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AUTOMOTIVE MECHATRONICS

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LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

NAVTTC

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AUTOMOTIVE MECHATRONICS

LEARNER GUIDE

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Introduction

Welcome to your Learner's Guide for the *Pipe Fitter Lev 3*. It will help you complete the training and go on with further study or go straight into employment.

The *Pipe Fitter Lev 3 training* is to engage young people with a program of development that will provide them with the knowledge, skills and understanding to start this career in Pakistan. This qualification will not only build the capacity of existing workers of this light engineering sector but also support the youth to acquire skills best fit for this sector.

The main elements of your learner's guide are:

- **Introduction:**
  - This includes a brief description of your guide and guidelines for you to use it effectively
- **Modules:**
  - The modules form the sections in your learner's guide
- **Learning Units:**
  - Learning Units are the main sections within each module
- **Learning outcomes**:
  - Learning outcomes of each learning units are taken from the curriculum document
- **Learning Elements:**
  - This is the main content of your learner's guide with detail of the knowledge and skills (practical activities, projects, assignments, practices etc.) you will require to achieve learning outcomes stated in the curriculum
  - This section will include examples, photographs and illustrations relating to each learning outcome
- **Summary of modules**:
  - This contains the summary of the modules that make up your learner's guide
- **Frequently asked questions**:
  - These have been added to provide further explanation and clarity on some of the difficult concepts and areas. This further helps you in preparing for your assessment.
- **Multiple choice questions for self-test**:
  - These are provided as an exercise at the end of your learner's guide to help you in preparing for your assessment.

Frequently Asked Questions

1. What is Competency Based Training (CBT) and how is it different from currently offered trainings in institutes?	Competency-based training (CBT) is an approach to vocational education and training that places emphasis on what a person can do in the workplace as a result of completing a program of training. Compared to conventional programs, the competency based training is not primarily content based; it rather focuses on the competence requirement of the envisaged job role. The whole qualification refers to certain industry standard criterion and is modularized in nature rather than being course oriented.
2. What is the passing criterion for CBT certificate?	You shall be required to be declared “Competent” in the summative assessment to attain the certificate.
3. How can I progress in my educational career after attaining this certificate?	You shall be eligible to take admission in the National Vocational Certificate Level-4 in Automotive Mechatronics. You shall be able to progress further to National Vocational Certificate Level-5 in Automotive Mechatronics; and take admission in DAE or equivalent course. In certain case, you may be required to attain an equivalence certificate from The Inter Board Committee of Chairmen (IBCC).
4. What is the importance of this certificate in National and International job market?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). These standards are also recognized worldwide as all the standards are coded using international methodology and are accessible to the employers worldwide through NAVTTC website.
5. Which jobs can I get after attaining this certificate? Are there job for this certificate in public sector as well?	You shall be able to take up jobs as an automotive mechatronics technician, spare parts dealers, supervisors and managers
6. What are possible career progressions in industry after attaining this certificate?	You shall be able to progress up to the management level after attaining sufficient experience, knowledge and skills during the job. Attaining additional relevant qualifications may aid your career advancement to even higher levels.
7. Is this certificate recognized by any competent authority	This certificate is based on the nationally standardized and notified

in Pakistan?	competency standards by National Vocational and Technical Training Commission (NAVTTC). The official certificates shall be awarded by the relevant certificate awarding body.
8. Is on-the-job training mandatory for this certificate? If yes, what is the duration of on-the-job training?	On-the-job training is not a requirement for final / summative assessment of this certificate. However, taking up on-the-job training after or during the course work may add your chances to get a job afterwards.
9. What is the examination / assessment system in this program?	Competency based assessments are organized by training institutes during the course which serve the purpose of assessing the progress and preparedness of each student. Final / summative assessments are organized by the relevant qualification awarding bodies at the end of the certificate program. You shall be required to be declared "Competent" in the summative assessment to attain the certificate.
10. Does this certificate enable me to work as freelancer?	You can start your small business as a pipe fitter. You may need additional skills on entrepreneurship to support your initiative.

AUTOMOTIVE MECHATRONICS

Module-1

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Modules

Module 1: Apply Work Health and Safety Practices (WHS)

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to apply work health and safety practices (WHS)

Duration: 30 Hrs **Theory:** Hrs **Practical:** Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Implement safe work practices at work place	**The trainee will be able to:** Implement relevant rules and procedures of WHS at work place. Comply with duty of care requirements Use personal protective equipment according to safe work practices Contribute to WHS consultative activities Raise WHS issues with relevant personnel		
LU 2: Participate in hazard assessment activities a work place	**The trainee will be able to:** Identify hazards or WHS issues in the workplace to relevant personnel Assess and control risks according to own level of responsibility, in line with workplace procedures		

	Report hazards or WHS issues in the workplace to relevant personnel Document risk control actions as required		
LU 3 : Follow emergency procedures at workplace	**The trainee will be able to:** Report emergencies or incidents promptly to relevant personnel Deal with emergencies in line with own level of responsibility Implement evacuation procedures as required		
LU 4: Participate in OHS consultative processes	**The trainee will be able to:** Contribute to workplace meetings, inspections or other consultative activities Raise OHS (Occupational Health and Safety) issues with designated persons in accordance with organizational procedures Take actions to eliminate workplace hazards or to reduce risks		

AUTOMOTIVE MECHATRONICS

Module-2

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 2: Identify and Implement Workplace Policy and Procedures

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to identify and implement workplace policy and procedures.

Duration: 20 Hrs **Theory:** Hrs **Practical:** Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Identify workplace policy & procedures	**The trainee will be able to:** Identify the workplace policy & procedures Apply appropriate strategies that can be used to measure whether your workplace health and safety obligations are being met. Assure the policies are realistic, resources and personnel to implement Implement the policy & procedures that reflects the organizations commitments Ensure the appropriate methods of implementation, outcomes and performance indicators		

LU 2: Implement workplace policy & procedures	**The trainee will be able to:** Apply and assign responsibility for recording systems to track continuous improvements in policy & procedures Implement strategies for continuous improvement in effective and efficient information		
LU 3: Communicate workplace policy & procedures	**The trainee will be able to:** Communicate procedures to help implement workplace policy Inform those involved in implementing the policy about expected outcomes, activities to be undertaken and assigned responsibilities		
LU 4: Review the implementation of workplace policy & procedures	**The trainee will be able to:** Identify the trends that may require remedial actions Record the trends that may require remedial actions. Ensure policy and procedures as		
	required are made for continuous improvement of performance		

AUTOMOTIVE MECHATRONICS

Module-3

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 3: Communicate at Workplace

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to communicate at workplace.

