LECTURE NOTES ON

VEHICLE MAINTENANCE AND MOTOR VEHICLE ACT

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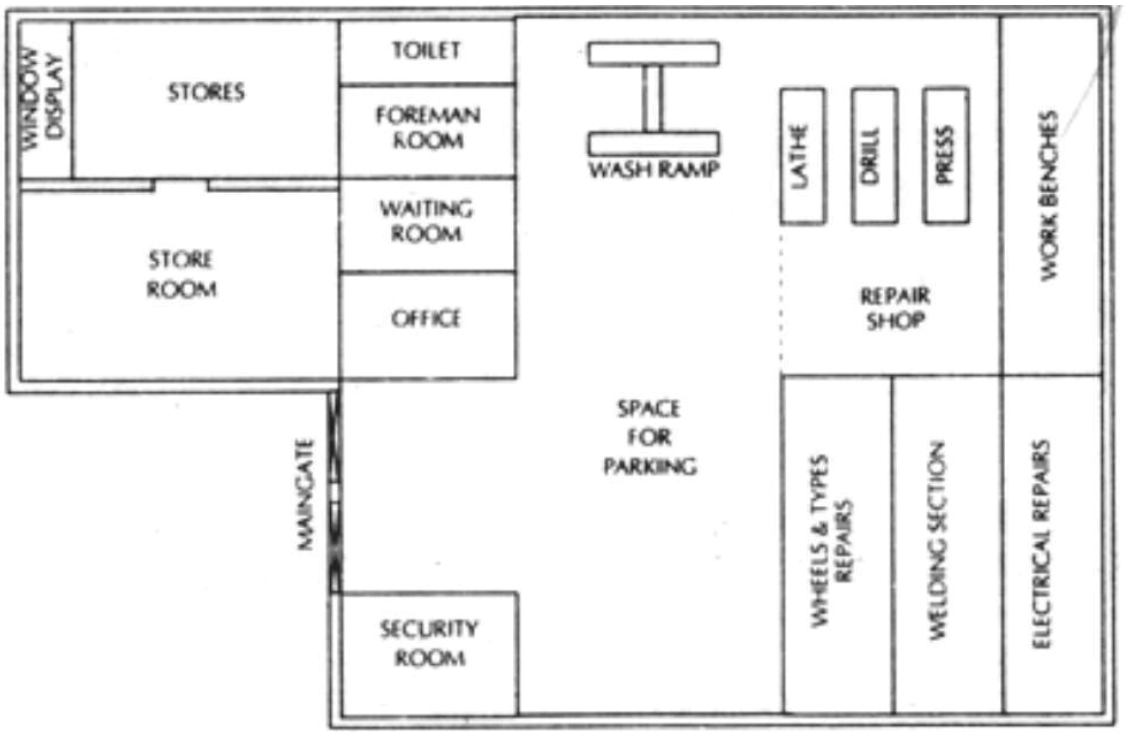
VEHICLE MAINTENANCE

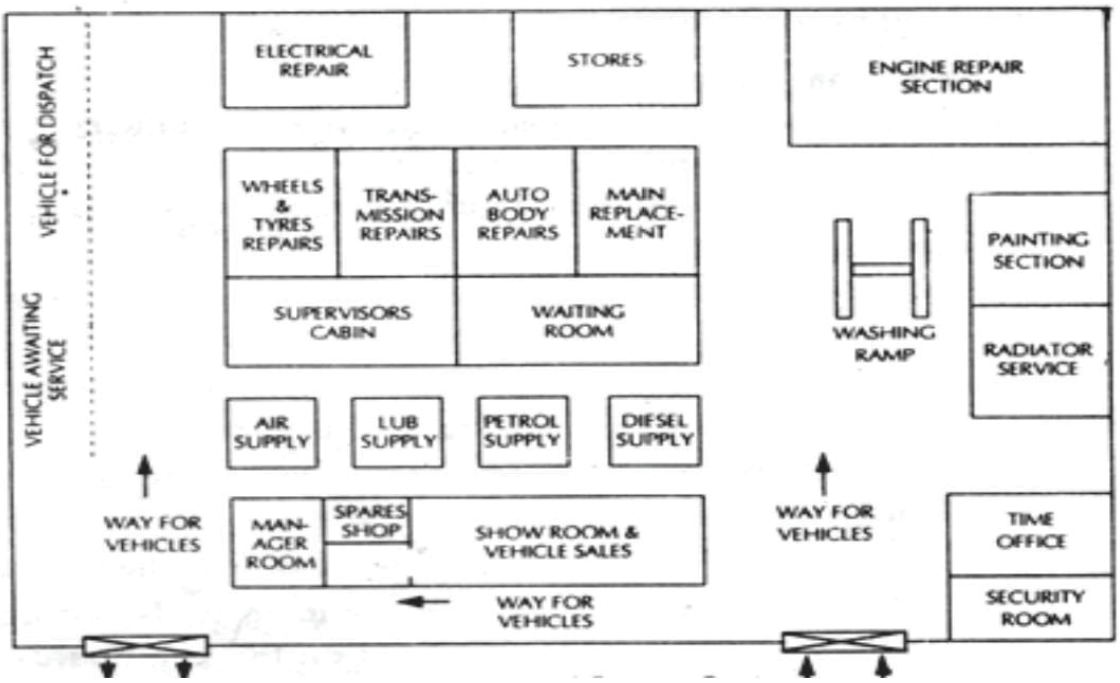
- Vehicle Maintenance means service, repair, or maintenance of any type of motor vehicle, including but not limited to: vehicle and equipment rehabilitation, mechanical repairs, painting, fueling, and lubrication.
- Regular service will keep your car in better condition for longer. It extends the life of your engine by ensuring that all the elements are functioning optimally and reducing the strain on your car's engine.
- All these elements contribute to maintaining the value of your car for a long time.
  - Improve safety on the road
  - Increase reliability
  - Reduce costs and increase fuel efficiency
  - Improve performance
  - Extend the life of your car
  - Create maintenance records
  - Increase the value of your car
  - Reduce the impact on the environment
- There are many Types of Maintenance
  - Corrective Maintenance
  - Preventative Maintenance
  - Predictive Maintenance
  - Total productive maintenance
- **Corrective maintenance** (CM) involves the replacement or repair of equipment after it fails.
- In response to equipment failure, CM tasks identify the failure (it may be an equipment component or equipment item) and rectify the failure so that the equipment can be reinstated and the facility production restored.
- **Preventive maintenance** (PM) is the regular and routine maintenance of equipment and assets in order to keep them running and prevent any costly unplanned downtime from unexpected equipment failure.
- A successful maintenance strategy requires planning and scheduling maintenance of equipment before a problem occurs.
- **Predictive maintenance**, also referred to as condition-based maintenance, involves performance monitoring and equipment condition monitoring during regular operations to reduce the chances of a breakdown.
- Manufacturers began using predictive maintenance in the nineties.
- **Total Productive Maintenance** is a holistic approach to equipment maintenance that strives to achieve perfect production: No Breakdowns. No Small Stops or Slow Running. No Defects.

SERVICE STATION

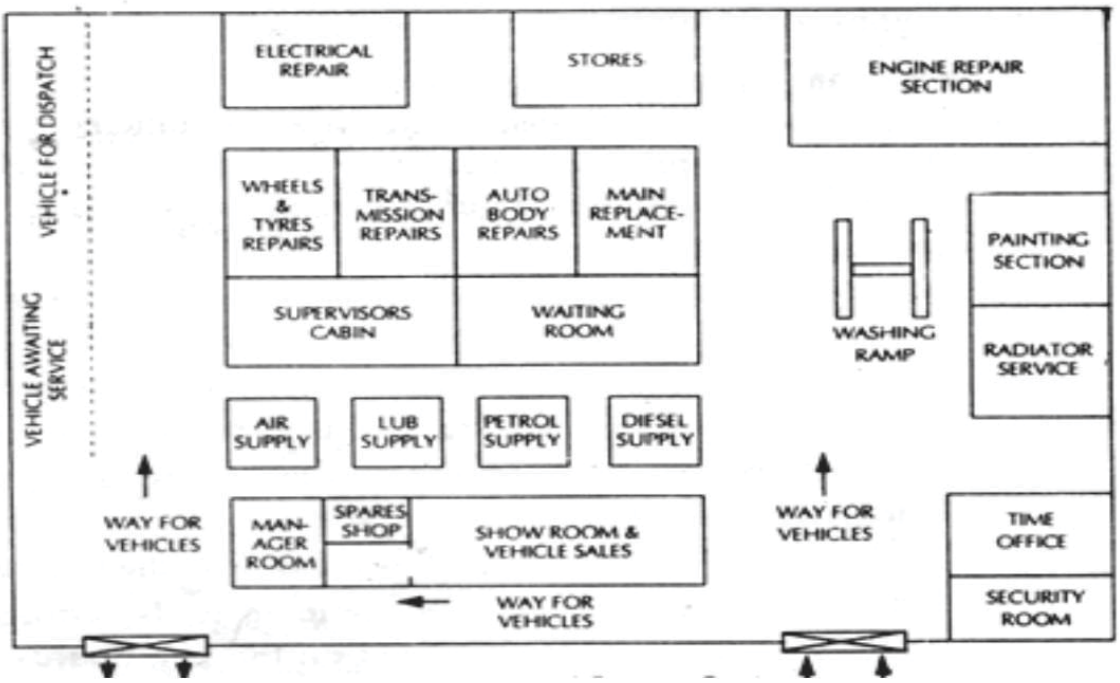
- Automobile service station means a building or structure or part thereof open to the public where motor vehicles are washed, serviced, repaired, fueled, leased, sold or displayed and may include, but are not limited to a gas bar, car wash, body shop or general or specialty repair shops
- In general it includes a number of sections like garage general it includes a number of sections like garage general service, mechanical service, major repair shop, tire shop, paint shop, body shop.
- A private service station is a place where all the vehicle can get service regardless their brand and model according to their availability.
- Authorised service station means any service station, or centre, authorised by any automobile manufacturer, to carry out any service or repair of any automobile manufactured by such manufacturer.
- Company's dealer service stations means any service station, or centre, authorised by any automobile manufacturer, to sell and marketing of any automobile manufactured by such manufacturer.



