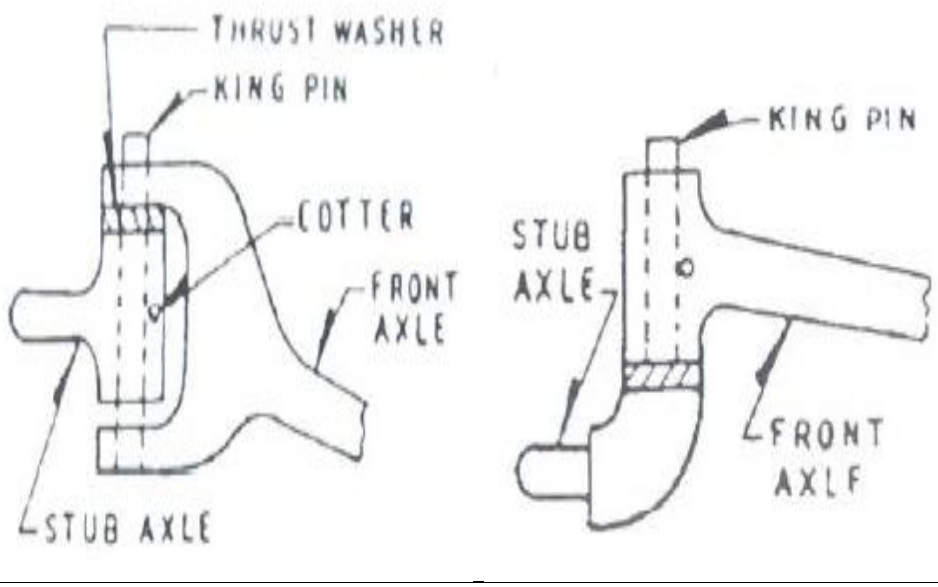
WINTER – 19 EXAMINATION

Model Answer

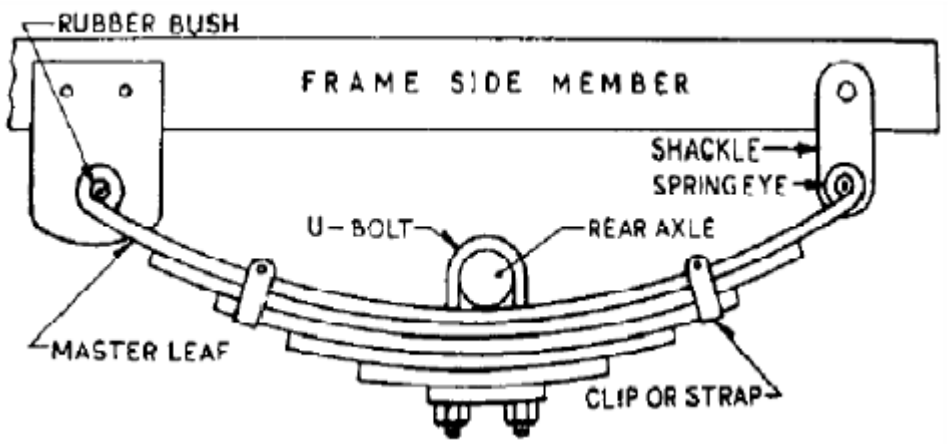
Subject Name: Automobile Systems & Body Engg. Subject Code: **22442**

Important Instructions to examiners:

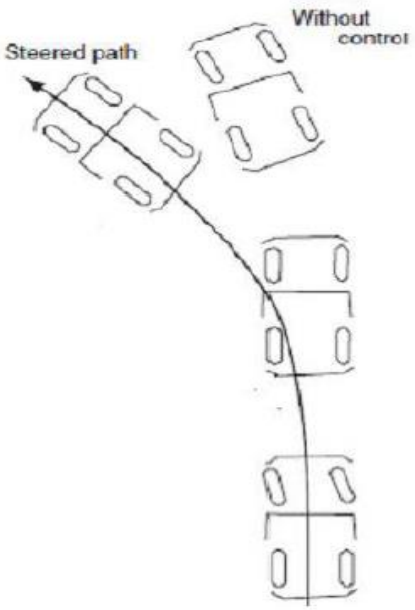
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 judgement 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.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following.**	**10**
	a)	**Draw neat labelled sketches of Elliot and Lamoine type stub axle.**	**02**
			**(01 mark each)**