Duration: 30 Hrs **Theory:** Hrs **Practical:** Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Communicate within the organization	**The trainee will be able to:** Communicate within a department Communicate with other departments. Use various media to communicate effectively Communicate orally and written		
LU 2: Communicate outside the organization	**The trainee will be able to:** Deal with vendors Deal with clients/customers Interact with other organisations Use various media to communicate effectively Work with people of different cultures / backgrounds		
LU 3: Communicate effectively in workgroup	**The trainee will be able to:** Assess the issues to provide relevant suggestion to group members Resolve the issues/ problems /conflicts		

	within the group Arrange group working sessions to increase the level of participation in the group processes Communicate messages to group members clearly to ensure interpretation is valid Communicate style /manner to reflect professional standards/ awareness of appropriate cultural practices Act upon constructive feedback		
LU 4: Communicate in writing	**The trainee will be able to:** Identify relevant procedures for written information Use strategies to ensure correct communication in writing .i.e. • correct composition • clarity • comprehensiveness • accuracy • appropriateness Draft assigned written information for approval, ensuring it is written within		

	designated timeframes Ensure written information meets required standards of style, format and detail Seek assistance / feedback to aid communication skills development		

AUTOMOTIVE MECHATRONICS

Module-4

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 4: Perform Computer Application Skills

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to perform computer application skills

Duration: 40 Hrs **Theory:** Hrs **Practical:** Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Prepare In-page documents as per required information	**The trainee will be able to:** Set keyboard preferences according to information requirements Layout Page according to information requirements Toggle between Languages Identify the usage of tool bar Insert Columns as per requirement Print the document		
LU 2: Prepare Spreadsheets as per required information	**The trainee will be able to:** Create workbook according to information requirements Insert sheet according to information requirements		

	Enter basic formulae / functions using cell referencing when required Correct formulas when error messages occur Use a range of common tools during spreadsheet development Edit columns and rows within the spreadsheet Filter data Save the spreadsheet to a folder on a storage device Format spreadsheet using formatting features as required Incorporate object and chart in spreadsheet Print spreadsheet		
LU 3: Use MS Office as per required information	**The trainee will be able to:** Use Microsoft Word for documentation Use Microsoft Excel for documentation Use Microsoft PowerPoint for presentation		

	Perform OneNote Perform Outlook for emails Perform Publisher applications		
LU 4: Perform computer graphics in basic applications	**The trainee will be able to:** Perform graphic fundamentals in basic applications Draw Points and lines to make images Draw Dots in space to make images Draw lightening blot Shapes to make images Enlarge circles and rectangles to block in forms		
LU 5: Create Email account for communications	**The trainee will be able to:** Make email account for communications Compose text of an email message according to organizational guidelines as required Create an automatic signature for		

	the user Attach files to email message where required Send email message Reply to / forward a received message using available features Save an attachment to the relevant folder Save email message using available settings Adjust email accounts to restrict and quarantine possible email security problems • Print email message as per requirements		

AUTOMOTIVE MECHATRONICS

Module-5

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 5: Manage Personal Finances

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to manage personal finances.

Duration: 30 Hrs **Theory:** Hrs **Practical:** Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Develop a personal budget	**The trainee will be able to:** Calculate current living expenses using available information to prepare a personal budget. Keep a record of all income and expenses for a short period of time to help estimate ongoing expenses. Subtract total expenses from total income to determine a surplus or deficit budget for the specified period. Find reasons for a deficit budget and ways to reduce expenditure identified. Identify ways to increase income		
LU 2: Develop long term	**The trainee will be able to:** Analyze income and expenditure		

personal budget	and set long term personal financial goals. Develop a long-term budget based on the outcomes of short-term budgeting. Identify obstacles that might affect the business Formulate a regular savings plan based on budget		
LU 3: Identify ways to maximize future finances	**The trainee will be able to:** Determine sources to maximize personal income, Get further education or training to maintain or improve future income. Identify the need for debt to finance living and other expenses, Determine the appropriate levels of debt and repayment. Consolidate existing debt, where possible, to minimize interest costs and fees. Seek professional money management services.		

AUTOMOTIVE MECHATRONICS

Module-6

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 6: 071400951 Perform General Inspection

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to perform general inspection of vehicle.

Duration: 40 Hrs **Theory:** 08 Hrs **Practical:** 32 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Inspect Mechanical Failure	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Check fluid level of engine, brake, gear and power steering. Check coolant level and its condition. Check filters (air filter, fuel filter, oil filter and A/C filter)of vehicle Check drive belts(alternator belt, power steering pump belt, A/C compressor belt) Check tyre conditions and air pressure in all tyres including spare tyre Check any abnormal noise in engine Check any fluid leakages	Understanding of appropriate tools and equipment for performing this task. Explaining the safety precautions regarding personal health and workplace Describing the vehicle braking system and its components (e.g. master cylinders, brake booster, brake lines, wheel cylinder, brake pads, brake shoes etc.) Explaining the causes of brake failure (i.e. old seals, worn brake shoes and brake pads) Defining the grading of brake fluid Describing the procedure of brake bleeding Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush (Steel Wire) Combination Spanner Set RPM Meter Multi Meter Hydraulic Jack

	(brake fluid, power steering fluid, gear oil and engine oil) Check parts of brake system, cooling system and lubrication system) Ensure housekeeping after completion of task		
LU 2: Inspect Electrical Failure	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Check the Battery function and level of its electrolyte Check/clean the battery terminals Check operation of all lights(head lights, back lights, brake light, indicator lights, reverse gear light and fog light) Check horn of the vehicle Check the ignition system Check the working condition of alternator Check the performance of	Understanding of appropriate tools and equipment for performing this task. Explaining the safety precautions regarding personal health and workplace Explaining about the common electrical failure in a vehicle (for example; Bad Spark Plugs or Wires, Blown Fuse, Dead Battery and Bad Alternator) Determining the function of Battery and its inspection procedures Defining the working of Alternator Explaining the working of Self Stator Motor Knowledge of electric safety (for example electrical systems, protective devices, switchboard cabinets and connection technologies) Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Philips/Flat Screw Driver Set Hammer Drill Cotton Rags Emery Paper Wire Brush (Steel Wire) Combination Spanner Set Multi Meter Electric Tester Hydrometer Battery Load Tester WD-40 Combination Plier Nose Plier Hydraulic Jack Relevant PPEs