Layout of a garage



Layout of modern workshop



Layout of service station

- Records are anything containing information which is made, produced, executed, or received in connection with the transactions and official activities of the University or executed in the conduct of University business, including research, teaching, service, and administration.

- The Workshop Documentation Form is a tool accomplished by the Coordinator for Training after each workshop session. It is used to determine the effectiveness of a particular course or speaker in meeting the objectives of the workshop.
- A job card is a detailed description of work that is performed for a work order
- A job card is a detailed description of the work completed for a job. Job cards are used in many industries to provide field workers with job details and get feedback once the job is done.

TOOLS AND EQUIPMENTS

- A tool is an object that can extend an individual's ability to modify features of the surrounding environment or help them accomplish a particular task.
- Some examples of tools that are often used today are the hammer, the wrench (also called a spanner), saws, shovel, telephone, and the computer. Very basic things like knives, pens, and pencils are also tools
- Classifications of tools and equipment according to their uses:
    - Measuring tools
    - Holding tools
    - Cutting tools
    - Driving tools
    - Boring tools
    - Electrical equipment
    - Miscellaneous tools/instrument/equipment
- Double Open Ended Spanner is generally used for tightening and loosening of rotary fasteners such as nuts and bolts.

- Ring spanners will not slip and therefore, where possible, should be used to break loose a tight nut. Their offset shanks provide clearance for knuckles or obstructions alongside the nut.
- They may also be used where there is an obstruction close to the sides of a nut.

- Combination spanners are double-ended tools and serve the functions of two spanners at once. One end is an open-ended spanner and the other end is a ring spanner.
- Combination spanners work for only one size of fastener, as both the profile heads are of the same fastener size.

- Socket or box spanner often used to remove fittings that are hard to reach, such as deeply set nuts or spark plugs tucked away in a recess.
- The box spanners come with a soft tool roll to make organisation and transport easier.

- A screwdriver is a tool, manual or powered, used for turning screws. A typical simple screwdriver has a handle and a shaft, ending in a tip the user puts into the screw head before turning the handle.

- A torque wrench is a tool used to control and apply a specific torque to a fastener such as a bolt or a nut. It is a fundamental element in general mechanics, tire changing operations and industrial maintenance & repair industries, to ensure customers' safety.

- Pliers are a hand tool used to hold objects firmly, possibly developed from tongs used to handle hot metal in Bronze Age Europe.

- An Allen key or Allen wrench is also known as Hex key. This is a small handheld tool used for turning bolts and screws which have hexagonal sockets.

- Hammers are used for general carpentry, framing, nail pulling, cabinet making, assembling furniture, upholstering, finishing, riveting, bending or shaping metal, striking masonry drill and steel chisels, and so on. Hammers are designed according to the intended purpose.

- Chisel, cutting tool with a sharpened edge at the end of a metal blade, used—often by driving with a mallet or hammer—in dressing, shaping, or working a solid material such as wood, stone, or metal.

- Files are cutting tools used to remove/smooth rough and sharp edges from cut metal. They are also used to file metal to shape or size. For each type of material there is an ideal tooth form that gives the most efficient cutting action. Length.

- A hacksaw is a fine-toothed saw, originally and mainly made for cutting metal. The equivalent saw for cutting wood is usually called a bow saw.

- Wire brushes are an excellent choice for the removal of rust and oxidations, paint, slag, weld splatter and other unwanted surface contaminants with angle grinders, bench grinders or drills.

- Taps and dies are tools used to create screw threads, which is called threading.
- Many are cutting tools; others are forming tools.
- A tap is used to cut or form the female portion of the mating pair (e.g. a nut). A die is used to cut or form the male portion of the mating pair (e.g. a bolt).
- The process of cutting or forming threads using a tap is called tapping, whereas the process using a die is called threading.

- Drill bits are cutting tools used in a drill to remove material to create holes, almost always of circular cross-section. Drill bits come in many sizes and shapes and can create different kinds of holes in many different materials.

- Reamer, rotary cutting tool of cylindrical or conical shape used for enlarging and finishing to accurate dimensions holes that have been drilled, bored, or cored. A reamer cannot be used to originate a hole.

- A measuring instrument is a device to measure a physical quantity. In the physical sciences, quality assurance, and engineering, measurement is the activity of obtaining and comparing physical quantities of real-world objects and events

- A valve spring compressor apparatus and method for compressing cylinder valve springs for the removal and installation of their locks or keepers and for replacement of valve stem seals or broken springs on an internal combustion engine, while the cylinder head is mounted on the engine or supported on a work bench.

- A piston ring compressor is a compressor that features pistons fit inside of a cylinder using compression rings that seal between the piston and cylinder wall. A piston ring compressor is a

compressor that features pistons fit inside of a cylinder using compression rings that seal between the piston and cylinder wall.

- An oil filter wrench is amongst the vehicle's repair and maintenance tools. This tool is used for removing or tightening spin-on-type oil filters.

- A puller is a tool used to remove parts such as bearings, pulleys or gears from a shaft. They have legs, typically two or three which circle around the back or inside of a part and they also have a forcing screw which centres up against the end of a shaft.

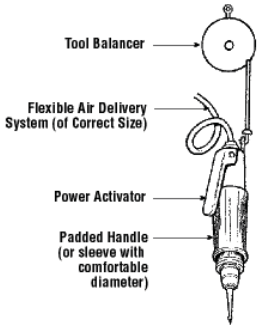
- The present invention relates to a coil spring compressor which is used in the assembly of subassemblies of automotive front or rear suspension systems, in particular, MacPherson type suspension systems.

- Tyre levers are little levers that are used for getting tyres off a wheel. A set of levers are one of the cheapest and most essential bits of cycling equipment. Everyone should carry them. Many tyres are almost impossible to get off without a set of levers

- A toolbox (also called toolkit, tool chest or workbox) is a box to organize, carry, and protect the owner's tools. They could be used for trade, a hobby or DIY, and their contents vary with the craft.

- A C-clamp or G-clamp or G-cramp is a type of clamp device typically used to hold a wood or metal workpiece, and often used in, but are not limited to, carpentry and welding.

- Pneumatic tools are powered by compressed air. Common types of these air-powered hand tools that are used in industry include buffers, nailing and stapling guns, grinders, drills, jack hammers, chipping hammers, riveting guns, sanders and wrenches.



- A drilling machine is a power tool that is used to create cylindrical holes in a workpiece. The tool bit is rotated at high speed and pressed into the workpiece to create a cylindrical hole that passes either partway (blind hole) or all the way through (through hole) the part.

- An angle grinder is a handheld power tool that can be used for a variety of metal fabrication jobs that include cutting, grinding, deburring, finishing and polishing. The most common types of angle grinder tools are powered by electricity; either corded or battery powered.

- A jack is a mechanical lifting device used to apply great forces or lift heavy loads. A mechanical jack employs a screw thread for lifting heavy equipment.

- Lubrication equipment generally comprise of Lubrication Injectors, Lubrication Pumps, Hydraulic Pumps, Oil Injectors, Lube Oil Systems, etc. The Lubrication process is of vital importance in machine's performance and working & hence a lot of prudence is taken to ensure the lubrication devices are used right.

- A tire changer is a machine used to help tire technicians dismount and mount tires with automobile wheels. After the wheel and tire assembly are removed from the automobile, the tire changer has all the components necessary to remove and replace the tire from the wheel.

- A balancer is a piece of shop equipment that helps a technician ensure the tire/wheel assembly's weight is even and balanced, so it rotates smoothly once mounted onto the vehicle. Once balance is checked and any points of imbalance established, the technician then can add wheel weights to correct any issues.

- Wheel alignment involves a mechanical adjustment of vehicle suspension to influence the direction and angle of the tyre's contact with the road surface. The optimum alignment for each make and model of vehicle is set by the manufacturer in order to influence the performance and handling.

- Brake bleeding is the procedure performed on hydraulic brake systems whereby the brake lines (the pipes and hoses containing the brake fluid) are purged of any air bubbles. This is necessary because,

while the brake fluid is an incompressible liquid, air bubbles are compressible gas and their presence in the brake system greatly reduces the hydraulic pressure that can be developed within the system. The same methods used for bleeding are also used for brake flushing or purging, where the old fluid is replaced with new fluid, which is necessary maintenance.

- High-pressure industrial air compressors intake ambient air and compress it to pressures as high as 6000 pounds per square inch (PSI) for breathing air and other applications. As the air moves through the multiple stages of compression it is cooled after each stage.

- High-pressure spray's ability to supply a high volume of pressurized water and ultra-sudsy car shampoo helps remove dirt, stuck-on debris, and other contaminants quickly and efficiently. Without this debris on the car, your paint is less likely to scratch when being brushed later in the tunnel.

- Engine analysers, also known as engine performance testers, were first developed in the 1960s to help tune and troubleshoot gasoline-fueled automotive engines. The engines of the time had manually-adjustable ignition (spark) timing, and required frequent repair, which necessitated a variety of information.

- Hydraulic presses are commonly used for forging, clinching, moulding, blanking, punching, deep drawing, and metal forming operations. Hydraulic presses are also used for stretch forming, rubber pad forming, and powder compacting.

- Spark Plug Cleaner and Tester is an instrument to completely clean and test an old used spark plug which is used in petrol, gasoline and kerosene engines. Spark Plug Cleaner is an instrument which is a necessity of a well equipped modern workshop/garage to make a used spark plug to work as a brand new one.

- Injector Cleaner & Tester can perform cleaning and testing of all types of top feed and side feed multipoint, mono/single point fuel injectors for all types of MPFI vehicles. Our Injector Cleaner & Tester is based on advanced and cost effective technology.