		Elliot type stub axle Lamoine type stub axle	
	b)	**Compare between the Live and Dead Axle with suitable example. (Any two points)**	**02**
		<table><tr><th>Dead Axle</th><th>Live axle</th></tr><tr><td>1) It has no connection with engine means it is dead and will not carry the engine power.</td><td>1) It is axle which contains differential mechanism through which the engine power flows towards the front wheels.</td></tr><tr><td>2) It has sufficient rigidity and strength to transmit the weight of vehicle from the springs to the front wheels.</td><td>2) In addition to transmit weight live has to supply engine power to wheels.</td></tr><tr><td>3) Generally front axle is dead in front engine real wheel drive or rear engine rear wheel drive.</td><td>3) Generally rear axle is live axle in front engine real wheel drive or rear engine rear wheel drive.</td></tr></table>	**02**
	c)	**State the necessity of brakes.**	**02**
		Necessity of brake: In an automobile, if the pressure from accelerator pedal is removed, the vehicle tends to slow up because of wind resistance, drag of engine and road friction. These forces, of course, would stop the vehicle but in present day traffic, this would be quite unpredictable and dangerous. The braking system provides added friction to overcome motion and to slow up or to stop the vehicle. The momentum or kinetic energy developed by the vehicle when in motion is converted to heat energy by the friction of brake shoes and drums which is dissipated into the surrounding air. Therefore the braking system is necessary to stop the vehicle or to retard the speed of vehicle within shortest interval of time with safety.	**02**
	d)	**List down the different types of friction material used in brake liners.**	**02**
		1. Asbestos 2. Ferodo 3. Cork 4. Leather	**02**
	e)	**Draw a proportionate sketch of "Semi Elliptical leaf spring."**	**02**

			**02**
	f)	**Classify the types of "Automobile Bodies."**	**02**
		Classification according to Body: A. Passanger car 1. Sedan /Saloon 2. Hardtop 3. Lift back (Hatchback) 4. Station Wagon 5. Coupe 6. Limousine 7. Convertible 8. Estate car B. Heavy vehicle / Trucks: 1. Trunk punjob body 2. Truck half body 3. Truck platform type 4. Truck with trailer 5. Dumper 6. Tanker	**02**
	g)	**Give the significance of "Body streamlining" in an automobile.**	**02**
		1. To reduce the air resistance during running. 2. Increase fuel efficiency. 3.Reduce power consumption.	**02 (any two points)**
2		**Attempt any THREE of the following:**	**12**
	a)	**Explain the concept of under steering and over steering with sketches.**	**04**
		During turns, centrifugal force acts on the wheels. Two cases can arise: i) Oversteering: When the slip angles of the front wheels are less than those of the rear wheels, radius of the turn is decreased. This means that the vehicle will turn more sharply than it should for a given rotation of the steering wheel. This condition is called oversteering. ii) Understeering: When the slip angles of the front wheels are greater than those for the rear wheels, radius of the turn is increased. This means that the vehicle will turn less sharply than	**02**

it should for a given rotation of the steering wheel. This condition is called understeering.



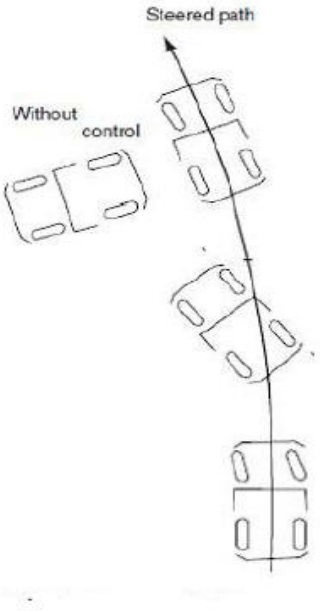
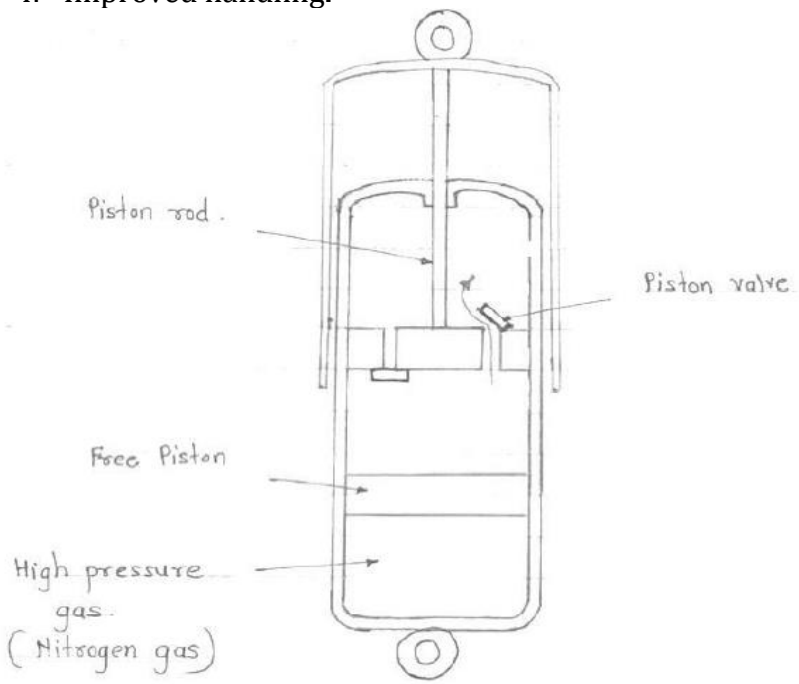


