough surface or for removal of excess unwanted material from surface. <b>5) Pick Tools:</b> Picking bars, Hook bar, Pull rods etc. are used to pick the bumped surface. <b>6) Acetylene torch, Soldering torch, Brazing torch:</b> These are used in joining processes.	4



4. Attempt any TWO of the following:

16

a) Explain electronic power steering with sketch. Give two applications of it.

8

Answer: **Electronic power steering:**

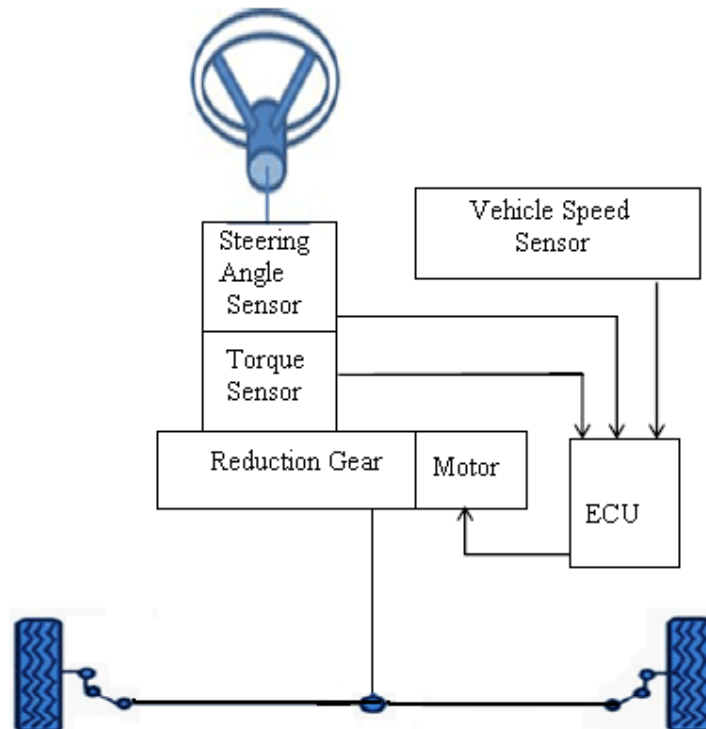
An electronically control power steering system adjusts steering boosts adaptively to driving conditions using electronic control of power steering the available boost is reduced by controlling a pressure relief valve on the power steering pump. The system consists of following components:

1. Steering column that connects the steering pinion with steering wheel inside the vehicle.
2. Steering pinion that converts the rotating steering movement into linear movement of the rack.
3. Rack connected to the wheels via tie rods and links.
4. Sensors to record the information required to calculate the necessary supporting steering torque.
5. Servo unit consisting of an ECU and servo motor (electric motor) that generates the supporting steering torque.

4

**Working:**

When the driver moves the steering wheel a sensor registers the steering torque exerted and sends this information as an electric signal to ECU. This calculates the supporting torque and activates the servo motor on the basis of the calculated result. Generally the steering torque generated by these motors is 3-6 Nm. The direction of rotation of motors depends on the direction of motion of steering wheel. The control electronics takes into account the different signals and parameters e.g. Driving speed, steering angle, steering torque and steering speed with the help of other sensors in the vehicle and due to networking of steering ECU with other ECUs in the vehicle framework. This steering system can be used to implement assistance function to enhance comfort and safety.