- A battery tester is an electronic device intended for testing the state of an electric battery, going from a simple device for testing the charge actually present in the cells and/or its voltage output, to a more comprehensive testing of the battery's condition, namely its capacity for accumulating charge and any possible flaws affecting the battery's performance and security.

SERVICE, REPAIR AND OVERHAUL

Troubles, Causes and Remedies In Engine:

Complaint	Possible causes	Remedy
Poor starting	**Starter will not run:**	
	1. Main fuse is blown off.	Replace.
	2. Contact is not closing in main switch or this switch is open circuited.	Repair or replace Recharge
	3. Run-down battery.	Repair or replace Clean and
	4. Defective starting relay.	Retighten Replace
	5. Loose terminal connection on the battery.	Retighten
	6. Defective brushes in starter.	Repair or replace
	7. Loose battery cord connections.	
	8. Open in field or armature circuit of starter	
	No Sparking:	
	1. Defective spark plug.	Adjust the gap or replace.
	2. Short circuit (grounded) fault in high tension cords.	Repair or replace defective cords. Replace.
	3. Cracked rotor or cap in distributor.	Replace.
	4. Burnt breaker contact points.	Adjust as prescribed
	5. Breaker contact gap out of adjustment.	Replace.
	6. Defective condenser.	Replace.
	7. Contact is not closing positively in main switch or this switch is open circuited.	Set right or replace Adjust as prescribed Replace.
	8. Loose or blown fuse.	
	9. Ignition timing out of adjustment.	
	10. Defective ignition coil.	
	Faulty intake and exhaust systems:	
	1. Carburetor needs readjustment	Adjust as prescribed.
	2. Fuel pump is not discharging adequately.	Replace.

	3. Clogged fuel filter. 4. Defective choke mechanism. 5. Loose intake manifold. 6. Carburetor is dirty and clogged. 7. Float level out of adjustment. 8. Clogged fuel hose. 9. Not enough fuel in the tank. 10. Clogged exhaust ports.	Clean or replace Repair or replace Retighten Disassemble and clean Adjust as prescribed Clean or replace Refill Clean
	Abnormal internal condition in engine: **1.** Ruptured cylinder head gasket. **2.** Valve clearance out of adjustment **3.** Weakened or broken valve spring. **4.** Loose manifold, permitting air to be drawn in. **5.** Worn pistons, rings or cylinders **6.** Broken valve timing belt. **7.** Poor valve seating. **8.** Wrong kind of engine oil. **9.** Burnt valves.	 Replace. Adjust as prescribed Replace. Retighten and as necessary, replace the gasket. Replace worn rings and pistons and as necessary re bore. Replace. Repair or replace Replace. Replace.
Not enough power.	**Inadequate compression:** 1. Valve clearance out of adjustment. 2. Valves not seating tight. 3. Valve stems tending to seize. 4. Broken or weakened valve spring. 5. Piston rings seized in grooves or broken. 6. Worn pistons, rings or cylinders. 7. Leaky cylinder head gasket.	 Adjust as prescribed Repair Replace. Replace. Replace. Replace worn parts and as necessary, re bore Replace. Adjust as prescribed Adjust the gap or replace Adjust or replace Replace Replace

	Improperly timed ignition: 1. Ignition timing out of adjustment. 2. Defective spark plug. 3. Breaker point gap out of adjustment. 4. Leaky high tension cords for some cylinders. 5. Distributor governor is not working correctly.	
	Fuel system out of order 1. Clogged carburetor 2. Defective fuel pump 3. Clogged fuel filter 4. Choke wire working erratically. 5. Float level out of adjustment. 6. Clogged fuel pipe. 7. Clogged fuel tank outlet. 8. Loose joint in fuel system.	Disassemble and clean Repair or replace Replace Adjust Adjust Clean or replace Clean Retighten
	Abnormal condition in air intake system: 1. Air cleaner dirty and clogged. 2. Poor returning motion of choke valve.	Clean or replace Repair, adjust or replace
	Clogged exhaust system: 1 Muffler is clogged with carbon.	Clean
	Overheating tendency of engine: 1. (Refer to the section entitled —over heating)	
	Others: 1. Dragging brakes 2. Slipping clutch	Adjust as prescribed Adjust or replace
Sudden drop of speed in high speed cruise	**Abnormal condition in electrical systems:** 1. Breaker contact point gap too large.\ 2. Spark plug gap too large. 3. Cracked rotor cap in distributor, resulting in leakage. 4. Defective condenser.\	Adjust as prescribed Adjust as prescribed Replace Replace Replace Replace Adjust as prescribed

	5. Deteriorated ignition coil or crack resulting in leakage. 6. Leaky high tension cords. 7. Ignition timing out of adjustment.	
	Abnormal condition in fuel system: 1. Float level set too low. 2. Clogged condition of main, jet circuit in carburetor. 3. Inadequately discharging fuel pump.	Adjust as prescribed Clean. Replace
	Abnormal condition in engine: 1. Loss of compression pressure due to leaky cylinder head gasket. 2. Compression pressure too low because of worn pistons, rings, cylinders or burnt valves.	Replace. Replace and as necessary, re bore
Engine not responding quickly to pedal control in picking up speed.	**Abnormal condition in electrical system:** 1. Ignition timing out of adjustment. 2. Defective spark plug or plug gap out of adjustment. 3. Leaky high tension cords for some cylinders. 4. Breaker contact points out of adjustment or defective. 5. Defective condenser.	Adjust as prescribed Replace or adjust as prescribed. Replace Adjust replace Replace.
	Abnormal condition in fuel system: 1. Float level too low or too high 2. Clogged jets in carburetor. 3. Air cleaner is dirty and clogged	Adjust as prescribed Clean Clean or replace
	Abnormal condition in engine: 1. Exhaust ports dirty with carbon.	Clean Clean

	2. Muffler clogged with carbon. 3. Compression pressure too low 4. Poorly seating valves. 5. Valve clearance out of adjustment 6. Pistons tending to seize. 7. Bearing tending to seize.	Replace worn running Parts or re bore Repair Adjust as prescribed Replace and as necessary, re bore Replace
Erratic idling	**Abnormal condition in Ignition system:** 1. Ignition timing out of adjustment. 2. Defective spark plug or plug gap too large 3. Cracked cap in distributor, there being leakage inside. 4. Leaky high tension cords. 5. Cracked rotor in distributor, there being leakage inside.	 Adjust as prescribed Replace or adjust. Replace Replace Replace
	Abnormal condition in fuel system: 1. Carburetor idling adjustment is disturbed. 2. Clogged pilot jet in carburetor. 3. Float level out of adjustment. 4. Air cleaner is dirty and clogged. 5. Air is being sucked in due to loose joints or broken parts. 6. Broken carburetor packings.	 Adjust as prescribed Clean Adjust as prescribed Clean or replace. Retighten or replace Replace.
	Abnormal condition in engine: 1. Exhaust ports clogged with carbon.\ 2. Valve clearance out of adjustment. 3. Poorly seating valves.	 Clean Adjust as prescribed Repair Replace.

	4. Blown cylinder head gasket.	
Abnormal detonation	**Abnormal condition in ignition system:** 1. Spark plugs are tending to overheat. 2. Ignition timing out of adjustment. 3. Defective breaker contact point. 4. Loose connection in high tension or low tension circuit.	 Change plug heat value. Adjust as prescribed Replace Retighten
	Abnormal condition in fuel system: 1. Air-fuel mixture too lean. 2. Carburetor is dirty inside. 3. Float level out of adjustment. 4. Water inside carburetor 5. Air is leaking in through inlet manifold joint.	 Clean and adjust Clean Adjust as prescribed Clean Retighten
	Abnormal condition in engine: 1. Excessive carbon deposit on piston crowns or cylinder head. 2. Blown cylinder head gasket, resulting in low compression pressure. 3. Valve clearance out of adjustment 4. Valves tending to size. 5. Weakened valve springs.	 Clean Replace Adjust as prescribed Replace Replace.

Troubles, Causes and Remedies In Fuel System:

Troubles	Causes	Remedies
High fuel consumption	Air cleaner may be chocked Fuel may be leaking Wrong idle adjustment	Clean Inspect the plug and the leak

		Adjust
Difficult starting	Carburetor jet may be clogged Fuel filter clogged Fuel pump pressure not constant	Service carburetor Clean the filter Check the pressure and rectify the defect
Poor acceleration	Fuel line clogged Fuel filter clogged	Check the fuel line Clean the filter
Lack of power	Incorrect carburetor setting Faulty inlet manifold	Adjust Replace

II. Diesel Fuel System

Troubles	Causes	Remedies
Engine cranks normally but will not start	Incorrect or dirty fuel No fuel to nozzle or injection pump Plugged fuel return	Flush system use Correct fuel Check for fuel to nozzles
Rough idle with abnormal noise and smoke	Injection pump timing off Nozzle trouble	Check return, clean retime Check in sequence
Idle correct, but misfires as throttle opens	Plugged fuel filter Injection-pump timing off\Incorrect or dirty fuel	Replace filter Retime Flush system use correct fuel
Combustion noise with excessive black smoke	Timing off Injection-pump trouble Nozzle sticking open Internal engine problems	Reset Replace the pump Clean or replace

Troubles, Causes and Remedies In Cooling System:

Troubles	**Causes**	**Remedies**
Loss of liquids coolant due to leaks.	1) External leak (2) Internal leak caused by a faulty gasket, loose cylinder head, cracked or wrapped head or, cracked engine block, which may allow some coolant to drain into the engine oil.	It can be noted by inspection and block the leak. Proper fit gasket must be placed and the cylinder head and engine block required to be repaired.
Over heating	Insufficient quantity of water in the cooling system, coolant loss. It also caused by the clogged radiator and water passages, in operative thermostat, too low engine	Check the water, coolant level and top up if required. Clean the passages and remove blockages if any present.

	oil level, clogged exhaust system etc.	
Over cooling (if it is running below the normal operating range)	(1) A thermostat that opens too soon or, remains open at all times. (2) The coolant by pass valve remaining open.	Remove the thermostat, test for its faults and then replace it.
Incorrect temperature Gauge reading.	1) Temperature gauge fitted on the instrument panel may be faulty.	It should be either replaced or correct.
Noise	(1) Dry bearing a loose pulley on the pump shaft an impeller loose on the shaft.	Some pumps require the addition of a special water-pump lubricant to the coolant by which the operation become noise less.
Frozen coolant	1) When the vehicle is parked where the temperature is below freezing point.	Check the cooling system for possible change by the frozen coolant before operation vehicle.