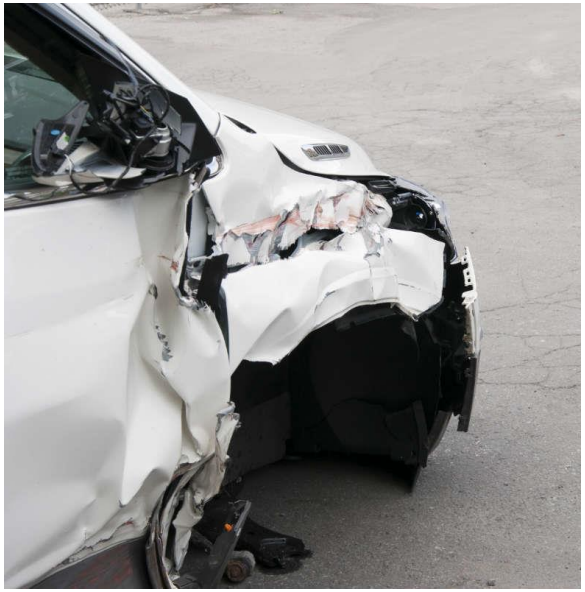
	self-starter Check the A/C system Check the wipers of the vehicle Ensure housekeeping after completion of task		
LU 3: Perform Road Test	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Perform road test applying correct procedure Accelerate the engine to check engine noise Apply brake to check loose parts and noisy suspension Check the wheel alignment during driving Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task. Explaining the safety precautions regarding personal health and workplace Explaining the organizational rules, regulations and policies regarding road test Checking the performance of vehicle Identifying different types of noises and vibrations Checking wheel alignment Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multi Meter Hydraulic Jack

LU 4: Prepare Job Card/Report	**The trainee will be able to:** Note down the mechanical faults Note down the electronic faults. Note down the hydraulic faults Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task. Explaining the safety precautions regarding personal health and workplace Introducing the Job card/report Explaining the purpose of Job card/report Describing the procedure to enlist vehicle faults in job card/report Explaining the periodic maintenance schedule and its importance Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set Multi Meter Hydraulic Jack Note book

Examples and illustrations

Mechanical Failure of a Vehicle:

Some common causes of **car accidents** include negligent and errant driver behavior combined with other factors such as bad road conditions, defective mechanical equipment, and bad weather conditions.



Mechanical failures cause about 13% of all accidents on the road. When accidents happen, it's not always the fault of the owner or operator of the car—especially if they've been maintaining the vehicle properly. An investigation into the accident's cause is necessary

Today, most vehicles are manufactured to adhere to safety standards established by experts, but there are certain mechanical faults that are known to cause car accidents.

Five Common Mechanical Failures

Keep an eye out for these common motor vehicle mechanical failures.

Faulty Brakes

Brake failure is one of the common mechanical defects that can lead to automobile accidents. Modern automobile technologies, such as dual brake systems, reduce the risk of mechanical failure. In case of a circuit failure, the other circuit will come into action and enable the car to brake. Another technology that has made cars safer is the anti-lock braking system that prevents the front car wheels from locking in case of an emergency.

Tire Blow Outs

Tires are much safer today than they were a few years ago. However, worn out tires and under inflated tires are a major cause of motor vehicle accidents. Faulty suspensions and improperly aligned suspensions may result in uneven tires and ultimately lead to an accident.

Faulty Steering Systems and Suspensions

If a car is traveling at a high speed and the suspension system malfunctions, it can cause a major accident no matter how experienced the driver is. In order to prevent accidents caused by mechanical failures, it is important for the driver to take preventive steps. Drivers should maintain their vehicles well and have the equipment and components tested from trained personnel at regular intervals.

Faulty Headlights and Taillights

A large percentage of car accidents occur at night compared to the day time, because of low visibility when drivers must depend on lights to be able to see. If the car has broken or dim headlights, brake lights, or taillights, then it can become extremely difficult for the motorist to see and for the other drivers to spot them. Inspect all lights regularly so as to make sure they are in perfect working order.

Malfunctioning Wipers

Driving in rain and snow can be extremely difficult and you need good quality and properly functioning wipers for safe driving. If the car's wipers malfunction when you are driving in a snow storm or rain, you will immediately lose visibility.

For more detailed information, please visit https://www.lowmanlawfirm.com/blog/bid/63142/top-5-mechanical-failures-that-cause-car-accidents and https://www.willenslaw.com/5-common-mechanical-problems-leading-to-car-accidents/ also visit https://www.wkw.com/products-liability/blog/common-car-mechanical-failures/

Electrical Failure of a vehicle:

A car is a maze of wires, fuses, relays and other major electrical parts. If any of these components have trouble operating it could result in a poor driving or non-driving vehicle. The following are 7 of the most common electrical problems in modern automobiles.

Dead Battery

A dead battery is the most common and obvious electrical problem. When you turn the key the car's engine won't turn over. You may still be able to use your lights and other accessories. This can usually be resolved with a jump start.

Battery Will Not Charge

However, a battery that will no longer hold a charge will need to be replaced. Batteries do wear out after many years of use.

Bad Alternator

A damaged or otherwise malfunctioning alternator could also prevent the battery from recharging. If your car begins to lose electrical function, such as dim headlights, as you drive, you can bet on alternator trouble.

Fatigued Starter or Solenoid

If the starter or solenoid goes out then the car's engine won't turn over. More than likely you'll hear a loud click or series of clicks if the starter has gone bad.

Bad Battery Cables

A corroded loose battery cable could be the root of a no start situation. Check the connections if the car won't start.

Blown Electrical Fuses

A blown fuse is a quick and easy fix, if it's the culprit of trouble.

Failed Spark Plugs

Loose or dirty plugs will affect the operation of a car. Common symptoms of spark plug trouble are lurching or rough idling.

For more detailed information, please visit https://www.autorepairmountainviewca.com/blog/common-auto-electric-problems.php
And https://www.ridetime.ca/blog/the-5-most-common-signs-that-your-cars-electrical-system-is-failing/

Checking the performance of vehicle:

The road test is one of the most important steps to take when troubleshooting a mechanical problem on any vehicle. When you listen to a complaint from the driver of the vehicle in question you may not get the whole story. There's many questions to ask before the road test like road speed, engine temperature, uphill or downhill, loaded or empty? …and so on.

AM Road Testing

One of the most important tasks which an auto technician performs before bringing the vehicle into the workshop for servicing is the pre-service road test.

Why is the Road Test So Important?

The primary reason to perform AM road test is to establish a base line. Technician needs to understand several things about the car like: how does the vehicle steer, brake, react over bumps, shift, sound, smell, perform… the list goes on and on! There are also the electrical items: wipers, air conditioning, gauges and warning lights. In understanding what's going on with a vehicle, there is nothing like actually experiencing

it. What sounds to the car owner like a loud click, may sound different to an auto technician. Actually driving the car is the best way to get at this baseline.