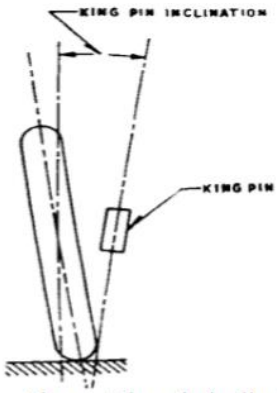
Figure: (a) Understeering **Figure: (b) Oversteering** **02**

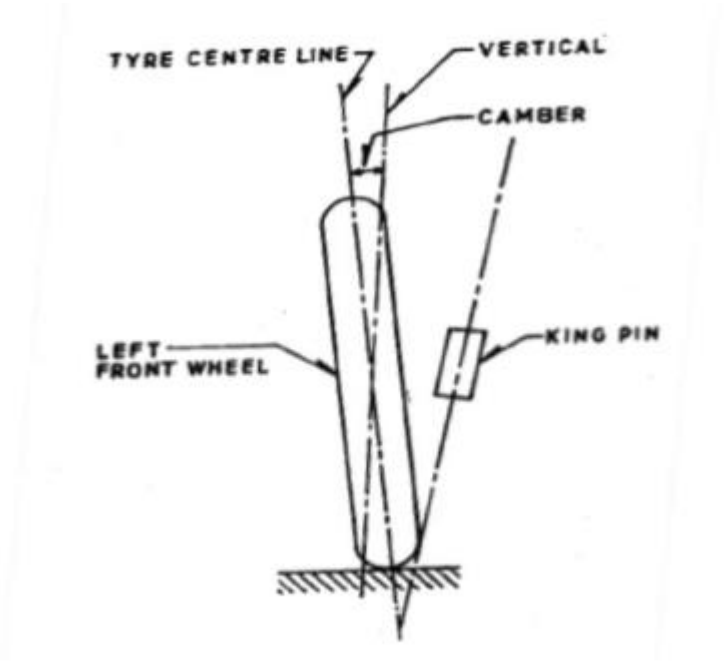
b) Differentiate between Drum and Disc brake with justification. (Any four points) **04**

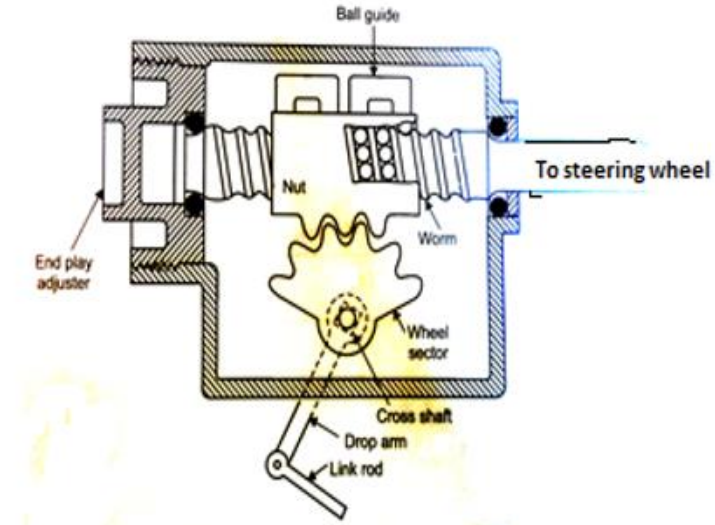
Sr.No.	Disc Brake	Drum brake
01	Friction surfaces are directly exposed to the cooling air.	Friction occurs on the internal surfaces, therefore heat dissipated only by conduction through the drum.
02	Flat friction pads are used.	Curved friction linings are used.
03	There is uniform wear of friction pads.	Non uniform wear of friction linings.
04	There is no loss of efficiency due to expansion.	There is loss of efficiency due to expansion.
05	Weight is less so saving upto 20 % is possible.	Comparatively higher weight.
06	Disc brakes have comparatively better anti-fade characteristics.	Comparatively poor anti-fade characteristics.
07	Simple in design.	Complicated design.
08	Comparatively easy to remove and replace friction pads.	Removal and replacement of brake linings is difficult and consumes more time.
09	Less frictional area	More frictional area