Troubles, Causes and Remedies In Lubrication System:

Troubles	Troubles	Remedies
High oil consumption (oil added frequently)	(1) External oil leakage out of the engine. (2) Internal leakage of oil into the combustion chamber(blue smoke in exhaust)	Replace the gaskets or, seals. Replace the badly worned piston rings and cylinders.
Low oil pressure (Gauge reads low, indicator light glows or, abnormal engine noises)	(1) Low oil level. (2) Worn connecting rod or, main bearings (Pump can not provide enough oil volume) (3) Weak or, broken pressure relief valve spring (valve opening too easily) (4) Thin or diluted oil (low viscosity oil, fuel in the oil) (5) Cracked or loose pump pick up tube (air being pulled into the oil pump) (6) Worn oil pump (excess	Top up oil Replace connecting rod or main bearings Replace relief valve Use proper specified oil Change the tube Change oil pump Clean the pump

	clearance between rotor or gears and hosing. (7) Clogged oil pick up screen (reduce amount of oil entering pump)	
High oil pressure	(1) Pressure relief valve struck open (not opening at specified pressure. (2) High relief valve spring tension (strong spring or spring has been improperly shimmers) (3) High oil viscosity (excessively thick oil or, use of oil additive that increases viscosity)	Clean the pressure relief valve Change the spring Use proper specified oil

Troubles, Causes and Remedies In MPFI Engine:

Troubles	Troubles	Remedies
Misfiring Engine	A clogged or, dirty fuel injector. An injector that won't open.	Clean the fuel injector. Replace it be injector.
Uneven power in engine	A dirty fuel injector	Clean the fuel injector.
Diminished fuel economy	Leakage present in fuel injection.	Block the leakage or, replace the fuel injector.
Inconsistent Engine idling	Dirty fuel injector	Clean the fuel injector

Checking and Servicing of Following Engine Components:

Cylinder head:

Checking cylinder heads for cracks:

Cracks in the cylinder-heads are hard to find by visual inspection. They often occur in or around the combustion chamber and the valve port areas. Often, cracks can only be located by special crack-detection methods. There are two methods used in automotive workshops-one uses magnetism and the other user's dye.

Magnetic method:

The magnetic method of crack detection is suitable for all of ferrous metals that is used on cast iron cylinder heads. The detector magnetizes the area being tested and, if a crack exists, one

side of the crack will become a north magnetic pole and other side a south magnetic pole. Metal powder or metallic fluid is applied to the area. The fine particles of the metal will be attracted to the poles and will form a line that follows the crack, making it visible as a fine grey line.

Dye penetrant method:

- The dye penetrant method is suitable for most materials, including nonferrous metals, that is can be used for both Aluminum alloy and cast iron Cylinder-heads. It can be used around the valve ports where magnetic attraction is difficult.
- The suspected area of the part is cleaned with a special solvent to remove all the dirt, Grease and this also cleans any cracks. A red dye penetrant is then sprayed over the surface and this penetrates any cracks.
- After allowing the dye penetrant, the surplus dye is removed and a developer is sprayed over the area any cracks will then be seen as fine red lines

Installing Cylinder-Heads:

- Installing a Cylinder-head is, generally, the reverse procedure to removal. Following are related points:
- Before installing Cylinder-head, the surfaces of both the Cylinder-head and cylinder-block must be clean. The bolts and threads into cylinder-block must alsobe clean.
- A new Cylinder-head gasket must be used. The gaskets are ready and sealer is not usually used. Aligning studs can be installed in two diagonally opposite holesto keep the gasket in place.
- Cylinder-one bolts must be tightened in the correct sequence and the correct torque. Incorrect tightening can cause head and block distortion, gasket leakageor bolt failure.

Cylinder Block:

- The cylinder block is typically made up of several cylinders, according to the type and size of the engine. The outer section is solid metal and seals off everything inside of it. It is the engine‘s central frame that houses the main parts that help vehicles operating on internal combustion continue to run. In older vehicles, it was made from a cast iron metal construction. Automobile manufacturers mainly install cylinder blocks made from aluminum

alloy.

- Cracks are the most common issues found within engine blocks. These can be caused by heat, frozen coolant, and stress levels that exceed the block's strength level. When coolant freezes, it can cause cracks to the outer surface near the core plugs of the block. Often, cracks in the cylinder bores, lifter valley, and near the main-bearing webs are the result of too much stress.

- Whether the engine ran without coolant or if a water pump has failed, the expansion and flexing can result in a crack or series of cracks. Other problems include stripped threaded holes, blockages, and blown cylinder head gasket. A hose might even have holes in it, leaking water under the engine. Many problems can be seen by the naked eye.

- However, it's critical to have a professional check it out with specialized equipment to rule the possibilities out. Flexible automotive bore scopes can be used for nondestructive, visual inspections of the cylinder block and other hard to see places without having to dismantle the entire vehicle.

- Automotive technicians frequently use automotive borescopes to check the molding and interior sections, which reduces the likelihood of a defective engine. These medical grade optics tools contain an articulating camera situated on the tip of a slender probe.

Cylinder Liners:

When doing the liner inspection, following points should be checked:

- Cracks on the surface and near scavenge port openings.
- Sharp edgy surface of scavenge ports.
- Ridge formation at TDC position.
- Mechanical friction wear marks and abrasive wear on the liner surface.
- Dark areas of liner surface - Acidic and cold corrosion.
- Scuffing and scoring marks of liner surface.
- Clover leafing-corrosive wear between the lubricator ports if he cylinder oil cannot neutralize the acid products of combustion.
- Cracks and damage at lubrication openings.
- Glazing of liner surface (mirror finish)
- Flow of oil from lubrication ports.
- Linear calibration to check the linear ovality and wear.

- Cylinder liner has to be gauged at regular intervals as specified in the maintenance manual. The records of gauging are kept for each cylinder and wear rate is calculated.

- The liner has to be cleaned and inspected before the gauging. Generally while taking the measurements, the temperature of the liner and micrometer should be same.
- If the temperature exceeds then that of the liner or vice versa, then the readings have to be corrected by multiplying the value with the correction factor and deducting the value obtained from the readings taken. The reading obtained at the end will be the correct reading.

PISTON AND RINGS:

After removing the piston and rod assembly from the engine, separate the piston and rod.Then remove the rings from the piston by a special ring tool. Remove the carbon fromthe piston surfaces and clean the ring grooves with a clean out tool. Also, clean the oil ring slots or holes. Inspect carefully the piston for worn, scuffed or scored skirts; and for cracks at the ring lands, skirts, ring bosses and heads. Check the piston pin bushings for wear. Also, check fit of piston rings in grooves.

Check the diameter of the piston by taking measurements perpendicular to the piston pin bore at the sizing point and parallel to the piston pin bore. Compare the sizing point reading with the measurement of the cylinder diameter. If the cylinder wall is excessively worn, it will require refinishing, which means that an oversize piston will be required. As a rule, engine manufacturers supply oversize pistons of the same weight as the standard pistons.

Piston rings are to be checked for tension, scratches and wear. Sometimes, all that is required is to free up the rings in the ring grooves by cleaning out carbon. New rings are to be installed depending upon the condition of the cylinder walls. If the walls have sometaper but not enough for re boring, special *severe* or *drastic rings* should be used. These rings have greater tension and more flexible. This enables them to expand and contractas they move up and down in the cylinder.

The pistons of some engines have an extra piston groove cut at the lower end. When walls wear tapered, an extra oil control ring can be fitted into this groove to improve oil control.

Piston rings must be fitted to the cylinder and the ring grooves in the piston. The ring should be first pushed down into the cylinder with a piston; and the ring gap should be checked with a feeler gauge. If the ring gap is correct, the outside surface of the ring should be inserted into the proper ring groove in the piston and the ring rolled around in the groove to make sure that

the ring has a free fit around the entire piston circumference. After the rings are installed in the grooves, fit should again be tested.This test is made by inserting a feeler gauge between the rings and the side of the groove.

To install the piston in the cylinder, compress as the rings in their grooves so that they will enter the cylinder. It is done by a piston ring compressor. The compressor clamps around the rings, compressing them into the groove so that the piston can be pushed into the cylinder. Care should be taken to install the piston facing in the right direction. Many pistons have a notch or other marking that must face to the front of the engine

Crankshaft:

The crankshaft is one of the most highly stressed engine components. The stress increases four times as the engine speed doubles. The crankshaft is rejected if there isany sign of a crack, because a cracked crankshaft may break if continues in service. Crankshaft cracks in high production passenger car engines can be detected with a close visual inspection. High-rpm racing crankshafts should be checked with Magna flux to detect any minute crack that may lead to failure.

A crankshaft-bearing journal:

Bearing journal scoring, one of the most common crankshaft defects appears as scratches around the journal circumference, generally near the center of the journal. Dirt and grit carried in the oil enter between the journal and bearing. If these particles are large enough to get through the oil clearance, they partially embed in the bearing and scratch the journal. Dirt can also be left on the journal during assembly. The most important factor for the maximum journal life is the continuous supply of clean lubricating oil

Crankshaft journals can have nicks or pits in them. Nicks are formed by carelessness when the journal is bumped with another part while exposed or while being assembled. Pits can be caused by corrosion.