The technician keeps all these items from the road test in his mind while he is performing the service on a car so that he can provide an accurate report on vehicle's condition. This baseline report is performed and saved every time for maintenance.

For more detailed information, please visit https://baautocare.com/2014/06/10/car-repair-education-and-info-bid-90513-the-auto-shop-road-test-why-your-mileage-is-different-at-pick-up/ Also visit https://www.mechanicshub.com/toolbox/mechanic-road-test-service-call-tips/

Automotive job card

An Automotive job card is a card related to a specific job. It gives details of the time taken to do a piece of work and the materials used in the process. The job card can be used to allocate labour and material cost to a specific job. The operation number, work station, CMR and customer can be updated in the job card.

For more detailed information, please visit https://uae.yallamotor.com/car-news/ask-sam:-tips-on-automotive-service-job-card-writing-644 and http://www.reachautoerp.sg/2017/12/22/automotive-job-card/

MAKE					
TYPE					
YEAR/MODEL					
COLOUR					
REG. NO					
SPEEDO					
ENG. NO					
PETROL	E	¼	½	¾	F

SERVICE JOB SHEET

Job No:.....

Date:.....

Name:.....

Address:.....

.....Post Code:.....

Phone:.....Fax:.....

Repair Order No:.....

DATE IN:	AM PM	DATE OUT:	AM PM	CHARGE:	CASH:

REPAIR INSTRUCTIONS

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SUNDRIES USED ON SERVICE & REPAIR		
	TOTAL LABOUR	$
	TOTAL PARTS	$
	TOTAL LUBE	$
		$
		$
	SUBTOTAL	$
	GST	$
	TOTAL AMOUNT DUE	$

I authorise the work described above and agree to pay for labour, spare parts and materials requireed for that purpose at the repairers current rates and prices. The repairer shall not be liable for the loss of or damage to the vehicle, its accessories or contents while garaged or being driven in connection with the work authorised unless caused by the negligence of the repairer or his employees.

I agree to pay to the repairer reasonable storage charges if delivery of the vehicle is not taken within two days after notice is given by the repairer to me and the repairs have been completed.

Unless drawn specifically to the attention of the repairer I certify that the vehicle (including its parts and equipment) is registered for the purpose of the Motor Traffic Regulations 1935 and to the best of my knowledge is in a safe and thoroughly serviceable condition.

Signature of Owner (or agent):.....

Address of person leaving vehicle:.....

VIDEOS:

	**How to inspect the steering and suspension system** **https://youtu.be/VBcIdCGdulQ**
	**How to Test an Alternator** **https://youtu.be/LGB6ZEjGm7Q**

	**Basic Automotive Maintenance (Part 1)** **https://youtu.be/nFtbf4prm78**

AUTOMOTIVE MECHATRONICS

Module-7

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 7: 071400952 Perform Engine Tuning

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to perform engine tuning of vehicle.

Duration: 50 Hrs **Theory:** 12 Hrs **Practical:** 38 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Clean/Replace Air filter	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Locate air filter on the vehicle correctly Remove the air filter Service air filter for clog/dust removal Clean out the canister Fix air filter into the vehicle for normal operation Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task. Explaining the safety precautions regarding personal health and workplace Explaining the function of air filters. (i.e. how filters protect engine from dust particles) Importance of air filter and air cleaner box, how to dissemble the air cleaner box and reassembling procedure Describing timely cleaning and replacing process of air filter. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Combination Spanner Set Air Compressor
LU 2: Adjust Engine Idle Speed	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing engine tuning and its purpose	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper

	health and safety precautions at all times Find the adjustment screws and start the engine Adjust engine idle speed by adjusting throttle valve adjusting screw Refit all parts to finish the job Ensure housekeeping after completion of task	Explaining the purpose of engine idle speed Defining the procedure to adjust engine idle to standard RPM. Explaining the importance of engine idle speed for fuel economy. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Wire Brush Combination Spanner Set RPM Meter Multi Meter Allen key set
LU 3: Adjust Air Fuel Ratio	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Locate the air filter and remove it Find the adjustment screws on the carburetor Start the engine and warm-up to normal operating temperature Adjust screw to find the right mixture Refit the air filter assembly	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the purpose of adjusting air fuel ratio Defining the procedure to adjust standard air fuel ratio. Explaining the importance of air fuel ratio for fuel economy. Explaining the effect of too much rich or too much lean air fuel ratio on engine. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multi Meter Allen keys set

	Ensure housekeeping after completion of task		
LU 4: Adjust Tappet Clearance	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Remove tappet cover and related parts Turn the crankshaft to close the intake and exhaust valves Use feeler gauge to adjust tappet clearance as per workshop manual Refit all parts with defined procedure Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Understanding the importance of engine tappet adjustment to improve engine efficiency. Explaining the importance of tappet cover seal and how it prevents engine oil leakages. Explaining the standard procedure of tappet adjustment using appropriate tools. Explaining the types of tappets used in different vehicles and their replacement procedures Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set Allen keys set Feeler gauges Socket Spanners
LU 5: Clean/Adjust/Replace Spark Plugs	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Disconnect and clean	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the function of spark plug in engine, describe its types and heat ranges and method to clean using appropriate tools. Describing how to adjust spark plug electrode gap using	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set Allen keys set

	spark plug wire Remove and clean spark plugs Adjust plug gaps as per standard if required Replace spark plugs with new if required Ensure housekeeping after completion of task	spark plug gauges according to ignition coil output high voltages Explaining how to inspect the spark plug high voltage cables and to protect it from heated exhaust manifold Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Spark plug gauges Socket Spanners Multimeter
LU 6: Clean/Adjust/Replace Contact Breaker Point	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Clean and adjust C.B points Replace C.B points if required Clean distributor cap segments Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the purpose and importance of Contact Breaker point in ignition system. Explaining the dwell angle of C.B point Describing the procedure to replace and adjust C.B point gap range (0.4 ~ 0.5mm) Cleaning of C.B point by using appropriate tools. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set Allen keys set Socket Spanners Multimeter

Examples and illustrations

Car Engine Air Filter:

All fuel burning engines require a constant supply of air in order to function properly. Air filters clean the air before it is passed through to the cylinders to prevent dust, dirt, grit, and other debris from causing any damage. It plays a vital role in keeping your mill healthy.

To put it in perspective, you can compare an air filter with your nose as it filters out foreign particles before the air reaches your lungs, ensuring that the respiratory system can function properly. It's important that you clean your car air filter every 15,000 miles to prevent too much of this dirt and debris from entering the engine. The build-up will eventually result in a loss of engine performance and reduced fuel economy.

