

**Q.1(a) Attempt any THREE of the following:** [12]

**Q.1(a) (i) Write functions of universal joint and slip joint.** [4]

**Ans.: Function of Universal Joint:**

Universal joint allows transmission of power and rotary motion at an angle which varies as a vehicle encounters a bump.

**Function of Slip Joint:**

This joint allows variation in length of the propeller shaft when vehicle came across road irregularities.

**Q.1(a)(ii) State purpose and function of clutch in automobile.** [4]

**Ans.: 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.

**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.

**Q.1(a)(iii) Draw neat labelled sketch of rack and pinion steering gear.** [4]

**Ans.:**

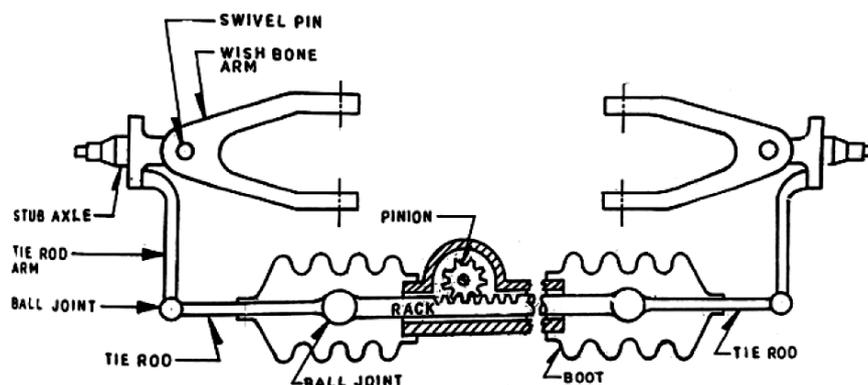


Figure: Rack and Pinion steering gear

**Q.1(a)(iv) State necessity of braking system. What is function of parking brakes?** [4]

**Ans.: Necessity of Braking System:**

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.

**Function of a parking brakes:**

- 1) To assist drivers in downhill braking.
- 2) To make sure that the vehicle doesn't move while parked.

**Q.1(b) Attempt any ONE of the following:** [6]

**Q.1(b) (i) Draw car air conditioning system layout and explain in brief.** [6]

**Ans.: Layout of car air conditioning system:**

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 the warm air which is passed over the evaporator. The warm 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.

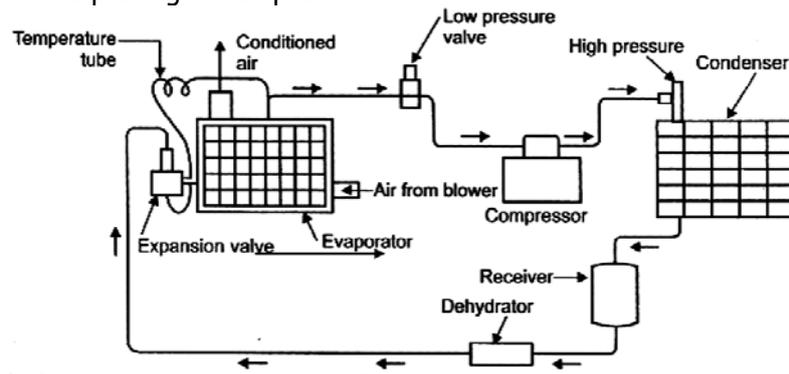


Figure: Layout of car air-conditioning system

**Q.1(b)(ii) Describe the working of overdrive with neat sketch.** [6]

**Ans.: Working of Overdrive:**

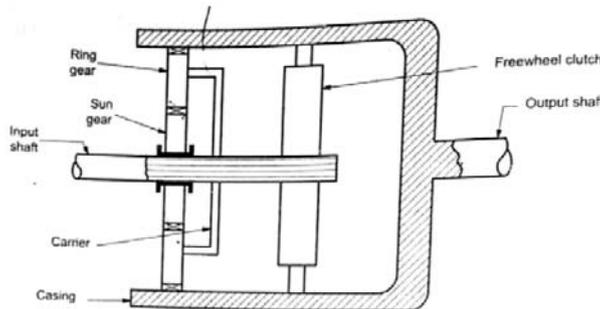


Figure - Overdrive

It consists of an Epicyclic gear train in which sun gear is free to rotate on the engine shaft (input shaft) which is splined while the carrier can be slide. A free clutch is also fitted on input shaft. The ring gear is mesh with the casing of the output shaft.