A bent crankshaft can be detected by a dial gauge by supporting the end main bearing journals in V-blocks. A dial gauge installed on the middle-bearing journal shows run-out as the crankshaft is turned. In the absence of V-blocks, the crankshaft can be supported by the two upper half end bearings in the block and the other bearing shells are removed. A dial gauge is used in the same manner to indicate the shaft bend or run-out.

Journals wear out-of-round and become tapered. Out-of-round and taper are measured using micrometer by taking measurements at a number of different locations on each journal. Rough journals and slight bends can be rectified by grinding the journals on true centers. Forged shafts with excess bend should be straightened before grinding.

Connecting rod:

Connecting Rod Side Clearance Measurement

The side clearance of the connecting rod is measured with a feeler gauge. If the side clearance exceeds the manufacturer‘s specifications, the journal width should be measured to find out the cause of the excessive clearance. The Plastigage method of measurement can be used and the procedure is the similar to the measurement of connecting rod bearing clearance.

Connecting rod reconditioning involves the following two steps:

- Reduce the rod bore size to slightly below its standard size.
- Remove just enough material from the rod bore to bring it back to the original standard size.

Connecting rod reconditioning restores the bore to its original shape with the specifiedaccuracy of roughness, straightness, surface finish, ad bore size.

Precision grinding of the rod and cap at the parting lines reduces the rod bore slightly.The micrometer dial control on the rod-and –cap grinder is used to accurately control metal removal. Equal amounts of metal are removed from both sides of the parting surfaces. The amount of metal removed from the cap and the rod is usually about 0.0508 mm. The grinding operation does not increase the center-to-center distance between the rod pin hold and the bore, and also it does not cause interference between the top of the piston and the valves.

Once the grinding operation is over, the cap should be assembled on the rod and the boltsare torqued to the specified values holding the rod is an assembly fixture. The rod bore ishoned back to its original size on a precision honing machine, which automatically centers the rod bore. The honing machine only removes metal from the smaller diameter of the bore, so that very little or no metal is removed in the parting line area.

Connecting Rod Alignment:

Connecting rod alignment is checked by a rod aligner. Rod alignment may be checked with the piston assembled to the connecting rod. When the connecting rod installed on the aligner, the

aligner V-block edges should make complete contact with the aligner precision ground surface as the piston is moved back and forth. If the rod is bent or twisted, the V-block edges do not make complete contact with the prevision ground surface. A slightly bent or twisted rod can be straightened with the bending bar supplied with the aligner.

Valves:

Valve service includes the following functions:

1. Adjusting valve-tappet clearances (called adjusting valve lash).
2. Grinding valves and valve seats.
3. Installing new set inserts.
4. Cleaning or replacing guides.
5. Timing the valve.
6. Servicing the camshaft bearing.
7. Checking valve springs.
8. Turning the engine.

- The valve-tappet clearance is measured by a feeler gauge. A two-step ‑go, no-go‖ feeler gauge of the specified thickness can be used. If the go‘ step fits the clearance, the adjustment is correct. If it is not correct, turn the adjusting screw in or out as necessary tocorrect it. On some engines, the measurement is made with the engine cold and not running. The engine is turned over until the valve lifter is on the low point of the cam; and the clearance is then checked. On others, the engine is warmed up on idling.

- Valves and valve seats are ground to correct size and shape so that the valve may seat properly on the seat. For effective valve seating and sealing, the valve face must be concentric with the valve stem; and the valve guide must be concentric with the valve face. Also, the valve face angle must match the valve seat angle.

- The valve seat insert is replaced if it is badly worn, or has been ground down previously so that there is no sufficient metal for another grind.

- Check the valve guides for wear. Clean, replace or ream for large guides as necessary. A wire brush or adjustable blade cleaner can be used to clean the guide. If the guide is worn, it should be replaced.

- The timing gears or sprocket and chain are marked to establish the proper positions and correct valve timing. Some engines have another marking system for checking valve timing. This marking is on the flywheel or vibration damper, near the ignition timing markings.

- Valve springs are tested for proper tension and for squareness. Spring tension is tested by special fixture. The pressure required to compress the spring to the proper length is measured in this test.

- For testing the squareness of the spring, stand the spring, closed coil end down, next to a surface plate. It should be rotated to see if the top coil moves away from the square more than 2 mm. If the spring is more than 2 mm out of square, of if it does not have the proper tension at the specified length, it should be replaced.

Servicing Valves

After removing the valve from the engine, clean the carbon deposits from it with a wire brush or buffing wheel. Valve stem should be cleaned with a fine abrasive cloth. To do this, clamp the valve in the soft jaws of a vise, wrap the abrasive cloth around the stem and pull it back and forth. This can also bed one on a lathe. Rotate the valve in a lathe, hold the abrasive cloth wrapped partly around the stem. While cleaning the valve examine it. If it is badly fitted, cracked, burned, worn or bent, replace it. After the valveis cleaned, inspect the specific parts of the valve, as shown in.

Tuning Of Engine:

Definition of tune up: Tune-up is the process of making checks and minor adjustmentsto improve the operation of the engine.Tune up is also preventive maintenance. Troubles can be caught early and prevented bychecking out the engine before it actually fails

Tune-up procedure

The tune-up procedure restores drivability, power, performance and economy that have been lost through wear, corrosion and deterioration of engine parts. These changes take place gradually in many parts during normal car operation. A typical tuning procedure is given below.

- Air intake and exhaust system
  - (i) Clean out pre cleaner
  - (ii) Remove and clean air cleaner
  - (iii) Swab out inlet pipe in air cleaner body
  - (iv) Inspect exhaust system and muffler
  - (v) Check crankcase ventilating system for restrictions.
- Basic engine
  - (i) Recheck air intake for restrictions.
  - (ii) Check radiator for air bubbles or oil indicating compression or oil leaks.
  - (iii) Cylinder head gasket leakage.
  - (iv) Retighten cylinder head cap scre
  - (v) Adjust valve clearance.
  - (vi) Check compression pressure in each cylinder.

Tuning procedure:

A typical tuning or tune up procedure is given below, whichincludes visual and mechanical checks and also checks with instruments. Some of the checks are not related to the engine but should be done for the safety purpose.

1. Loose spark plugs, start engine to blowout carbon and dirt, shut off engine and remove plugs.
2. Test engine compression.
3. If the compression ratio is not up to specifications, perform engine services that will eliminate the trouble. If the compression is all right, re-install the spark plugs.
4. Remove distributor cap, clean it, and visually check it for carbon tracks, chips and corroded terminals. Replace it if it is not in good condition.
5. Clean and inspect rotor and replace it if it is not in good condition.
6. Inspect the high tension leads, and if they have cracked, or frayed insulation or wires or damaged, replace them.
7. Check distributor centrifugal advance.
8. Test the vacuum advance.
9. Check distributor contact points and clean them. Read just the point opening.
10. Re-install distributor cap and replace wiring.
11. Check battery state of change, water and hold down clamps.
12. Check battery cables for damage, corrosion and loose connections and make necessary corrections.
13. If the battery has been overcharged or undercharged, check the alternator and

regulator

14. Check drive belts and tighten or replace them as required.
15. Check the condition of the manifold heat control valve, making sure that it is free to operate.
16. Check the intake manifold bolts for tightness to proper specifications. Even aslight leak will reduce engine performance.
17. Check fuel lines for tight connections and kinks, beads or leaks.
18. Check the cooling system for leaks, weak or collapsed hoses, correct coolantlevel and anti-freeze protection.
19. Check and adjust the accelerator linkage, if necessary.
20. Check crankcase ventilation system.
21. Check intake manifold and air injection system.
22. Remove carburetor, air cleaner, and check choke valve to make sure -Choke is working normally‖. Clean or replace air filter element, if necessary.
23. Check and adjust contact point dwell and ignition timing.
24. Adjust idle speed and mixture to specifications.
25. Check the doorjamb sticker to see if lubrication is required.
26. Check the working of lights and horn. Check headlight adjustment.
27. Check steering system for looseness and ease of action.
28. Check suspension system and shock absorbers for looseness, excessive play andwear.
29. Check front wheels and ball joints for excessive wear or loose bearings.
30. Other tests that can be done included cylinder balance test to find a weakcylinder, cranking motor operation, conditions of ignition coil and condenser, tightness of mounting bolts, oil level in the engine, air pressure in tires, condition of tires and efficiency of the brakes.

Fuel Feed System:

1. Check fuel lines for leaks or restrictions.
2. Clean fuel pump sediments bowl
3. Test fuel pump pressure
4. Clean and check carburetor
5. Service diesel fuel filters
6. Check diesel injection pump
7. Check and clean injector
8. Bleed diesel fuel system
9. Check diesel injection pump timing.

Carburetor:

Carburetor is the most important item in the fuel feed system of spark ignition engines. Itis connected between the fuel filter and the induction manifold. It supplies the air-fuel mixture of varying proportions to suit engine operating conditions. The fuel enters the float chamber of the carburetor. The air enters the air horn of the carburetor. Mixing of the fuel and air take place when both pass through the venture in the mixing chamber of the carburetor. This air-fuel mixture then goes to the intake manifold.

Maintenance of Carburetor:

The carburetor should be cleaned time to time in order to avoid blocking of the jests and passages. For this purpose, it is preferable to use compressed air. Never use wire for cleaning the jets. Also check periodically for tightness of flange securing nuts, starter fixing screws, main jet, starter jet and pilot jet. Make sure that there is no side play in the throttle spindle.