3

Figure: Electronic Power Steering

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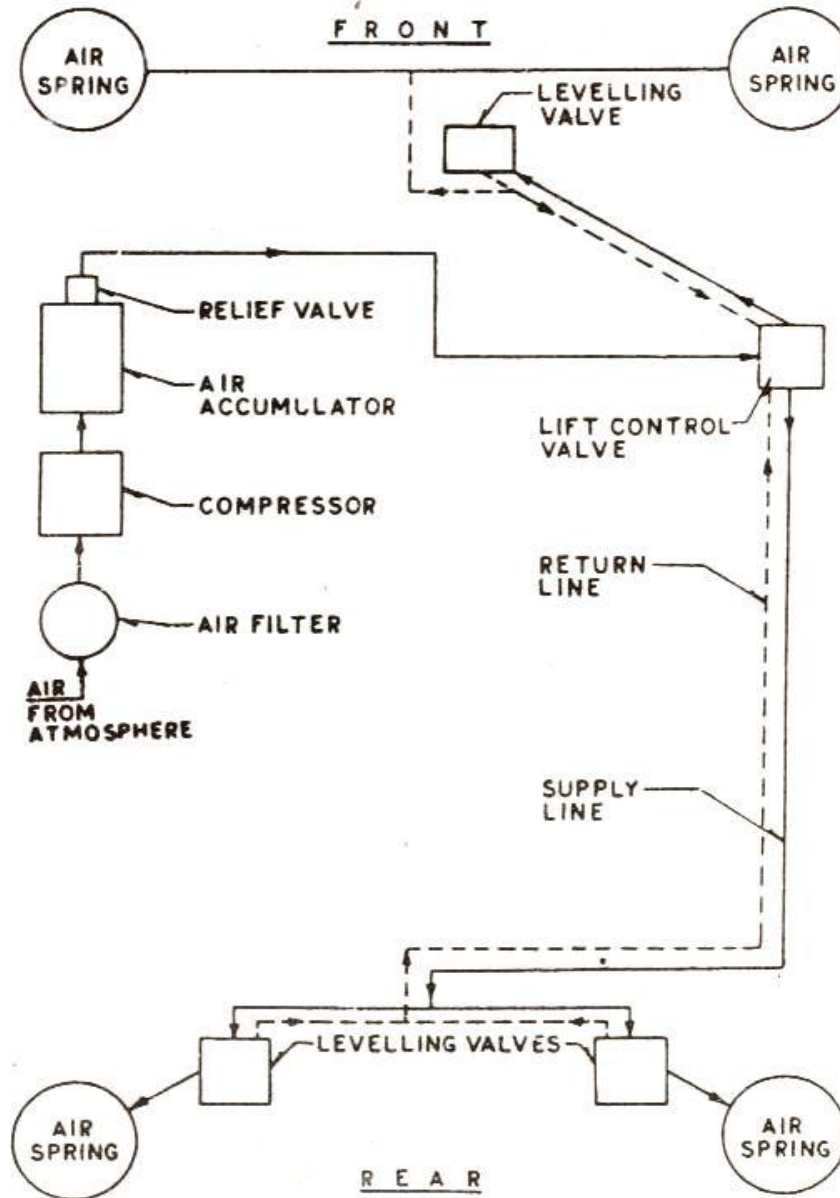
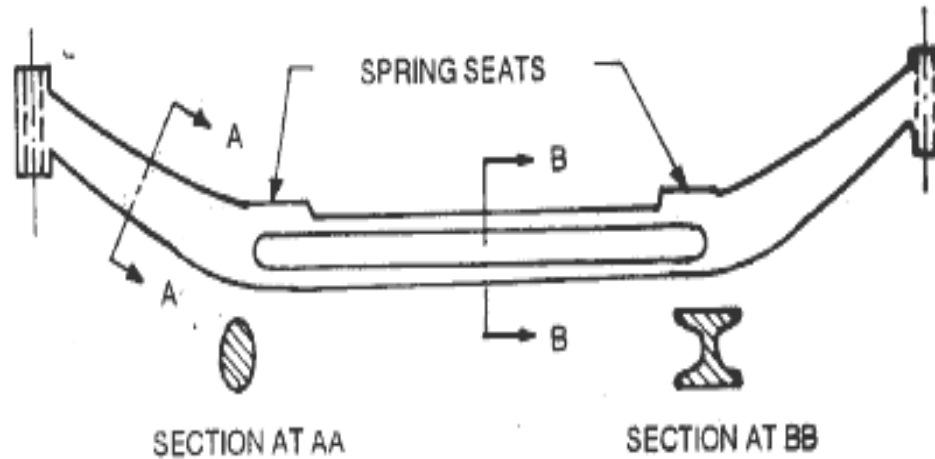


Figure: Schematic diagram showing the layout of an air suspension system.

4

5. Attempt any FOUR of the following:	16
a) Explain conventional front axle with sketch.	4
<p><b>Answer: Conventional front axle:</b></p> <p>The conventional front axle is used to carry the weight of the front part of the vehicle as well as to facilitate steering and absorb shocks due to road surface variations. It must be right and robust in construction. It is usually a steel drop forging having 0.4 % carbon steel or 1-3 % nickel steel. It is made of I- section in the central portion, while the ends are made either circular or elliptical. With this construction, it takes bending loads due to the load of the vehicle and also torque due to braking of the wheels. To keep the components of the front axle are the axle beam, stub axle, swivel pin and track rod.</p>	2



Conventional front axle

2

b) Describe saloon and hatchback type vehicle body with examples.