How to Clean Car Air Filter

Locate and Remove Air Filter
If you have the manual for your vehicle, take a look to locate your filter. If not you can check the Internet or ask your mechanic the next time your car is serviced. The filter will usually be fairly easy to access and is in a little canister. Most open either with a wing nut or a couple of clamps that can be easily removed. The filter usually just sits in there and you can simply pull it out.

Clean the Filter
If you choose to use soap, place the filter in a bucket with a soapy water solution. Swish it around and pull it out. Shake the filter to get as much liquid out as you can. Set it down on a towel to dry. Be sure to allow plenty of time to be sure it is completely dry.

For those who prefer the vacuum cleaner approach, run the vacuum over the filter for a minute or so on each side. Look it over again and remove anything that is left on the outside.

Clean the Canister
Whichever method you use to clean the filter, be sure to clean out the canister as well. A soft cloth or paper towel will do a good job. Just be sure not to leave any pieces behind. If you use anything wet, make sure the canister is completely dry before putting the filter back in. Once again, moisture left behind can cause engine damage.

Replace Filter
Put the filter back in. Reverse the process you used to open it. You are done. Remember that rather than paying to have a new filter put in you can save some money by doing it yourself. It's completely the same process - minus cleaning the filter.

For more detailed information, please visit https://auto.ndtv.com/news/what-does-a-car-engine-air-filter-do-1248487 and https://mobiloil.com/en/article/car-maintenance/basic-car-maintenance-tips/learn-about-car-air-filters also visit https://www.carsdirect.com/car-maintenance/how-to-clean-your-cars-air-filter and https://www.chipsaway.co.uk/blog/how-to-clean-your-car-air-filter/

https://www.carbibles.com/how-to-change-car-air-filter/#forward

How to Adjust a Car Idle

As cars get older and accrue more mileage, the idle speed of an automobile may be higher or lower than it needs to be, either wasting precious fuel or causing the car to stall out.

Step 1

Start the car and allow it to cycle through at least one period of going through a higher RPM rate. This will ensure that the engine is completely warmed up and able to adjust the idle properly.

Step 2

Locate the throttle body. You can recognize it by tracing your air intake hose as it exits the air filter. The next part that the air hoses connect to is a metal part called the throttle body. Look on the sides of the throttle body until you locate a screw or a rubber casing that houses a screw.

Step 3

Remove the rubber casing for the idle switch by prying it off with a screwdriver. This casing is usually installed by manufacturers but is not needed for the performance of the idle switch. If idle has been adjusted before, then there will be no covering over the screw.

Step 4

Disconnect the idle air adjustment valve, which regulates whether the idle opens or closes depending on the air intake. Disconnect the valve by locating the electrical connector behind the throttle body. Be careful not to touch any hot engine parts while working on the idle.

Step 5

Turn the idle screw, now exposed from the protective rubber coating, in order to adjust the idle. Loosen the screw in a counter-clockwise fashion to increase idle speed or tighten it in a clockwise manner in order to decrease the idle speed. Ideally, you will want the idle to rest at 650 RPM.

Reconnect the idle air controller valve electrical connection. Lower the hood and turn the car off.

Tip

- When adjusting the idle, only turn the screw 180 degrees at a time. Wait for 30 seconds to notice the new idle speed and then adjust the idle screw again if necessary.

For more detailed information, please visit https://itstillruns.com/adjust-car-idle-6104363.html

Air-Fuel Ratio

The ideal chemical air-fuel ratio, in which all the fuel is oxidized, is 14.7:1, that is, 14.7 parts air to 1 part fuel. A “rich” condition means more fuel is being used, an air-fuel ratio less than 14.7, while a “lean” condition means less fuel is being used, an air-fuel ratio higher than 14.7. For best power, most engines run rich, 12.5 to 13.5 at full-throttle. For best part-throttle low-load cruising fuel economy, engines typically run higher than 15. Proper balance is critical, however, as running higher than 14.7 in full-throttle high-load conditions could lead to engine damage.

For more detailed information, please visit iveabout.com/how-to-adjust-a-carburetor-4580451

Tappet:

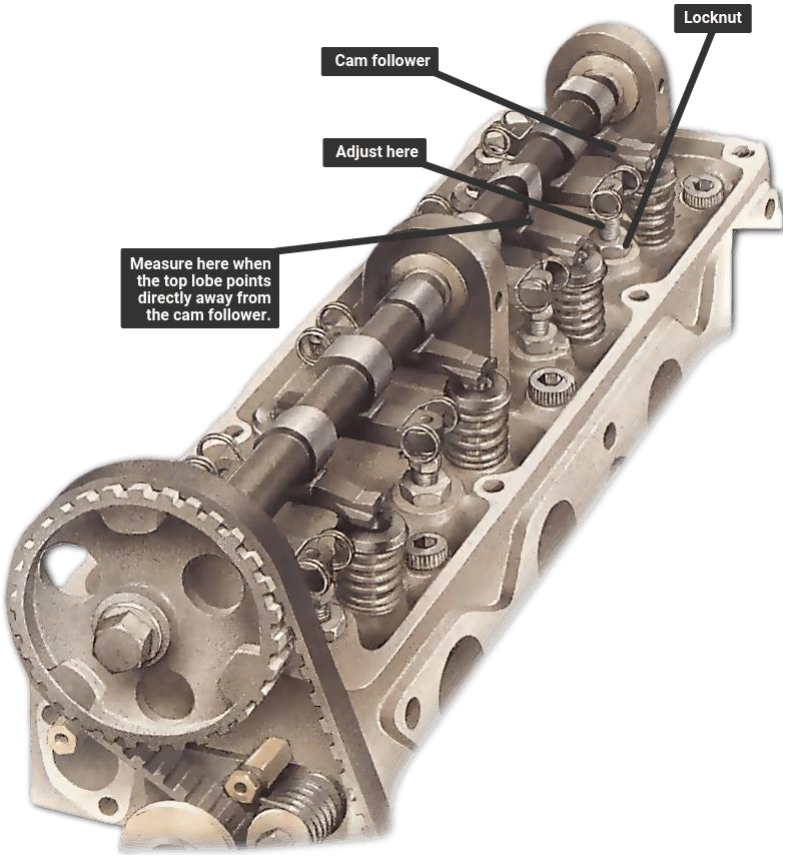
Tappets are devices that impart linear motion to some other component within the mechanism. In internal combustion engines though, the term tappet is used to describe the cam follower or the lifter.

These are present in overhead valve engines and are moved vertically by the action of rotating cams. These in turn, then drive push rods leading to rockers at the top of the engines. The rockers reverse this direction to open valves in the cylinder head.