- When the sun gear is locked with the casing i.e. it became stationary, the speed of the output shaft increase hence says as overdrive is engaged.
- When the sun gear is locked with the carrier or ring gear, solid drive through the gear train is obtained.

- Thus depending upon the locking of sun gear with casing or carrier the overdrive or direct drive is obtained.
- Thus depending upon the locking the sun gear with casing or carrier the overdrive or direct drive is obtained.
- There is another possible control of mechanism there is a direct drive through the free wheel clutch when engine develops the power.
- When accelerator pedal is brought to zero position and engine is idling, the output shaft will tends to override the input shaft.
- The rollers of free wheel no longer remain wedge and the vehicle freewheels.
- Thus for gear changing driver has to lift his foot off the accelerator pedal, clutch pedal not be operated.

**Q.2 Attempt any FOUR of the following :**

[16]

**Q.2(a) State the advantages of LPG and CNG operated engines.**

[4]

**Ans.: Advantages of LPG & CNG operated engines:**

1. Low cost of fuel.
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.

**Q.2(b) Define TOE-IN and TOE-OUT, state its effects and its normal range.**

[4]

- Ans.:**
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.
  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.

**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.

**Q.2(c) Explain working of Bendix drive used in starting system, with neat sketch.**

[4]

**Ans.: Bendix drive used in starting system:**

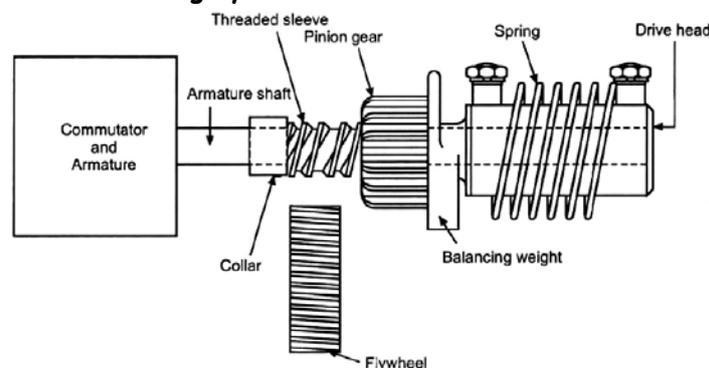


Figure: Bendix drive

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 unit it engages with the flywheel ring gear. Since the pinion cannot move further axially, it starts to rotate along with the sleeve thereby also rotating the flywheel. When the flywheel starts rotating at above 100 rpm the engine gets started. After the engine has started the pinion gear is turned by engine much faster than rotated by starting motor. This causes the pinion gear to turn back on the threaded sleeve, making it disengage with the flywheel.

**Q.2(d) Describe with neat sketch working of Rear Axle used in Truck.**

[4]

**Ans.:** Full Floating Rear Axle:

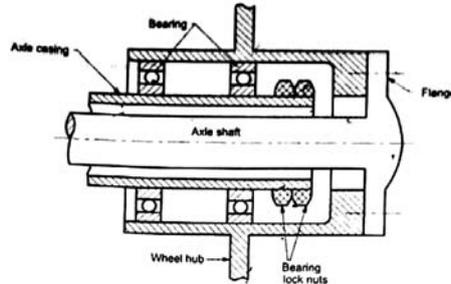


Fig. 2.16: Full floating axle

- In this type of axle two taper roller bearings are used. Bearings are placed between the axle housing and the wheel hub. Since the load of the vehicle is supported completely by the axle housing.
- The axle only transmits driving torque. The inner end is supported inside gear of differential and outer end have a flange to which wheel hub is bolted.
- The axle may be removed or replaced from the housing without disturbing the wheel by removing the nut. This type of axle is more expensive and heavier than other axle. This type is used in trucks or commercial vehicles.