4

**Answer:**

**Saloon type vehicle body:** A sedan (American English) or saloon vehicle body is a passenger carrying type with two rows of seats and adequate passenger space in the rear compartment for adult passengers.

2

**Example:** The vehicle usually has a separate rear trunk (boot in British English) for luggage, although some manufacturers such as Chevrolet and Volkswagen have made rear-engine models.

**Hatchback type vehicle body:** Hatchback (a.k.a. lift back) sedans typically have the fastback profile, but instead of a trunk lid, the entire back of the vehicle lifts up (using a lift gate or hatch). A vehicle with four passenger doors and a lift gate at the rear can be called a four-door hatchback, four-door hatchback sedan, or five-door sedan.

2

**Example:** TATA Indigo

c) Describe working of telescopic shock absorber.

4

**Answer: Telescopic shock absorber:**

**Working:**

When the vehicle comes across a bump the lower eye moves up. Therefore the fluid passes from the lower side of the valve A to its upper side but since the volume of the space above valve A is less than the volume of the rod the fluid exerts pressure on the valve B. This pressure of the fluid through the valve opening provides the damping force. Similarly when the lower eye moves down the fluid passes from the upper side of the valve A to the lower side and also from the lower side of the valve B to its upper side.

2

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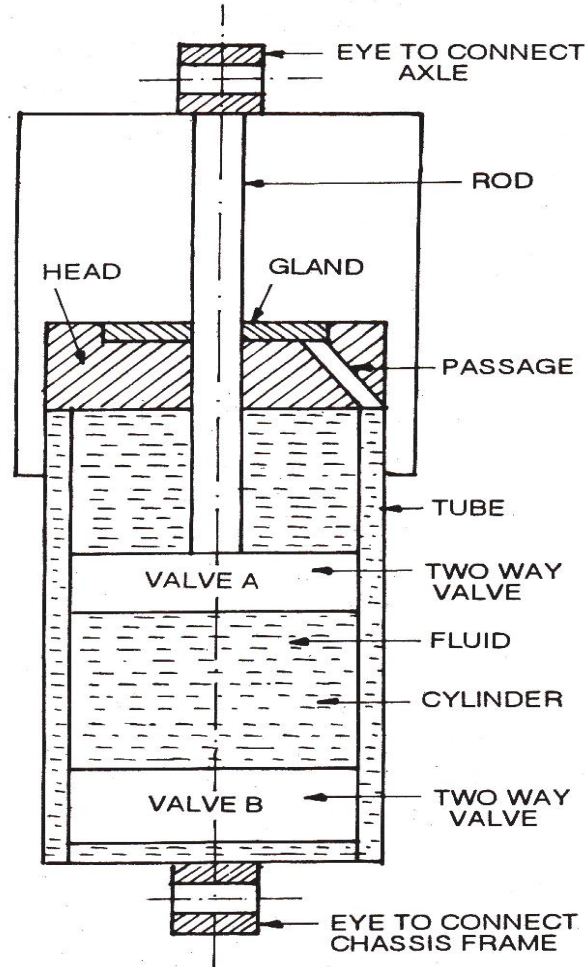


Figure: Telescopic shock absorber

2

d) State human comfort conditions used in car Air Conditioner.

4

**Answer: Human comfort conditions used in car Air conditioner:**

- 1) **Temperature:** Temperature is the most important factor which affects human comfort to a great extent. Most of the human being feels comfortable at a temperature  $21^{\circ}\text{C}$  to  $25^{\circ}\text{C}$ . Generally human being feels comfortable at relatively higher temperature in winter season and feels comfortable at relatively lower temperature in summer season. The comfort temperature of individual person depends on his body structure, eating habits, the area in which he is to make familiar to live. 1
- 2) **Humidity:** The control of humidity is not only necessary for human comfort but it is also important from point of view of efficiency of driver. For human comfort, relative humidity is kept within a range of 35% to 60%. 1
- 3) **Purity of air:** A person does not feel comfortable when breathing in contaminated air even if temperature and humidity is within comfortable range. Therefore, proper filtration, cleaning and purification of air is necessary to keep it free from dust, dirt and other impurities. The proper percentage of oxygen in air is necessary to be maintained for human comfort. Therefore, proper filtration system is provided in HVAC system in automobiles. 1