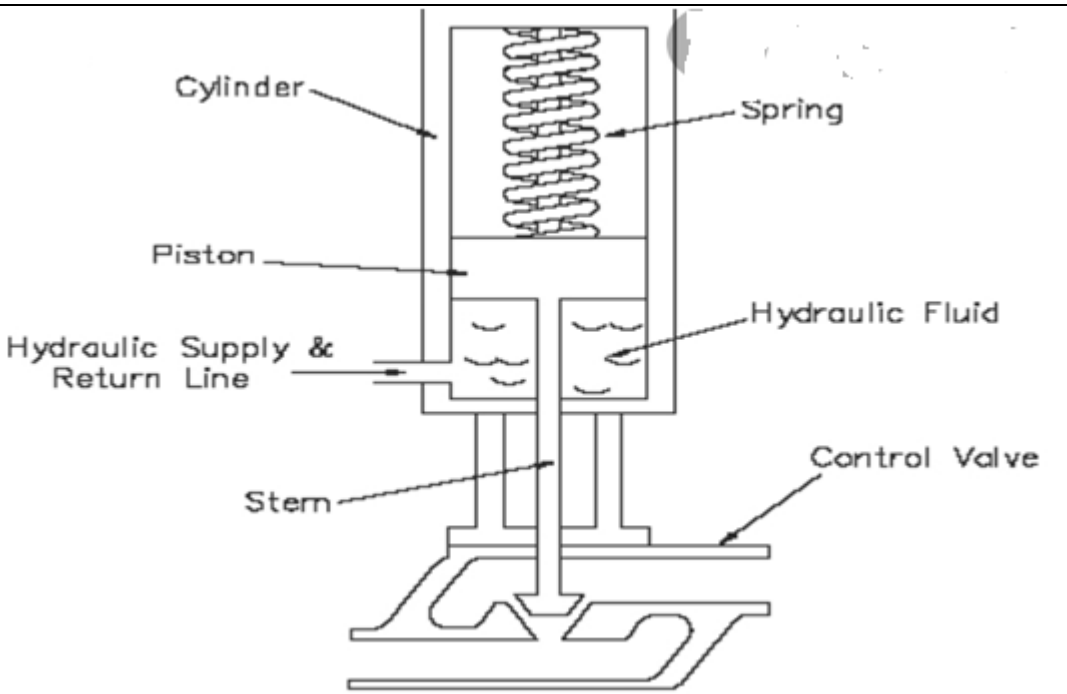
04

		10	Pressure intensity is more	Pressure intensity is less
	c)	**Explain the constructional features of Gas filled shock Absorber with sketch.**		**04**
		Features: 1. Control tire motion better than non gas shock absorber 2. Vibration is reduced 3. Reduced aeration. 4. Improved handling.  		**02** **02**
	d)	**Describe the stepwise procedure for painting of used vehicle.**		**04**
		Painting procedure for used vehicle: Remove dent using denting tools and dent removing procedure. Preparing the Surface: Begin by sanding the car's surface with a dual action sander		**04**

		and 120 grit sandpaper to remove old paint and primer. Carryout any necessary masking so that paint remover may not fall on the finished surface. Wipe the surface down with a proprietary sprit. **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. **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. **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.	
3.		**Attempt any THREE of the following:**	**12**
	a)	**Explain the following terms with sketch and suitable range:** **(i) King pin inclination** **(ii) Camber**	**04**
		(i) King pin inclination  Figure: King pin inclination. It is the angle between vertical line and centre line of king pin or steering axis when viewed from the front of the vehicle. King pin inclination helps the straight ahead recovery of steering wheel, thus providing directional stability. It also reduces tyre	**01**

		wear. It is normally about 70 to 80 . **(ii) Camber** It is the angle between centre line of tyre and vertical line when viewed from front of the vehicle. Camber is the tilt of the car wheels from the vertical, when viewed from the front of the vehicle. Camber is positive if the tilt is outward at the top. Camber should not generally exceed 2°.  Fig. Camber	**01** **01** **01**
	b)	**Describe the working of recirculating ball type steering gear box with sketch.**	**04**
	Ans.	**Working of Recirculating ball type steering gear box:** It consists of worm at the end of steering rod. A nut is mounted on the worm with two sets of balls in the grooves of the worm, in between the nut and worm. The balls reduce the friction during the movement of nut on the worm. the nut has large number of teeth on the outside, which mesh with the teeth on a worm wheel sector, on which is further mounted the drop arm, which steers the road wheels through the link rod and steering arm. When the steering wheel is turned, the balls in the worm roll in the grooves and cause the nut to travel along the length of the worm. The	**02**

		balls , which are in Two sets are recirculated through the guides as shown in the fig. the movement of the nut causes the wheel sector to turn at an angle and actual the link rod through the drop arm, resulting in the desired steering of the wheels.  **Fig. Recirculating Ball Type Steering Gear**	**02**
	c)	**State and explain the working principle of hydrodynamic spring with neat sketch.**	**04**
	Ans.	**(credit should be given to appropriate answer)** **Working principle:** Hydrodynamic springs are comparatively small, thick walled cylinder in which the spring effect is produced by applying load to the fluid in the cylinder through a small piston entering at the centre of one end of the cylinder. The piston movement and deflection is produced by the compression of the fluid and deformation of the cylinder wall. These springs are particularly useful in applications requiring high load capacities and stiffness.	**02**

			**02**
	d)	**Explain operation of anti lock breaking system with its layout.**	**04**
	Ans.	Fig. shows block diagram of the ABS system. Typically ABS includes a central electronic control unit (ECU), four wheel speed sensors, and at least two hydraulic valves (hydraulic unit or actuator) and pump. The brake lines from master cylinder connect to hydraulic unit or actuator. Lines from the actuator connect to the wheel brakes. The actuator is controlled by ECU. Wheel speed sensors at each wheel continuously send rotational wheel speed information to the ECU. If it detects a wheel rotating slower than the others, it means there is tendency of wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster.	**02** **02**