Valve clearances are the small gaps between the tops of the valve stems and the part of the mechanism which presses on them to open the valves.

Check the clearances at regular intervals as specified in the car service schedule, and adjust if necessary. Reset the clearances whenever the cylinder head has been removed.

The job is commonly called adjusting the tappets.



For more detailed information, please visit https://www.howacarworks.com/engine/checking-and-adjusting-valves also visit https://www.pakwheels.com/blog/what-are-tappets-affect-performance/ and https://www.yourmechanic.com/article/how-to-inspect-valve-clearance-adjustment-by-robert-kulp

Spark Plug:

It's an essential part of any working combustion engine and all modern cars.

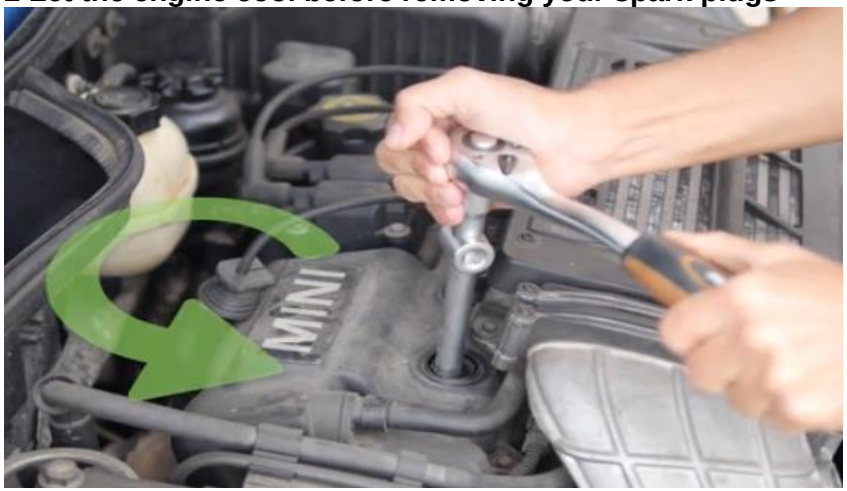
Replacing spark plugs:

In fact, some carmakers recommend replacement at 30,000-mile intervals. So always follow the spark plug service intervals shown in your owner’s manual to figure out when to replace spark plugs.

Removing Old Spark Plugs

1 Locate the spark plugs in car (refer to owner’s manual).

2 Let the engine cool before removing your spark plugs



3 Remove the first spark plug.

4 Measure the gap of the spark plug.

5 Check the existing plugs for wear.

Installing New Plugs

1 Get the correct replacement plugs.

2 Consider cleaning around the threads before reinserting the new spark plugs.

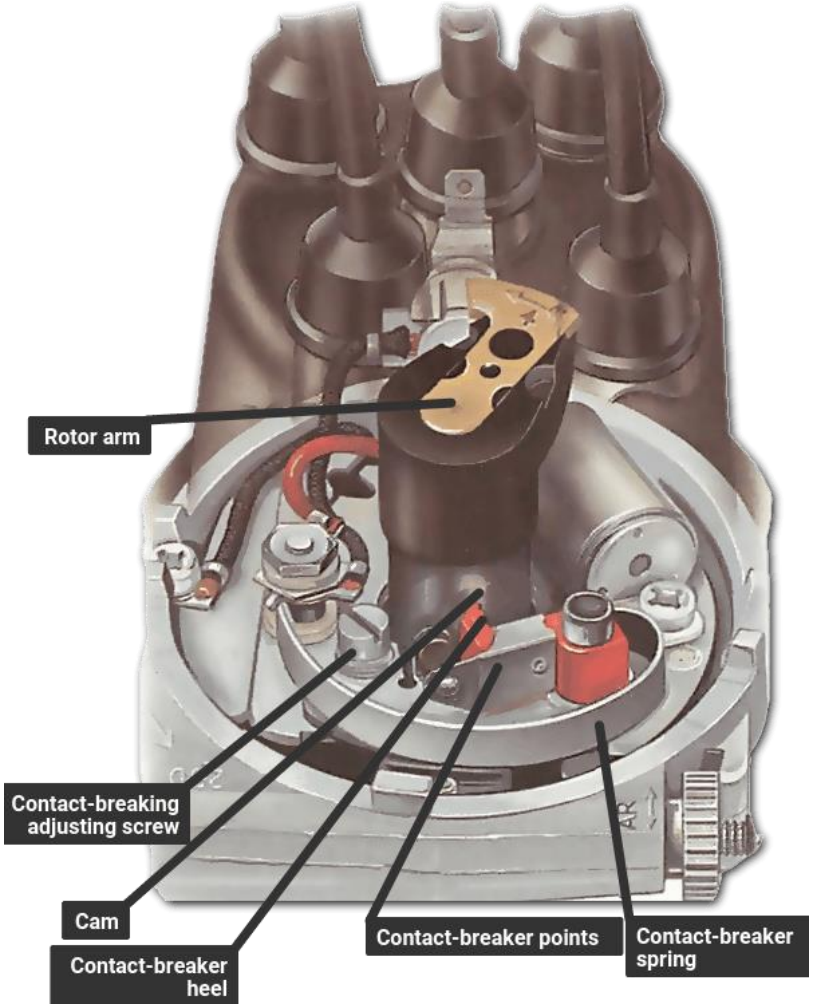
3 Insert the new plugs and tighten with your ratchet.

4 Lubricate the plugs prior to installing them.

For more detailed information, please visit https://www.wikihow.com/Change-Spark-Plugs-in-a-Car Also visit https://www.familyhandyman.com/automotive/car-maintenance/how-to-replace-spark-plugs/

Contact-breaker

The contact-breaker setting is often neglected, but it is vital to good running. Ideally, check and set the gap, between every major service, and replace the contact breaker after 6,000 miles or 10,000 km, or twice a year.



General Method of removing the points

Exact details vary from type to type; but on all types begin by removing the distributor cap, which is held on by spring clips or screws.

Setting the contact gap

The correct setting for the points is given in the car handbook or workshop manual.

Turn the crankshaft pulley in the direction of the engines normal rotation with a spanner or socket wrench, until the contact heel is on the tip of one of the distributor cam lobes , so that the contact-breaker points are fully open.