**Q.2(e) State the various types of automobile bodies.**

[4]

**Ans.:** Types of automobile bodies:

- (i) Closed Cars
  - a) Saloon
  - b) Hatchback
  - c) Coupe
  - d) Limousine
- (ii) Open cars
  - a) Sports
  - b) Convertible
- (iii) Special Style
  - a) Estate Cars
  - b) Station Wagon
- (iv) Transport Vehicles
  - a) Van
  - b) Truck
  - c) Articulated Vehicle
  - d) Bus
  - e) Coach

**Other types of bodies are**

1. Tractor with articulated trailer
2. Half body Truck
3. Dump truck
4. Tanker
5. Delivery truck

Q.3 Attempt any TWO of the following :

[16]

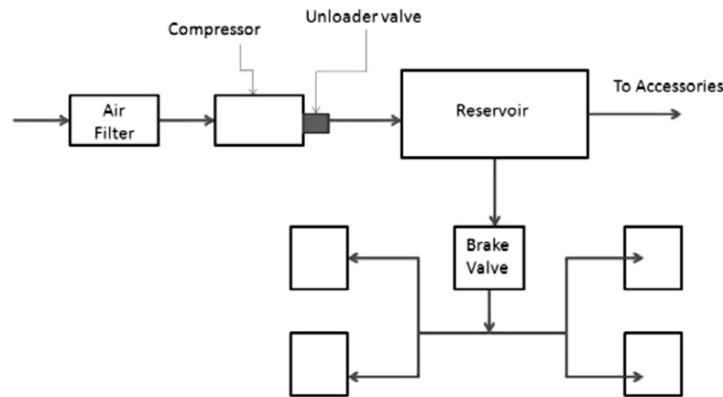
Q.3(a) Describe pneumatic braking system with neat sketch and state its advantages. [8]

Ans.: **Pneumatic braking system:** Compressor takes air from the atmosphere to the filter and the compressed air is sent to the reservoir through the unloader valve, which gets lifted at a predetermined reservoir pressure (900KPa) & relieves the compressor of load. From the reservoir the air goes to various accessories & also to the brake chambers located at each wheel.

The control of brake valve is with driver who can control the intensity of braking according to the requirements. When pressure drops to 700 KPa, the governor again cuts in the compressor to raise system pressure. When air system pressure falls to 400 KPa, a warning in the form of a buzzer is sounded.

**Advantages: (any two, 1 mark for each)**

- (1) More powerful than mechanical or hydraulic brakes, are exclusively used in heavy vehicles.
- (2) Simplifies the chassis design.
- (3) Its location & working is easy & simple.
- (4) Available compressed air also used for tyre inflation, windscreen wipers, horns & many other accessories.



Layout of Air Brake System

Q.3(b) Differentiate between Drum and Disc brake (any eight point).

[8]

Ans.:

Sr. No.	Drum brake	Disk brake
1	Consists of drum and internal expanding curved shoes.	Consists of disc and float shoes.
2	Brake pads on shoes are curved in shape.	Brake pads on shoes are of flat shape.
3	Pad wear adjusting is not automatic.	Pad wear adjustment is automatic.
4	Non-uniform pressure on curved drum surface.	Uniform pressure on disc surface.
5	Less stability.	Better stability.
6	Less cooling of brakes due to closed design.	Better cooling of brakes.
7	More braking effort required.	Less braking effort required.
8	Non-uniform wear on brake pad.	Uniform wear on brake pad.
9	More weight than disc brake.	Less weight than drum brake.
10	Takes time to replace friction pad.	Easy to replace friction pad.