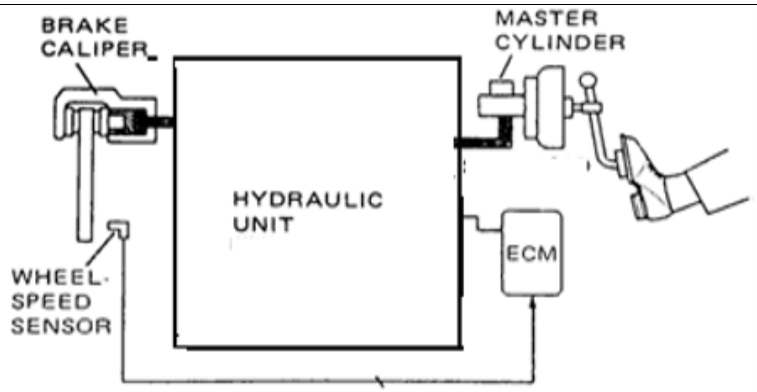
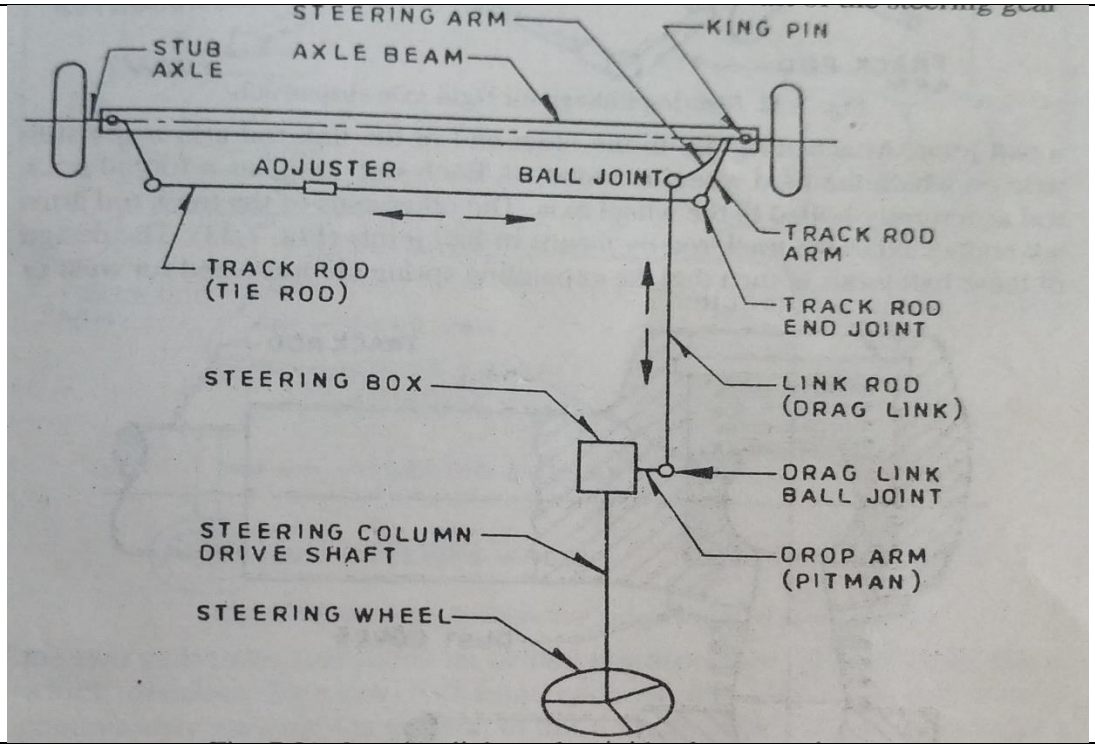
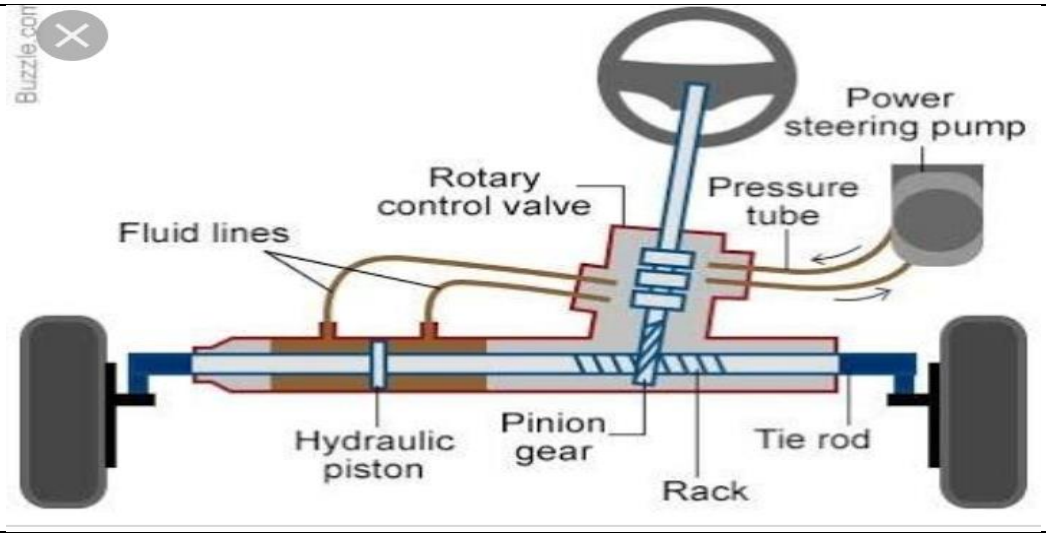
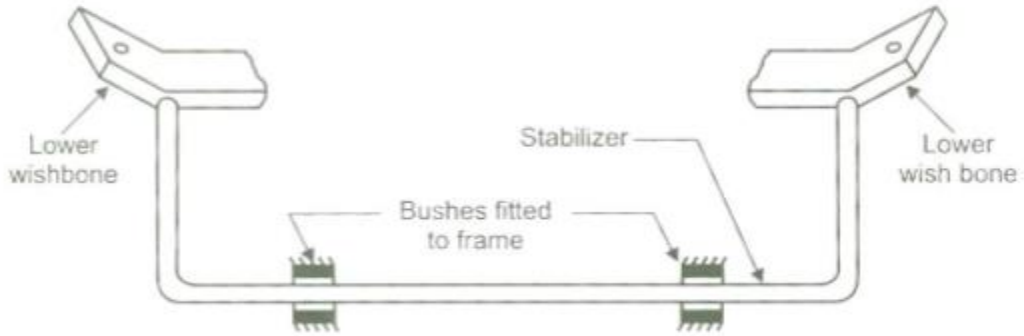