Service Points:

Make sure that:

1. Gasket between the fixing flanges is not damaged.
2. Spraying nozzle is not pulled out, it is press fitted
3. Float toggle is not in an inverted position.
4. Pilot air bleed is not blocked.
5. The float is not damaged.
6. Volume control screw taper is not damaged.
7. The petrol level is not changed.
8. Jets and passages are not leaking, sticking or worn.
9. Needle valve is not leaking, sticking or worn.
10. Float chamber vent is not blocked.
11. Acceleration pump diaphragm is not porous or assembled incorrectly.
12. The loose glass ball positioned under the pump injector is not sticking or lost.
13. Injector tube is not pulled out of the injector assembly.
14. Injector is blocked.
15. Pilot jet seating fully.
16. All jets and needle valve are screwed tightly.
17. All gaskets and washers are placed properly. They are not leaking.
18. Filter is cleaned properly every 800 km.
19. Acceleration pump is adjusted and cleaned.
20. Gaskets are changed while opening the carbure

Nozzle Cleaning:

Remove the injector from the cylinder and clean the carbon deposits, if any, by washing them thoroughly in petrol. Remove the nozzle and dip it in the clean fuel of and the nozzle needle too. After cleaning the needle, insert into the nozzle body.

Note: Nozzle needle and body are lapped together and must not be exchanged

Initial Test:

Visual test (Only on used nozzle):

- After cleaning, used nozzle should bevisually inspected.
- Look on nozzle needle for damaged or rough needle seat, for worn or damaged orcarboned seat and for out of round of needle hole.

1. **Slide test:** After visual test all nozzle should be given slides test.

Fist dip the nozzle needle in clean fuel oil and insert into the nozzle body. Holding the body almost vertically, pull up the needle by one third of its engaged length. When released, the needle should slide down by its own weight.

Testing with Nozzle tester:

The following is tested on the nozzle tester:

(a) Opening pressure.

(b) Leakage.

(c) Chattering characteristics and spray pattern.

Use clean test oil for testing.

- It is very important that the oil is clean. The nozzles are adjusted by their respective nozzle holders.
- When clamping the nozzle into nozzle holder take care that the sealing surface is clean and undamaged. Place nozzle on sealing surface of nozzle holder, tighten cap nut first by hand and then with a well-fitting wrench to torque 6-8 kg-m.

Connects nozzle holder with its respective delivery pipe to the outfit. To test for nozzle jamming, press the hand lever of the nozzle tester down vigorously a few times (approximately 6-8 downward movements per second) with pressure gauge bypass. With nozzle moving properly, with nozzle should chatter with shrill whistling buzz.

Opening pressure: The opening pressure is specified under description and operation for individual engine and should be adjusted correspondingly. With the pressure gauge open to pressure slowly depress hand lever until the nozzle ejects with slight chattering. Take reading on the pressure gauge, if this pressure differs from the specified opening pressure, it is necessary to change total shim thickness.

Caution: When the pressure gauge is open to pressure, increase and decrease pressure slowly otherwise the gauge may be damaged.

Leakage test: Operate hand lever of the nozzle tester until pointer on the pressure gauge indicates 20 kg/cm^2 (285 p.s.i.) below the specified opening pressure.

The nozzle considered leak-proof if no drop of fuel emerges out at the end of the nozzle within 10 seconds.

Chatter test and spray pattern. For these tests, it is absolutely necessary that the pressure gauge be by passed.

Testing speed range: 1stroke is in approx.. 0.2 to 2 sec (5 to ½ downward movements per sec.)

Chatter test: These types of nozzles chatter in the entire range of attainable lever velocity (lowest test velocity: One downward movement per second). Single non- chattering in intermediate range is of no significance.

Spray pattern: At low test velocity, atomization is course. In the non-chattering ranges, non-atomized streams are formed.

Phase angle test:

The object of this test to check interval between successive injections, so that for a six- cylinder

pump the intervals will be 60 and for a four-cylinder pump 90.

1. The rack is set to a position stated by manufactures, using a pump rack setting device, the delivery valve and spring are removed from number one element and the test pipe connected to this element.

2. If necessary the tappet adjusting screw, tappet pads, or phasing shims should be altered to provide a small clearance usually 0.6-1 mm between the top face of the plunger and the base of the delivery valve seat. This is clearance may be measured with a dial gauge or by a special tool.

3. The pump camshaft is rotated by hand until number one element is at the bottom of its stoke, a valve on the test bench is opened to allow fuel to flow out of the test pipe, this is long spill.

4. Continued rotation of the camshaft will eventually cause the flow from the rest pipe to cease, indicating the point at which both inlet and spill ports are closed and delivery is about to commence i.e. end of long spill.

5. The position of the camshaft when this occurs can be read from a pointer and 360scale on the test machine.

6. This process should be repeated several times to verify the reading. Care must be taken not to confuse end of long spill and end of short spill. Which occurs when the plunger is moving down from T.D. position

7. Number one valve and spring should be replaced and the above procedure repeated in the firing sequence of the engine.

8. It is necessary the tapped adjusting screw, tapped pads, or phasing shims should be corrected until the timing of injection to each cylinder is within the prescribed tolerance typical value being ±½ of camshaft rotation. If adjustment has to be made, recheck the clearance of the plungers at the top of their respective strokes.

It is essential, therefore, during adjustment of the pump, to ensure that the subsequent pumping elements commence to inject at exactly the correct interval in the camshaft degree after No.1 element. Assuming that the injection sequence of a 6-cyliner pump is 1, 5, 3, 6, 2, 4, and then No.5 element must commence injection 60^{O} after No

(the pump work at half engine speed) and No. 3 at the same interval after No. 5 and soon. The interval on all types of pump is 360^{o} camshaft angle divided by the number of elements in the pump. This adjustment for correct timing interval is known as ‑phasing‖ or adjusting the phase angle of the pump.

Calibration:
Calibration of the pump should be carried after the phase angle test. This consists of adjusting each element to deliver an equal quantity of fuel to the cylinders. The quantity delivered per stroke depends upon the manufacturer‘s requirement. As theelements of the fuel pump deliver the fuel at various speeds and for different control-rod position. Fuel injection pump calibrated is as under.

1. Mount and couple the injection pump with the pump calibrating machine.
2. Set the control rod to the mid position or stay at 5 mm rack position.
3. Make all the connections of fuel pipes at inlet and outlet of pump elements, ensuring them leak-proof.
4. Operate the machine and run the pump at 600 rpm and bleed the system by opening the air vent cock.
5. The trip plate is arranged in its position; allow the fuel to enter the glass tubes at 600 rpm and for 200 stocks. Then take the readings of fuel delivered into theglass tubes.
6. Compare these readings with the manufacturer‘s chart values for the 5 mm rack position.
7. If there are variation in these readings then adjust the pump elements to bring the reading as close as possible to the given chart. This adjustment can be done by slacking the clamping screw and moving the control sleeve in desired direction and then again tightening the clamping screw. This adjustment should be corrected up to ±2.5% if fuel delivery.
8. Repeat the experiment at other speeds within the maximum range and check the collection of fuel at each speed. If there is any variation, the pump has to be serviced to put in normal working condition

Injector Testing:

- Coil Test-Specific current supplied measures voltage drop.
- Injector Balance- Inj. Energized for a precise time frame, record fuel pressure drop.

- Noid lights.
- Simple test light that plugs into injector connector.
- Light flashes with each electrical pulse.

Injector Cleaning:

- Periodic cleaning removes varnish & other deposits.
- Pressurized canister dispenses cleaning solution.
- Must disconnect fuel pump

Sensors Used In Multipoint Fuel System:

Typical sensors for multi-point FUEL system include:

An exhaust gas or oxygen sensor (Lambda sensor)

Oxygen sensor measure the oxygen level in engine as a means of checking combustion efficiency. Oxygen sensor voltage output vary with change in the content of the exhaust. Increase in oxygen makes the sensor output voltage to decrease and a decrease oxygen content causes increased sensor output. Sensor then sends data to the computer. The computer then alters the opening and closing of injector to maintain a correct air-fuel ratio for maximum efficiency.

Intake Manifold pressure sensor

This sensor measures the pressure inside the engine intake manifold. High pressure indicates a high load that requires a rich mixture and low manifold pressure indicates small load requiring a leaner mixture. The manifold pressure sensor changes resistance with change in engine load and thus computer alter the fuel mixture.

A throttle position sensor

In throttle position sensor a variable resistor is connected to the throttle plate shaft. Whenthe throttle wings is opened for more power or closes for less power, the sensor changes the resistance and sends the signals the computer. Computer then makes the mixture richer or leaner as required.

An engine coolant temperature sensor.

Engine coolant temperature sensor monitors the operating temperature of the engine. This sensor is kept so that it is exposed to the engine coolant. When the engine is cold,the sensor might provide a high current flow. The computer would enrich the air-fuel mixture for cold operation. When the engine warms, the sensor would supply information so that the computer could make the leaner mixture.

An airflow sensor

Airflow sensor is used to measure the amount of air entering the engine. This helps the computer to determine the amount of fuel required in combustion. Air flow through the sensor causes an air flap to swing tone side. The air flap is connected to a variable resistor; the amount of air flow into the engine is converted into an electrical signal for the computer. Computer then make the mixture richer or leaner as required.

An inlet air temperature sensor.

Inlet air temperature sensor measure the temperature of the air that enters the engine. Cold air being denser than warm air requires a little more fuel as compared to warm air. Air temperature sensor helps the computer compensate for the changes in outside air temperature and maintain an almost perfect air-fuel ratio

A crankshaft position sensor and distributor rpm sensor

Crankshaft position sensor or distribution rpm sensor is used to detect the engine speed and cylinder identification. The sensor consists of magnet and coil. It is mounted on oil pan with specified air gap between the sensor core end and crankshaft timing belt pulley tooth. This sensor allows the computer to change injector opening with changes inengine rpm. Higher engine speeds generally require more fuel. Lower engine speeds require less fuel. This data is

used by the computer to alter the fuel mixture.

Vehicle speed sensor

The vehicle speed sensor, located on the transmission gearbox or speedometer, generates a signal in proportion to the vehicle speed. Receiving this signal, the speedometer uses it for operation of its indicator and also converts it into to the ON/OFF signal by doubling the cycle. This signal is sent to ECM where it is used as one of the signals to control various devices.