Q.3(c) Explain construction and working of Wishbone type suspension system with neat sketch. [8]

Ans.: Wishbone type suspension:

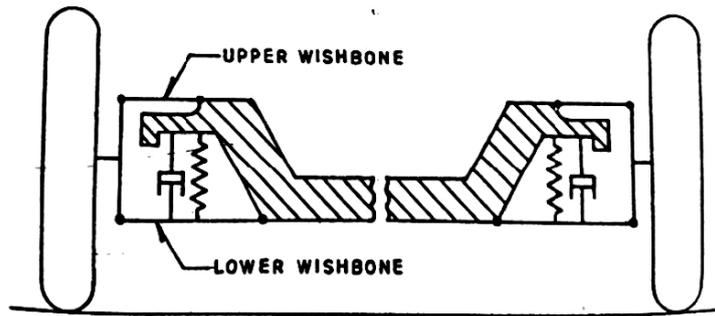


Figure: Wishbone type suspension (Schematic)

(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.

**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 come to its original position with upper arm. This type of suspension resists up and down forces that develop after bump, acceleration, braking and cornering.

Q.4(a) Attempt any THREE of the following: [12]

Q.4(a) (i) Differentiate between radial and cross ply tyres. [4]

Ans.:

Sr. No	Radial ply tyre	Cross ply tyre
1	Plies are running radially straight from bead to bead	Plies are running diagonally opposite from bead to bead
2	Stiffness of tyre is less	Stiffness of tyre is more
3	It gives ultimate comfort for speed more than 55 Km/hr.	Because of more stiffness tyre is less comfortable.
4	Steering is harder	Steering is easy
5	Tyre has firm grip with road	Tyre has lesser grip with road.
6	Radial ply tyre has more breaking grip	Cross ply tyre has less breaking grip
7	Parking of vehicle is difficult	Parking of vehicle is easy
8	It is costlier	It is cheaper than radial
9	Tread life is more	Tread life is less

Q.4(a) (ii) What is the requirement of suspension system in Automobile? [4]

- Ans.:
1. It should provide comfort.
  2. It should provide safeguard to the occupants.
  3. It should have high strain energy per unit weight.
  4. It should be of minimum weight.
  5. It should have low maintenance and low operating cost.
  6. It should have minimum tyre wear.

Q.4(a) (iii) Draw neat labelled sketch of single plate coil spring clutch of automobile. [4]

Ans.:

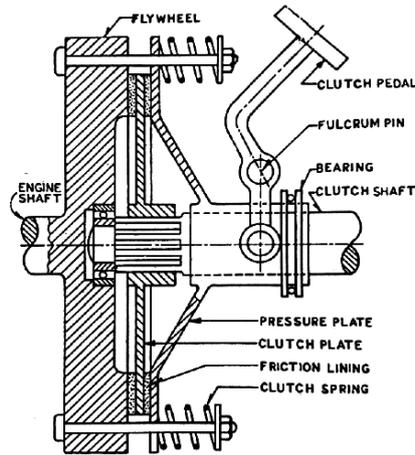


Figure: Single plate coil spring clutch

Q.4(a) (iv) Draw a layout of lighting system of four wheeler. [4]

Ans.:

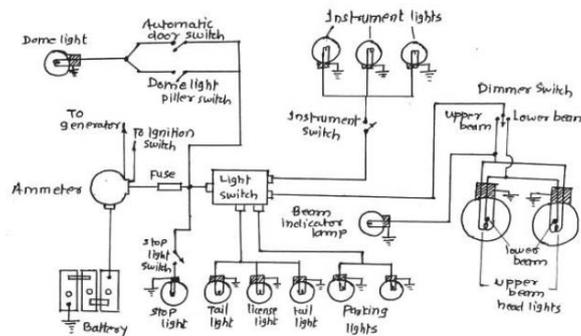


fig. Wiring Diagram of four wheeler

Q.4(b) Attempt any ONE of the following: [6]

Q.4(b) (i) State the important precautions to be taken while using air-conditioning system of a vehicle. (any four) [6]

Ans.: Important precautions to be taken while using air conditioning system of vehicle:

- Operate the air conditioner periodically or at least once a week to keep the internal parts lubricated as well as prevent the hoses from hardening.
- Do not switch ON the A.C. at high speeds which may result in the ceasing of compressor.
- Do not stick anything into the air outlet or the air inlet. As it dangerous and it can cause injury or damage.
- Avoid exposing a body directly to a continuous cool air flow for long periods- It is not good for health.
- Avoid placing any obstacles near the inlet or outlet- if inlet or outlet is blocked it may causes damage to the unit.
- Do not run or stop the unit frequently. If run or stop the unit more than 4-5 times an hour, it may cause damage to the unit.
- The air filter should be cleared at least once every two weeks
- When the unit is cleaned, set the selector switch at off position
- Never operate A.C. with heater on.
- Do not charge the refrigerant in the A.C. system before flushing.

**Q.4(b)(ii) Modern car uses R134a refrigerant instead of R-12. State [6]  
reasons thereof.**

**Ans. : Modern car uses R134 a refrigerant instead of R12. State reasons thereof**

- (i) Refrigerant R134a is a hydro fluorocarbon (HFC) that has zero potential to cause the depletion of the ozone layer and very little greenhouse effect.
- (ii) R134a is the non-flammable and non-explosive, has toxicity within limits and good chemical stability.
- (iii) It has somewhat high affinity for the moisture.
- (iv) The overall physical and thermodynamic properties of refrigerant R134a closely resemble with that of refrigerant R12.
- (v) Due to all the above factors, R134a is considered to be an excellent replacement for R12 refrigerant

**Q.5 Attempt any FOUR of the following:**

**[16]**

**Q.5(a) Compare two-wheel and four-wheel drive of vehicle.**

**[4]**

**Ans. :**

Sr. No.	Point	Two-wheel	Four-wheel
(i)	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.
(ii)	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.
(iii)	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.
(iv)	Merits, demerits (Any one)	<ul style="list-style-type: none"> <li>• Initial cost is less as compare to 4WD. Running cost is less due to lower fuel consumption.</li> <li>• Weight is concentrated only on driving wheels.</li> <li>• Aerodynamic design is possible.</li> <li>• Floor height can be reduced hence lower ground clearance can be kept.</li> <li>• It is applicable in high speed, light motor vehicles and cars.</li> </ul>	<ul style="list-style-type: none"> <li>• Higher initial cost as well as running cost because of extra fuel consumption.</li> <li>• Weight is uniformly distributed on all the wheels.</li> <li>• Aerodynamic design isn't possible.</li> <li>• Floor height cannot be reduced hence ground clearance is more.</li> <li>• It is used in heavy duty motor vehicles as well as in off road/cross country vehicles.</li> </ul>

**Q.5(b) State the necessity of wheel alignment and wheel balancing.**

[4]

**Ans.:** The necessity of wheel alignment (Any two)

- 1) To eliminate tyre wear
- 2) To give vehicle proper handling
- 3) To eliminate pull, drift, wander, stiff steering and poor steering return ability
- 4) To improve driving stability
- 5) To improve riding characteristics

The necessity of wheel balancing (Any two)

- 1) Wheel imbalance causes wheel tramp, wheel hop, makes the tier vibrate up and down
- 2) Centrifugal forces try to throw heavy areas outward when the wheel is spinning
- 3) Weight must be evenly distributed around the axis of rotation
- 4) Wheel balancing is necessary to balance the wheel and distribute the weight of wheel evenly.

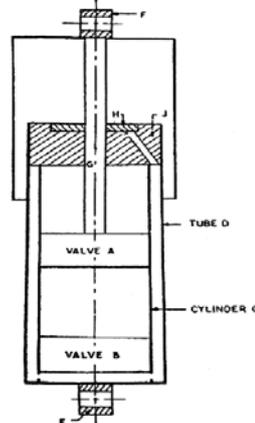
**Q.5(c) Describe telescopic shock absorber with sketch.**

[4]

**Ans.:** **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.



**Q.5(d) Explain battery capacity and rating.**

[4]

**Ans.:** **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 –

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

About  $1/10 \text{ m}^2$  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 continuously for 20 hours after which cell voltage should not drop below 1.75 and battery temperature is 80° 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° F before cell voltage drops below 1 volt.
3. 25 Ampere rating: Measures battery performance at a moderate constant current output at 80° 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°C is maintained at the start of the test.