Figure: Antilock brake system.

4.		**Attempt any THREE of the following:**	**12**
	a)	**Identify and explain the various components of rigid axle steering linkage with sketch.**	**04**
	Ans.	**The drop arm** (also called Pitman arm) is rigidly connected to the cross-shaft of the steering gear at its upper end, while its lower end is connected to the link rod arm through a ball joint. **Stub axle** is rigidly attached to the other end of link rod arm. Each stub axle is has a forged track rod arm rigidly bolted to the wheel axis. The other end of track rod arms is connected to track rod by means of ball joints. In case of conventional rigid axle suspension, the main **axle beam** ensures the movement of stub axle in the horizontal plane only, there is no vertical deflection of the suspension and hence there is no change in the effective track-rod length. In case of Independent suspension, the two stub axles can move up or down independent of each other due to which distance between ball-joint ends of the two **track rod arms** is continuously varying. Here three piece track rod is used , the centre portion being called relay rod is used , which is connected at one end to the idler arm supported on body structure and to drop arm of steering gear at the other end through ball joints	**02**

			**02**
	b)	**Describe the salient features of hydraulic type power assisted steering with sketch.**	**04**
	Ans.	**Salient features :(credit should be given to appropriate answer)** 1) Absorbs road shocks 2) Minimum efforts 3) Greater safety 4) Controllability under critical situations. 5) Oil output directly proportional to the steering speed.	**02** **02**

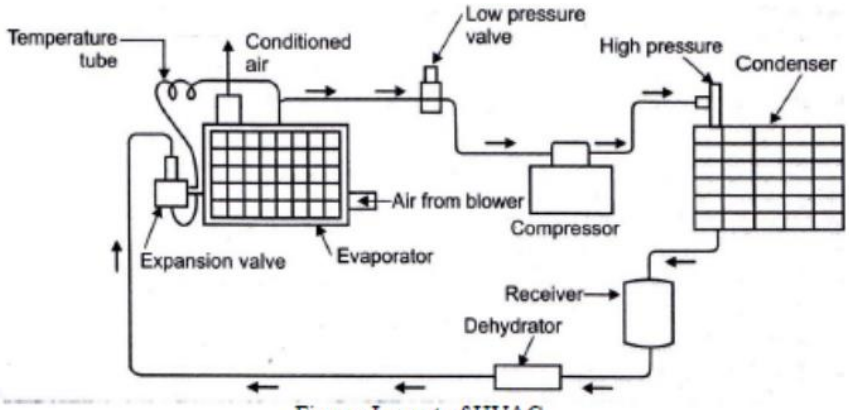
			
	c)	**Describe the properties of brake fluid used in light motor vehicle.**	**04**
	Ans.	**Properties of brake fluid (any four- 1 mark each)** **1) Boiling point**: Boiling point of fluid must be high because due to continue operation of brakes, generates the heat inside the drum, which increases the 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. 25000 C to 30000 C. **2) Viscosity:** 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. **3) Lubrication properties:** The brake fluid should provide proper lubrication to the pistons in the master cylinder, wheel cylinder. Otherwise these components wear out quickly. **4) Effect on rubber:** 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. **5) Corrosive action:** The brake fluid should not corrode the metal components with which it comes into contact. **6) Storage stability:** Brake fluid should have sufficient stability at least 3 years. During this period the fluid should not be spoiled.	**(1 mark each) any 4 points**
	d)	**Explain the necessity of anti roll bar in automobile with justification.**	**04**
	Ans.	**Necessity-** Antiroll bar is used to reduce the tendency of the vehicle to roll on either	**02**