Lubrication System Service:

Engine Lubricating Troubles

It may be due to

- Failure of oil pump
- Clogged oil lines and oil passages
- Contaminated oil

Maintenance of Lubricating System

- Maintaining Proper oil level
- Choose proper grade of oil.
- By keeping the breather clean in the sump.

Oil Filter:

Oil filter is used in the engine lubricating system of most of the motor vehicles to filter out the dirt or grit particles from the oil.

The oil filter systems are of the two types:

1. By-pass system
2. Full flow system

In by-pass system, the whole of theoil does not pass through the filter at the same time, but some of the oil without being filtered goes to the bearings. Remaining oil passes through the filter and then goes to bearings. When the engine is run continuously for a long period, the whole oil is, however, filtered.

In full flow system, the whole oil passes first through the filter and then goes to the bearings. If the filter is clogged due to any reason, the system fails completely and bearings would be starved.

The different types of oil filters used in automotive engines are as follows:

1. Cartridge type
2. Edge type
3. Centrifugal type

Oil Pump:

Oil pump is generally located inside the crankcase below the oil level. The function of the oil pump is to supply oil under pressure to the various engine parts to be lubricated. The different types of the oil pumps used for engine lubrication are as follows:

1. Gear pump

2. Rotor pump
3. Plunger pump
4. Vane pump

High Oil Consumption:

The oil consumption may be high due to the following reasons:

1. Loose bearing.
2. Tapered or out-of-round cylinder
3. Excessive clearance in the intake valve guides.
4. Worm piston rings.
5. Broken or improperly installed oil pan, valve cover, timing gear over gaskets.
6. Worn oil seats at front or rear main bearings.
7. Loose connections in oil filter lines.
8. Worn rear camshaft oil seal.
9. Excessive oil pressure.
10. Clogged oil breather.
11. Clogged oil return from the distributor.
12. Stuck positive crankcase ventilation regulator valve.
13. Cylinder distortion due to improper tightening of the cylinder head nuts.
14. Leaky fuel pump vacuum booster diaphragm which sucks oil from the crankcase.
15. Excessive clearance in the intake valve guides.
16. High speed and high temperature, which reduce oil viscosity. More oil flows and more oil leaks and more oil burns.

External oil leakage:

It is detected as darkened oil wet area on or around the engine. Oil may also be found in small puddles under the vehicle. Leaking gaskets or seals are usually the source of external engine oil leakage.

Internal oil leakage-shows up as blue smoke exiting the exhaust system of the vehicle. For example, if the engine piston rings and cylinders are badly worn, oil can enter the combustion chambers and will be burned during combustion.

Note: Do not confuse black smoke (excess fuel in the cylinder) and white smoke (water leakage into the engine cylinder) with blue smoke caused by engine oil.

Low Oil Pressure:

For proper lubrication of the engine parts, the oil pump should supply the oil at the required pressure. If the oil pressure is too low, as indicated by the oil pressure gauge, the vehicle should be stopped and fault should be found out, otherwise the lack of lubricating oil due to the too low pressure will cause any serious damage. The oil pressure may be low due to any one of the **following reasons:**

1. Less oil in the oil pan.
2. Loose connection in the oil lines.
3. Faulty pressure gauge giving incorrect reading.
4. Excessive clearance in the bearing causing rapid oil leakage from the bearing ends.

5. Too weak relief valve spring.

Denting:

The process of body repairing and refinishing is called denting. It mainly involves sheet metal works in which the damaged body panels and fenders and straightened or given profiles to make them look like the original item.

The need for denting of a vehicle arises when,
The fenders, doors or panels are junked.

- A series of ridges are seen on certain area.
- A damaged wrinkled panel is to be straightened.
- A protruding sheet metal is to be pressed back into position.
- The patches or scratches have come up and the original color has faded.

The denting is also called as dinging process which involves number of processes suchas bending, flatting, shearing, filling, painting, color matching etc. These processes are performed with the help of modern tools are equipments most of which are described. Some tools are very common and essential for the denting and are generally referred as denting tools. These are fender-straightening hand tools, center punches, metal shears, pull rods, dolly blocks, dinging hammers etc.

Body Paint:

It is very difficult to touch up the stoving enamel surface. However, the following technique may be adopted for touch up work to get better results.

1. **Chipping:** Chipping at door edges to be touched up with Hylux or Golac bybrush.
2. Small spots:

(i) Sand thoroughly the damaged part of the stoving enamel film with 400 water proof paper and water with rubber block. After this, the effected portion should be sanded with 600 paper.

(ii) Whatever metal is exposed, N.C. primer surface should be sprayed.

(iii) After proper flash time (4 hours), the N.C. primer surface should be wet sanded with water and 400 waterproof paper. After this, again 600 paper should be used on this area.

(iv) Hylux paint of I.C.I or Glolac paint of additions is to be used for touch up work.

(v) One coat is to be sprayed first on the primer surface film only. After sometime, apply second coat of the paint starting from inner side of the

area. After 5minutes flash time, spray Hylux thinner or Gloalac thinner, as the case may be, on the dry spray area to wet it. Now, dry it by infraredlamp for 30minuts, keep it for 48 hours for air dry.

(vi) Now rub car polish by a soft cloth on the touched up area.

To give you an idea of how to apply body filler, here are a few general instructions that suit most situations (but be sure to read and follow the directions on the product you buy):

1. Clean the body area thoroughly:Remove all

   traces of dirt, wax, and rust.

2. Sand the area:

Use#180 or #220 aluminum oxide sandpaper or the type specified or your vehicle‘s plastic or aluminum parts.

Selection. Because body fillers don‘t stick to paint, you must sand the area. When sanding, be sure to feather-edge (blend_ the paint edges to prevent the old paint from chipping up through the new paint in the future and to ensure a good bond. Gently work inward from the edges of the dent to avoid enlarging the damaged area.

3. Mix only as much hardener-filler as you‘re going to use right away.
4. If you‘re patching a hole, place something beneath the hole to keep the filler inplace.

- For a hole in the metal part of the body: Put fiberglass screening or finealuminum chicken wire beneath the hole (on the underside of the body)
- For a fiberglass or plastic part: Use the appropriate patch kit available at yourlocal auto supply or auto paint store.

Be sure to clean the area under the edges of the hole thoroughly to get rid of any dirt or paint. Then mix a very small proportion of filler and hardener and apply it to the edges of the screen and the edges of the area to be patched in order to hold the screen in place. If the kit contains no applicator, use a putty knife or plastic pot scraper to apply the filler.Let the screen patch dry for several hours before moving on to the next ste

5. Apply the filler

Work slowly and carefully to avoid spreading the filler outside the dent or hole and marriage the surrounding area. After you finish, the filled portion should be slightly higher than the surface of the car around it.

6. As soon as the filler starts to harden (about to the consistency of hard cheese), use a perforated file to bring the level down almost to the level of the paint.
7. Wait at least 20 to 30 minutes until everything is bone dry; then sand the area with medium-grain sandpaper until it conforms perfectly to the surrounding body surface.
8. When everything is smooth and even prime the area and touch up the paint.

You can use primer as a last layer of filler to fill-tiny holes or irregularities. Apply several layers of primer, sanding each layer with a sanding block, until the area appears perfectly smooth. (To check that it's smooth, wet the primer and look at the way light reflects off the surface.

Defects In Paint Work:
The defects which are commonly found in paint work are as follow:

1. Blistering

Formation of bubbles like shapes on the painted surface is known as blistering. The primary cause of this defect is water vapor. When water vapor trapped under the paint layer, it creates bubbles under the film of paint.

2. Blooming

Formation of dull patches on the painted surface is known as blooming. The primary cause of this defect is poor quality of paint and improper ventilation.

3. Fading

When there is a gradual loss of color from the pained surface, it is known s fading. The main cause of this defect is the reaction of sunlight on pigmentsof paint.

4. Flanking

In this type of defect, some portion of the paint film is not sticked properly with the surface; resulting flaking off of the paint layer. This is cause due to poor adhesion between paint and the surface to be painted.

5. Flashing

Presence of glossy patches on the painted surface is known as flashing, The cause of this defect

is mainly due to poor workmanship, cheap paint or weather actions.

6. Grinning

If the thickness of the final coat of paint becomes very thin, the background can be seen clearly. This is known as grinning. Poor workmanship is the maincause of this defect.

7. Running

This type of defect is seen when the surface to be painted is very smooth. In case of smooth surface the paint runs back and leaves small areas of surface uncovered.

8. Sagging

This type of defect is more prominent when a thick layer of paint is appliedon a vertical or inclined surface.

9. Saponification

Formation of soap patches on the painted surface is termed as saponification. Chemical action of alkalis is the cause of this defect.

10. Wrinkling

This type of defect is more prominent when a thick layer of paint is appliedon a horizontal surface.

Adjustment Of Doors And Locks:

When checking door alignment, look carefully at each seam between the door and body. The gap should be even all the way all the way around the door. Pay particular attention to the door seams at the corners farthest from the hinges; the this is the area where errors will be most evident. Additionally, the door should push against the weather strip when latched to seal out wind and water. The contact should be even all the way around and the stripping should be about half compressed. The position of the door can be adjusted in three dimensions; fore and aft, up and down, in and out. The primary adjusting points are the hinge-to- bolts.

1. Apply tape to the fender and door edges to protect the paint. Two layers of common masking tape works well.

2. Loosen the bolts just enough to allow the hinge to move. With the help of an assistant, position the door up and down as required and snug the bolts.

3. Inspect the door seams carefully and repeat the adjustment until correctly aligned.

4. Inspect the front door seal and determine how much it is being crushed. If there islittle or no contact in this area, or if the door is recessed into the body at the front when closed, loosen the hinge-to-door bolts and adjust the door in or out as need. Don‘t worry about the latch yet.

5. Make sure the door moves smoothly on the hinges without binding. When the door fits the opening correctly, tighten the bolts.

6. To adjust the latch, loosen the large cross point screw holding the striker on the door jam on the body. These bolts will be very tight; an impact screwdriver is the best tool for this job. Make sure you are using the proper size bit.