**Q.5(e) How Automobiles are classified?**

**[4]**

**Ans.: 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
- (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

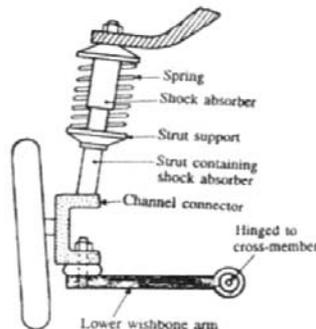
**Q.6 Attempt any TWO of the following:**

[16]

**Q.6(a) Describe construction of MacPherson suspension system. State its advantages.**

[8]

**Ans.:** Mac-pherson strut type independent suspension: 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.



**Figure: Mc-pherson strut type independent suspension**

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

The advantages of MacPherson suspension system (Any two)

- 1) System is light in weight, which reduces up-sprung weight.
- 2) Camber does not change when wheel moves up and down.
- 3) It provides maximum space for engine.

**Q.6(b) Explain with neat sketch electronic ignition system.**

[8]

**Ans.:** Electronics Ignition system is similar to conventional point type Ignition System with a small difference. Electronics Ignition system is provided with Electronic control unit which opens and close the primary circuit instead of contact breaker point as in Contact breaker point ignition system.

**Construction:** Electronics Ignition system is having two circuits Primary and Secondary circuit. Battery, primary winding, ECU and the timer forms primary circuit. Whereas secondary winding, distributor and spark plug forms secondary circuit. A timer is employed in the distributor instead of contact breaker. This timer may be Pulse generator or Hall-effect switch which Triggers the Ignition module also called as electronic control unit.

**Working:** this control unit primarily contains transistor circuit whose current is triggered off and on by timer which results in the stopping and starting of the primary circuit. The secondary circuit worked in the similar manner as in conventional contact breaker type. i.e. when the magnetic field collapses it induces current in the secondary winding having more number of turns. This results in development of very high voltage necessary to generate the spark at the spark plug.

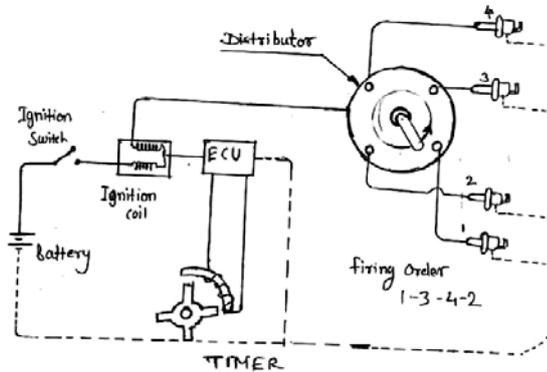


Figure- Electronic ignition system

Q.6(c) Explain construction and working of alternator, state its advantages. [8]

Ans.: Construction and working of alternator:

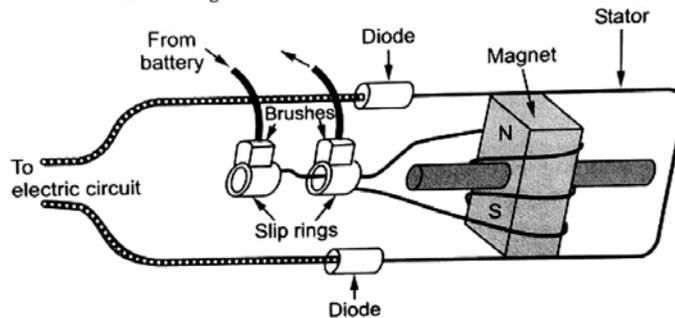


Figure: Alternator

(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 alternation 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 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 case aluminum 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 :**

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.