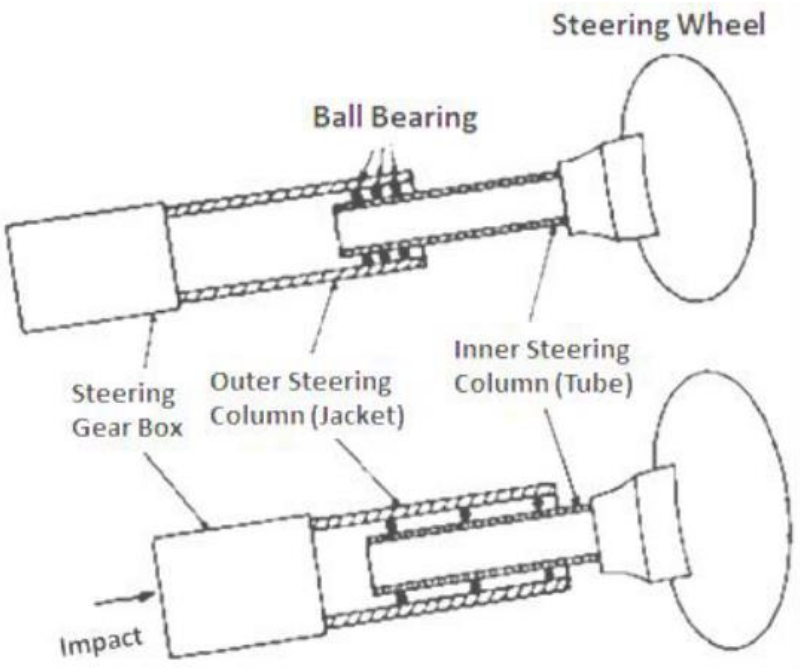
		side when taking a turn.  Figure: Anti roll bar for front axle independent suspension. **Justification-** When both the wheels deflect up and down by the same amount, the stabilizer bar simply turns in the bearings. When only one wheel deflects, then only one end of the stabilizer bar moves, thus twisting the stabilizer bar which acts as a spring between the two sides of the independent suspension.	**02**
	e)	**Compare between hydraulic and air braking system with justification.(any four points)**	**04**
	Ans.		**04**

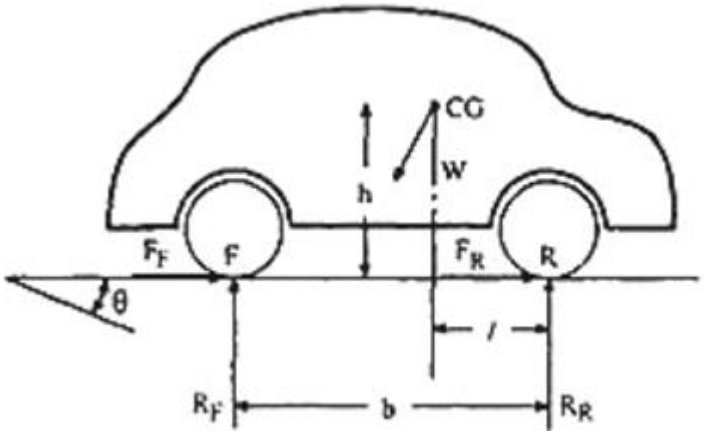
Air brakes	Hydraulic brakes
1. Compressed air is used as a working substance.	1. Hydraulic oil is used as a working substance.
2. Air brake has more powerful than hydraulic brake.	2. Hydraulic brake has less powerful than air brake.
3. Components: Air compressor, unloader valve, brake valve, brake chamber.	3. Components: Master cylinder, wheel cylinder, oil reservoir.
4. Air brake system is used in trucks, buses, trains etc.	4. Hydraulic oil brake system is used for light vehicles such as cars, light duty trucks etc.
5. Air compressor uses a certain amount of engine power.	5. No engine power is used.
6. It is not self lubricating.	6. Hydraulic brakes are self lubricating.