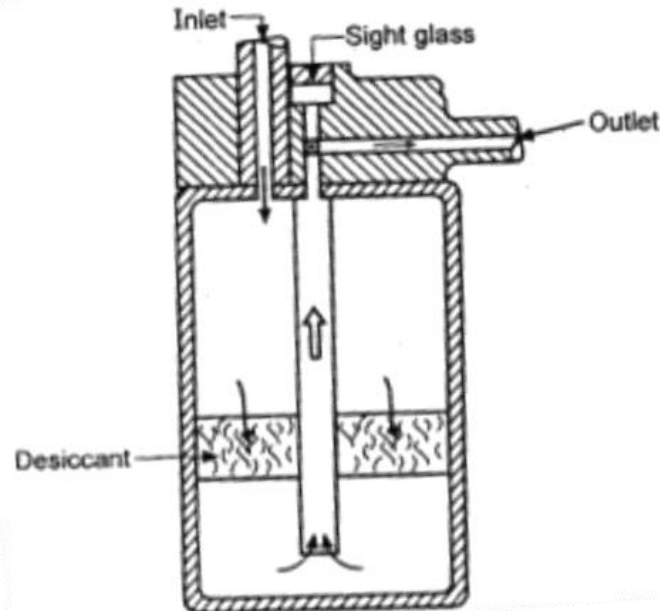


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evaporator coil; the moisture content in the air condenses on its surface.



1

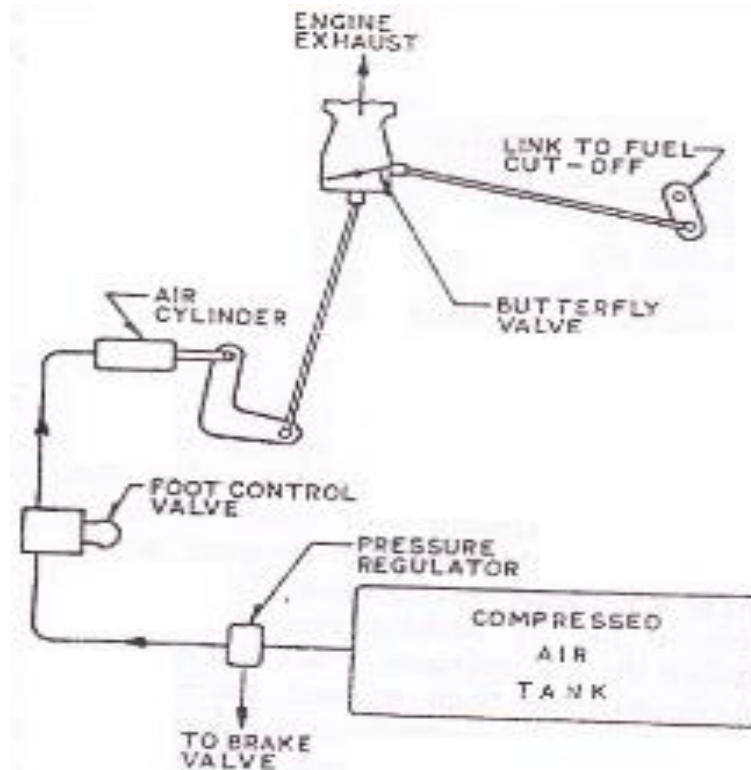
6 Attempt any TWO of the following

16

a) Describe exhaust brake with neat sketch and write its applications.

8

**Answer: Exhaust Brake:**



3

Figure: Exhaust brake system.





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It consists of pressure regulator, Foot control valve, Air cylinder, Butterfly valve and Linkages. In it, the pressure regulator is common with the air (service) brake

3

When the exhaust gas brake is to be applied, the driver presses upon the control valve by his foot. This allows flow of compressed air from the air cylinder, which in turn operates the linkage to close the butterfly valve at the exhaust manifold. It prevents exit of the exhaust gas into atmosphere and diverts it to apply the brakes. As soon as the foot is taken- off the foot control valve, the brake is released. In this way, this type of brake effect fuel economy of vehicle.

**Application:**

This is an auxiliary brake (a non –service brake) used to work when the vehicle is either moving on a long downhill gradient, or in busy traffic where it has to slow down continuously over a large distance.

2

b) Describe working of vapour compression cycle with sketch.

8

**Answer: Vapour compression cycle:**

In Vapor compression cycle working medium is liquid refrigerant, (i.e. R12 or R 134 a) which is pressurized by using compressor. It consists of compressor, condenser, evaporator, receiver and expansion valve.

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 the body to be cooled. Due to heat absorption, liquid refrigerant gets converted into vapor and these vapors are passing to compressor.