For more detailed information, please visit https://www.howacarworks.com/ignition-system/fitting-and-adjusting-contact-breaker-points

VIDEOS:

	**How to Clean and Replace Your Air Filter** **https://youtu.be/36fxZ_Z92is**
	**How to Adjust Idle Speed in Car Engine** **https://youtu.be/HSbgpzuuK8k**

	**How to adjust engine idle speed in car or pic up truck.** **https://youtu.be/xbkuOF1WXcw**
	**How To Adjust Air Fuel Mixture (three different ways) By Corvette Hop** **https://youtu.be/VEDFi2RdhQc**

	**Air Fuel Ratio - Explained** **https://youtu.be/9uFdrcPkMGE**
	**Engine Tappet clearance Adjustments Maruti Suzuki Alto Car** **https://youtu.be/HZxHTEwtJkg**

	**How To: Check, Set Gap, and Replace Spark Plugs** **https://youtu.be/ltkqiX_1i0E**
	**How to Install Adjust and Set Breaker Points** **https://youtu.be/0HQN2B_c8ME**

AUTOMOTIVE MECHATRONICS

Module-8

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 8: 071400953 Maintain Ignition System

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to maintain ignition system of vehicle.

Duration: 50 Hrs **Theory:** 12 Hrs **Practical:** 38 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Maintain Contact Breaker Ignition System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Check battery voltage Check ignition switch using Multimeter. Check ignition coil Check/ replace and adjust CB point gap Adjust firing order Clean/adjust/replace spark plugs Check ignition distributor components Replace capacitor/condenser, if required Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace. Describing main components of ignition distributor (Distributor cap, rotor arm, cam, contact breaker point, base plate, vacuum and centrifugal advance mechanism) Describing the procedure to check battery performance (Voltages, Electrolyte Specific gravity) Describing the working of ignition switch and coil. Testing of ignition switch and coil using Multimeter Describing the procedure to replace and adjust C.B point gap range (0.4 ~ 0.5 mm) and method to clean using appropriate tools Explaining the purpose of firing order and procedure to adjust firing order. Describing how to adjust spark plug electrode gap using spark plug gauges according to ignition coil output high voltages Describing the function of capacitor and how to check it by using Multimeter. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set WD-40 Grease Oil Gun Electric Tester Socket Spanner

LU 2: Maintain Electronic Ignition System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Check battery voltage Check ignition switch using Multimeter. Check ignition coil Service distributor Check induction coil for resistance Replace ignition module, if required Service spark plugs Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing the working of electronic ignition system and how ECU controls the electronic ignition system Describing main components of electronic ignition system (Distributor cap, rotor arm, reluctor, pick-up assembly, base plate, vacuum and centrifugal advance mechanism) Describing the working of ignition switch and coil. How to check it using Multimeter Describing the procedure of servicing of ignition distributor Describing how to adjust spark plug electrode gap using spark plug gauges according to ignition coil output high voltages Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set WD-40 Grease Oil Gun Electric Tester Socket Spanner OBD-II Scanner
LU 3: Maintain Coil-On-Plug (COP) System	**The trainee will be able to:** Select appropriate tools and equipment.	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper

	Check battery voltage with Multimeter Check ignition coil resistance Connect OBD-II scanner for scanning engine & note down the code Check performance of sensor Replace the faulty parts Reconnect the OBD-II scanner Verify the maintenance of fault Ensure housekeeping after completion of task	Explaining the advantages of coil on plug system and distributor less ignition system. Describing the procedure to check resistance of ignition coil using Multimeter. Explaining the usage of OBD-II Scanner for faults diagnosis and rectification of these faults on Coil-On-Plug (COP) ignition system and distributor less ignition system. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set WD-40 Grease Oil Gun Electric Tester Socket Spanner OBD-II Scanner

Examples and illustrations

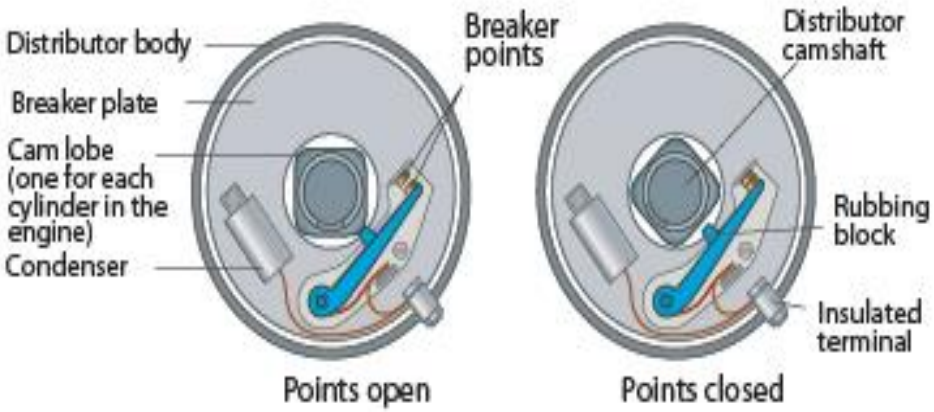
Contact Breaker Point Ignition Systems

The contact breaker is a mechanically operated electrical switch that is fixed to the distributor base plate and opened and closed by the distributor cam with the rotation of the engine. This process builds up and collapses the magnetic field in the ignition coil in order to create a high-voltage output of the ignition coil.

Contact breaker point ignition systems provide a simple means of establishing and interrupting the current flowing in the primary ignition circuit.

A basic system consists of:

- The battery: Provides a source of energy.
- The ignition switch: Provides the driver control over system operation.
- An ignition coil: Provides step-up transformer action.
- Contact breaker points: Opened and closed by lobes on the distributor cam as the engine rotates to make and break the primary circuit at the correct time in the ignition cycle



- A capacitor: Assists in the rapid collapse of the ignition coil's magnetic field. Any voltage surge across the contacts will charge the capacitor, rather than cause damaging arcing. The condenser is typically mounted on the breaker plate or on the side of the distributor.
- A distributor: Rotates at half the speed of the crankshaft to house the contact breaker points and distribute the high voltage from the ignition coil and spark plugs, thus igniting the air–fuel mixture in each cylinder in the correct firing order.
- Connecting wires and leads suitable for conducting the current flowing in the ignition system, at the appropriate voltage level.

Maintenance of Ignition Systems

The complete or partial failure of an ignition system, was the most common cause of vehicle breakdowns in past. This could have been prevented if the recommended maintenance schedule had been carried out at the appropriate time. With the use of modern breaker less systems, many maintenance activities have been reduced, like breakdown due to faulty adjustment.