With the bolts just loose enough to allow the striker to move if necessary, hold the outer door handle in the released position and close the door. The striker will move into the correct location to match the door latch. Open the door and tighten the mounting bolts. The striker may be adjusted towards or way from the center of the car, thereby tighten or loosening the door fit. The striker can be moved up and down to compensate for door position, but if the door is correctly mounted at the hinges this should not necessary.

1. After the striker bolts have been tightened, open and close the door several times. Observe the motion of the door as it engages the striker; it should continue its straight in motion and not deflect up or down as it hits the striker.
2. Check the feel of the latch during opening and closing. It must be smooth and linear, without any trace of grinding or binding during engagement and release. Itmay be necessary to repeat the striker adjustment several times (and possibly re- adjust the hinges) before the correct door-to-body fit is achieved.

The door alignment within the door opening in the body shell is adjusted my loosening the hinge bolts moving the door as necessary. The door closure is adjusted by moving the latch pin or bracket.

The door hinges should be adjusted such that:

1. The door shell is level with lower door jamb.
2. On front doors, the forward edge of the door is even with or slightly recessed, notto exceed 0.040 inches (1 mm), relative to the rear portion of the front fender.

3. On rear doors, the forward edge of the door is even with, or slightly recessed not to exceed 0.040 inches (1 mm), relative to the rear edge of the front door, which can be accomplished by moving the hinges of the rear door or by moving the striker pin or bracket of the front

door if the front door closure is properly adjusted.

The closure of the doors is accomplished by moving the latch pin or bracket on the door pillar. The latch brackets are secured by2 fasteners that are loosened to allow the bracket to be moved. The latch pin is adjusted by turning it counterclockwise to loosen it, moving it to the desired position and then tightening it. Use either a thin wall deep well socket or a boxed and wrench to loosen or tighten it.

Adjust the closure of the doors by loosening and moving the latch pin or bracket on the door pillar such that:

1. On front doors, with the door closed the rear edge of the door is slightly above the leading edge of the rear door not to exceed 0.040 inch (1 mm).

   Note if the door has a tendency to rattle over bumps, check and adjust the height of the latch pin or bracket as necessary.

2. On rear doors with the door closed the rear edge of the door is slightly above the adjusting body panel, not to exceed 0.040 inch (1 mm) Note, if the door has a tendency to rattle over bumps, check and adjust the height of the latch pin or bracket as necessary.

On Audi A4 models the upper door window frame can be adjust with the help of an assistant as follows:

1. Remove all the door panel.
2. Loosen the 2 rear and the upper front fasteners that secure the window frame to the vehicle just enough the window frame can be moved but tight enough to hold its position. Loosen the front lower fastener such that it is just touching the door shell.
1. Have the assistant sit in the vehicle and firmly press upward on the upperwindow frame toward the roof and the A-pillar, while, from the outside the fit of the window carrier is observed, marking sure it is properly seated, then have the assistant slide the graduated wedge as necessary to retain the position.
2. Open the door and tighten the window carried-to-door shell mounting bolts to 22 ft. lbs. (30 Nm.)
3. Close the door and recheck the adjustment. If necessary, repeat the adjustment procedures to attain the proper adjustment.
4. Once the adjustment is completed, reinstall the door panel.

MOTOR VECHILES ACT

- The Motor Vehicles Act, 1988 The Act came into force from 1 July 1989. It replaced Motor Vehicles Act, 1939 which earlier replaced the first such enactment Motor Vehicles Act, 1914.
- Motor vehicle: Any mechanically propelled vehicle adapted for use upon roads whether the power of propulsion is transmitted from an external or internal source of power. The Motor Vehicles Act, 1988, like the earlier Act of 1939, makes the insurance of motor vehicles compulsory. The owner of every motor vehicle is bound to insure his vehicle against third party risk. The insurance company, i.e, the insurer covers risk of loss to the third party by the use of the motor vehicle.
- Section 3: No person shall drive a motor vehicle in any public place unless he holds an effective driving licence issued to him authorising him to drive the vehicle
- Section 4: No person under the age of eighteen years shall drive a motor vehicle in any public place
- Section 5: No owner or person in charge of a motor vehicle shall cause or permit any person who does not satisfy the provisions of section 3 or section 4 to drive the vehicle.
- Section 19: Power of licensing authority to disqualify from holding a driving licence or revoke such licence.
- Section 39: No person shall drive any motor vehicle and no owner of a motor vehicle shall cause or permit the vehicle to be driven in any public place or in any other place unless the vehicle is registered in accordance with this Chapter and the certificate of registration of the vehicle has not been suspended or cancelled and the vehicle carries a registration mark displayed in the prescribed manner
- Section 49: If the owner of a motor vehicle ceases to reside or have his place of business at the address recorded in the certificate of registration of the vehicle, he shall, within thirty days of any such change of address, intimate in such form accompanied by such documents as may be prescribed by the Central Government, his new address, to the registering authority by which the certificate of registration was issued, or, if the new address is within the jurisdiction of another registering authority, to that other registering authority, and shall at the same time forward the certificate of registration to the registering authority or, as the case may be, to the other registering authority in order that the new address may be entered therein.
- Section 50: Transfer of ownership.
- Section 51: Special provisions regarding motor vehicle subject to hire-purchase agreement, etc. Where an application for registration of a motor vehicle which is held under a hire-purchase, lease or hypothecation agreement (hereafter in this section referred to as the said agreement) is made, the registering authority shall make an entry in the certificate of registration regarding the existence of the said agreement.
- Section 128: No driver of a two-wheeled motor cycle shall carry more than one person in addition to himself on the motor cycle and no such person shall be carried otherwise than sitting on a proper seat securely fixed to the motor cycle behind the driver's seat with appropriate safety measures.
- Section 129: The section imposes the law for motorcyclists to wear helmets while riding.
- Section 130: The driver of a motor vehicle in any public place shall, on demand by any police officer in uniform, produce his licence for examination
- Section 133: Duty of owner of motor vehicle to give information
- A driving licence is an official document that authorises its holder to operate various types of motor vehicles on highways and some other roads to which the public has access.
- Unless a person have a proper driving licences he/she cannot drive motor vehicle of above 50cc in public place according to motor vehicle act section 3

- **Restrictions on the granting of learner's licences for certain vehicles**

No person shall be granted a learner's licence--

1. to drive a heavy goods vehicle unless he has held a driving licence for at least two years to drive a light motor vehicle or for at least one year to drive a medium goods vehicle;
2. To drive a heavy passenger motor vehicle unless he has held a driving licence for at least two years to drive a light motor vehicle or for at least one year to drive a medium passenger motor vehicle;
3. To drive a medium goods vehicle or a medium passenger motor vehicle unless he has held a driving licence for at least one year to drive a light motor vehicle.

2. No person under the age of eighteen years shall be granted a learner's licence to drive a motor cycle without gear except with the consent in writing of the person having the care of the person desiring the learner's licence.

- **Grant of learner's licence.**

1. Any person who is not disqualified under for driving a motor vehicle and who is not for the time being disqualified for holding or obtaining a driving licence may, subject to the provisions of , apply to the licensing authority having jurisdiction in the area--

1. in which he ordinarily resides or carries on business, or
2. in which the school or establishment referred to in from where he intends to receive instruction in driving a motor vehicle is situate, for the issue to him of a learner's licence.

- The Registration Certificate (RC) of your vehicle is **the official document which states that your vehicle is registered with the Indian Government**. It mentions the territorial boundary in which the vehicle can be used, engine and chassis number, fuel used, cubic capacity, and specifies the category of the vehicle.
- **Without a valid registration certificate, you do not have the legal rights to sell the vehicle or transfer the ownership of the vehicle**. Claiming insurance in case of accidents: In case of an accident, you will be able to track the driver or the owner of the vehicle through the vehicle registration details.
- **Procedure of vehicle registration**
  - Step1: Visit the local RTO office with your new vehicle.
  - Step 2: Fill the Application Form 20 and submit it along with the required documents.
  - Step 3: After that, the documents will be inspected by the RTO superintendent.
  - Step 4: Pay the required registration fee with the tax at the cash counter.
  - Step 5: Your vehicle will be inspected by the Inspector of Motor Vehicle.
  - Step 6: The RTO office will enter the vehicle data into the central database.
  - Step 7: The RTO Superintendent will verify the vehicle data entered in the database.
  - Step 8: The Assistant Regional Transport Officer (ARTO) will approve the registration.

- Step 9: The RTO office will initiate the process for the Smart Card and once it is printed, it will be delivered to the applicant by post to the registered mailing address

- **Refusal of registration or renewal of the certificate of registration.**

- The registering authority may, by order, refuse to register any motor vehicle, or renew the certificate of registration in respect of a motor vehicle (other than a transport vehicle), if in either case, the registering authority has reason to believe that it is a stolen motor vehicle or the vehicle is mechanically defective or fails to comply with the requirements of this Act or of the rules made hereunder, or if the applicant fails to furnish particulars of any previous registration of the vehicle or furnishes inaccurate particulars in the application for registration of the vehicle or, as the case may be, for renewal of the certificate or registration thereof and the registering authority shall furnish the applicant whose vehicle is refused registration, or whose application for renewal of the certificate of registration is refused, a copy of such order, together with the reasons for such refusal.

- A temporary registration number is assigned by the dealership from which the vehicle is purchased which serves the purpose when the vehicle is brand new and is yet to be permanently registered. This unique number is normally valid for a period of maximum one month, in which the vehicle should be registered by the concerned Regional Transport Office (RTO) authority.
- The vehicle can be driven or allowed to be driven in public place only after registration by registering authority as under the provision of section 39 of motor vehicle Act 1988. An application for registration of a motor vehicle is required to be made to the registering authority within a period of seven days from the date of taking delivery of such vehicle, excluding the period of journey.
- Every registration certificate is required to be renewed not more than 60 days before the date of its expiry of the registration for its continuous use.