4

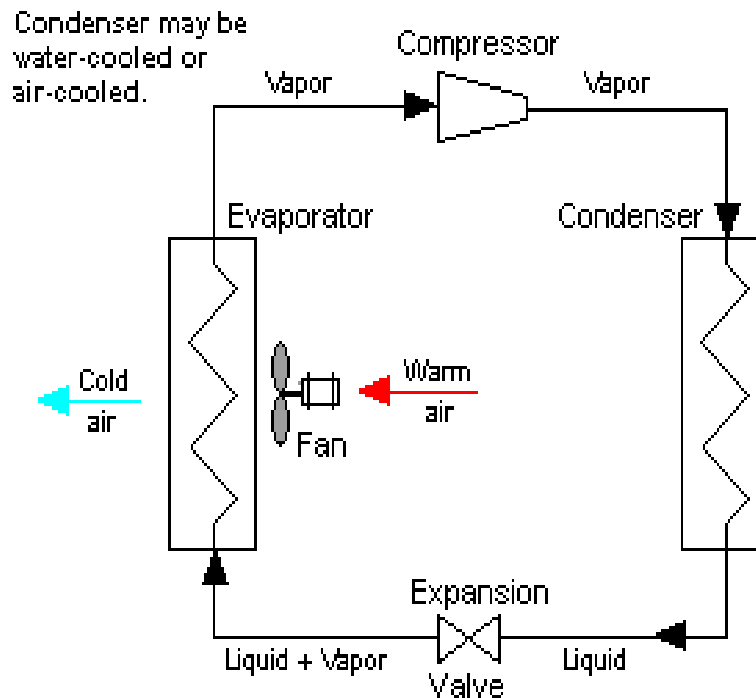


Figure: Vapour compression cycle.

4



c) Describe stability of vehicle on slopes and turns.

8

**Answer: Stability of vehicle on slopes and turns:**

When vehicle is taking a turn along a curved path three conditions arises-

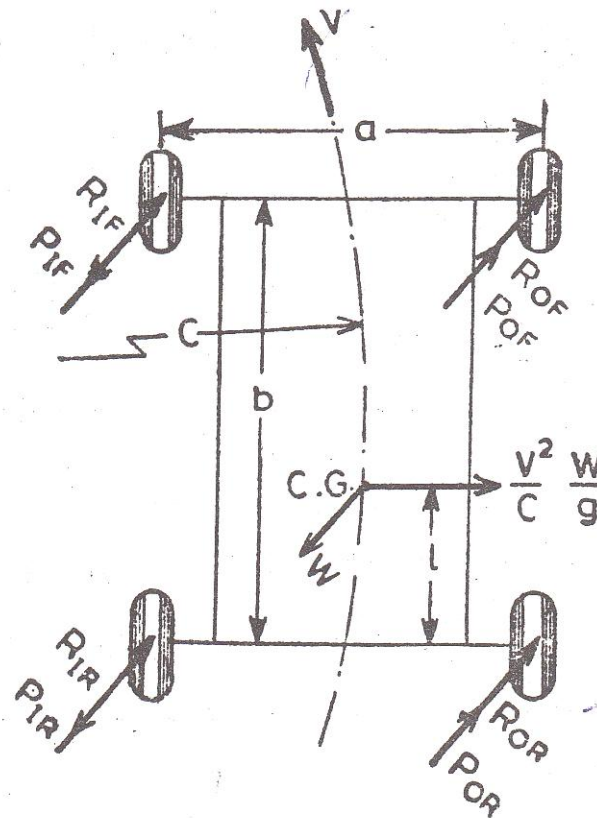
1) Centrifugal force acts at centre of gravity in radially outward direction and normal reaction due to centrifugal force acts at wheel contact. The reactions ( $P_{IF}$ ,  $P_{IR}$ ) will be in inward direction at inner wheels and the reactions ( $P_{OF}$ ,  $P_{OR}$ ) outward directions at outer wheels. The centrifugal force and reactions forms overturning couple.

4

2) At the wheels reaction due to weight ( $R_{IF}$ ,  $R_{IR}$ ,  $R_{OF}$ ,  $R_{OR}$ ) acts at a wheel in radially outward direction.

3) Reaction at a wheel due to gyroscopic couple.

These three conditions causes the over turning couple leads to sliding (skidding) and overturning of the vehicle. To avoid this height of centre of gravity of the vehicle should be lower; speed during turning should be lower.



4

Figure: Stability of vehicle on turn.

(Note: If derivation is written, due credit should be given.)