5.		**Attempt any TWO of the following**	**12**
	a)	**(i) Give the detail classification of suspension system.** **(ii) State the necessity of suspension system.**	

		i) **Classification of suspension system.** 1. Rigid suspension system 2. Independent suspension system a. Wishbone type parallel link type b. Mac pherson strut type c. Vertical guide type d. Trailing link type e. Swing half- axle type **ii) Necessity of suspension system. (Any two – 1 mark each)** 1) To prevent road shocks from being transmitted to the vehicle component and the Passengers. 2) To safeguard the occupants form road shocks. 3) To preserve stability of vehicle while in motion. 4) To maintain the road wheels in contact with road surface.	**03** **03**
	b)	**List the different body accessories used for passenger cars and explain any two body accessories with their function**	**06**
		(Any Six Body Accessories and their Functions 01 Mark Each) **(1) Body Cover:** To keep the car covered in open parking. **(2) Puncture Repair Kit:** To repair the punctured vehicle in case of emergency **(3) Tyre Inflator:** To fill the air in the flat tyre. **(4) Air Pressure Gauge:** To check tyre air pressure regularly. **(5) Comprehensive Tool Kit:** To attend the minor repairs. **(6) Cleaning Cloth:** To wipe out dirt dust etc. from car body. **(7) Spoilers:** To spoil unfavorable air movement across the body. **(8) Sports Mirrors:** Better Appearance **(9) Head And Tail Light Cover:** Better Look **(10) Window Visors:** To keep the window open in all type of seasons. **(11) Sun Roof:** To provide natural air conditioning to the car. **(12) Infotainment system**	***Any Six Body Accessories and their Functions 01 Mark Each***

	c)	**Explain the working of HVAC system with proper layout.**	**06**
		 Figure: Layout of HVAC. **Operation of HVAC:** HVAC 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 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. For heating the passenger compartment, hot engine coolant is passed through heater core. The air from blower motor fan is passed over the core thus passenger compartment gets warm.	**03** **03**
6.		**Attempt any TWO of the following.**	**12**
	a)	**Describe the working of collapsible steering column with sketch.**	
		Collapsible steering column: **Working:** The design of these columns is such that they collapse due to impact forces caused during head-on collision of the vehicle. The collapsing columns ensure greater safety to the driver by minimizing or avoiding a direct severe impact to him. This type of column consists of inner tube and outer tube. Ball bearing is provided between the two overlapping tubes. The inner tube is attached on the steering wheel while the outer jacket is fitted over the brackets (not shown in figure) on the body or	**03**

		on the frame. In case of a collision, the inner tube collapses by sliding inside the outer jacket and thus saves the driver from severe impact.  Figure: Arrangement of a ball type collapsible steering column in normal mode and in collapsed condition.	**03**
	b)	**Explain the human condition in Car AC system with justification.**	**06**
		Human comfort condition: (two mark each) 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 210C to 250C. 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. 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%. 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	**02** **02** **02**

		provided in HVAC system in automobiles. 4) **Air motion and circulation:** Even if temperature, humidity and purity of air is satisfactory, certain amount of air motion is necessary for human comfort. We do not feel comfortable in dead or still air. It is therefore, necessary that there should be equidistribution of air throughout the space to be air conditioned.	
	c)	**Explain the concept of 'stability of vehicle on turn and slopes' with sketch.**	**06**
		Stability of vehicle on Slope: Let the vehicle rest on a slope of inclination Q to the horizontal. This alters the distribution of the weight between the front and back axle and gives rise to reaction which can have com-ponents along the perpendicular to the inclined plane as shown in Fig.  Figure: Stability of vehicle on slope. If the angle θL is increased gradually, a situation arises when, 1. The vehicle about to overturn, or 2. The vehicle is about to slide down the slope, The limiting angle θL for overturning is given by,	$1^1/_2$ $1^1/_2$

$$\tan \theta_L = \frac{b - l}{h}$$

If the second condition arises, the limiting angle θ_L is given by,

$$\tan \theta_L = \mu.$$

$1^1/_2$

Stability of vehicle on turn: 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 (PIF, PIR) will be in inward direction at inner wheels and the reactions (POF, POR) outward directions at outer wheels. The centrifugal force and reactions forms overturning couple. 2) At the wheels reaction due to weight (RIF, RIR, ROF, ROR) 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 center of gravity of the vehicle should be lower; speed during turning should be lower.

$1^1/_2$

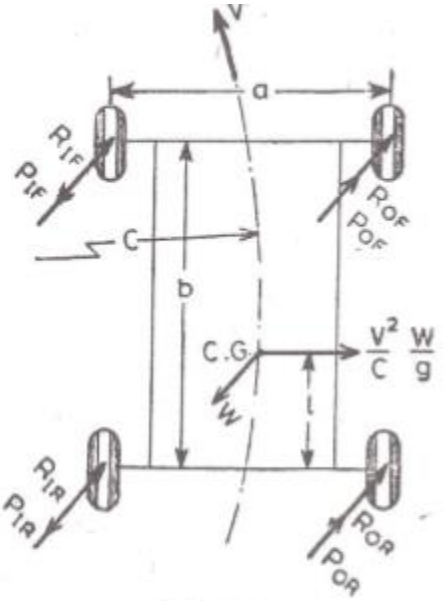


Figure: Stability of vehicle on turn.