Maintenance of a Conventional Ignition system

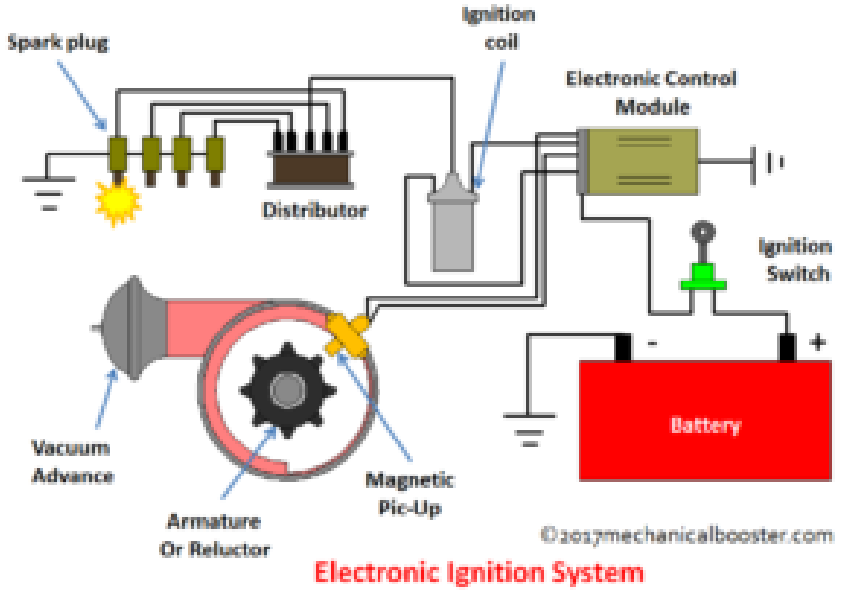
Many manufacturers recommend that the ignition system should be checked after every 10,000 km use and the following activities are recommended during the checking, (a) Contact breaker is replaced and adjusted. (b) Spark plugs are cleaned and tested, (c) Wiring is checked for condition and security. (d) Dirt and moisture is removed from the coil and any other surface, exposed to HT charges. (e) Lubrication of the cam face and also the moving parts of the automatic advance system is carried out.

For more detailed information, please visit http://prod.lv2014.gener8cms.net/index.php/55-disc-brakes/section-9/igniso/1284-contact-breaker-point-ignition-systems Also visit http://what-when-how.com/automobile/maintenance-of-ignition-systems-automobile/
And http://constructionmanuals.tpub.com/14273/css/Contact-Point-Ignition-System-65.htm

Electronic ignition system

It is the type of ignition system that uses electronic circuit, usually by transistors controlled by sensors to generate electric pulses which in turn generate better spark that can even burn the lean mixture and provide better economy and lower emission.

Main Components



1. Battery
It is the powerhouse of the ignition system as it supplies the necessary energy to the ignition system, same as battery coil ignition system.

2. Ignition Switch
It is the switch used in ignition system which governs the ON and OFF of the system, same as the battery coil ignition system.

3. Ignition Control Module or Control Unit of Ignition System
It is the brain or programmed instruction given to the ignition system which monitors and control the timing and intensity of the spark automatically. It is the device that receives voltage signals from the armature and set the primary coil to ON and OFF, it can be placed separately outside the distributor or can be place in electronic control unit box of the vehicle.

4. Armature

Contact breaker points of battery ignition system is replaced by an armature which consists of a reluctor with teeth (the rotating part), vacuum advance and a pickup coil (to catch the voltage signals), Electronic module receives the voltage signals from the armature in order to make and break the circuit, which in turn sets the timing of the distributor to accurately distribute current to the spark plugs.

5. Ignition Coil

Same as the battery ignition coil system ignition coil is used in electronic ignition system to produce high voltage to the spark plug.

6. Ignition Distributor

As the name indicates it is the device use to distribute the current to the spark plugs of the multi cylinder engine.

7. Spark Plug

Spark plug is used to generate spark inside the cylinder.

For more detailed information, please visit https://www.mechanicalbooster.com/2017/11/electronic-ignition-system.html and https://www.pepboys.com/auto-care/diy/guides/service-your-ignition also visit http://www.munfarid.com.pk/2017/11/28/how-to-repair-automobile-electronic-ignition-system/

Coil-On-Plug Ignition System

The Coil-On-Plug (COP), also known as **direct ignition systems**, which includes all electronic controls found inside a car with DIS (Distributior less Ignition System). However, instead of two cylinders sharing a single coil, each coil in the Coil-On-Plug ignition system utilizes a single cylinder. It has twice the time to develop the maximum magnetic field. Some cars with the COP can generate 40,000 to 50,000 volts and stronger sparks.

As the coil mounts directly on top of the car spark plug, it does not require the spark cables as the plugs receive the firing voltage directly. The coils inside this type of ignition system are at risk of damage by degreasers and water during engine cleaning. Hence, car drivers need to make sure to wrap in plastic and protect them before any cleaning begins. Therefore, the Coil-On-Plug ignition system is also amongst popular car ignition systems in the automotive industry.

Coil-on-plug ignition misfires

COP problems can include many of the same ailments as other ignition systems such as misfiring, hard starting or a no start. Spark plugs can still be fouled by oil or fuel deposits as well as pre ignition and detonation. So COP ignition systems are not immune to trouble. It is important to remember that ignition misfire can also be caused by other factors such as worn or fouled spark plugs, lose or damaged coil connectors or

terminals, dirty fuel injectors, low fuel pressure, intake vacuum leaks, loss of compression in a cylinder, even a tankful of "bad" gas contaminated with water. These other possibilities should all be ruled out before a COP unit is replaced.

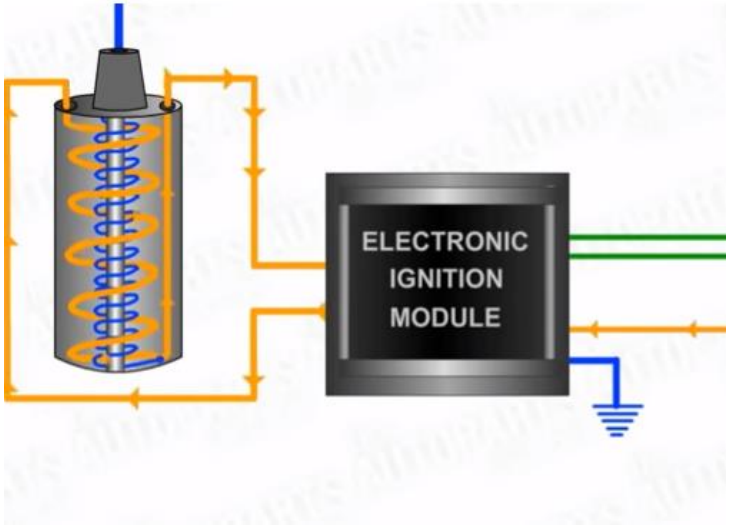
How to fix a broken coil pack.

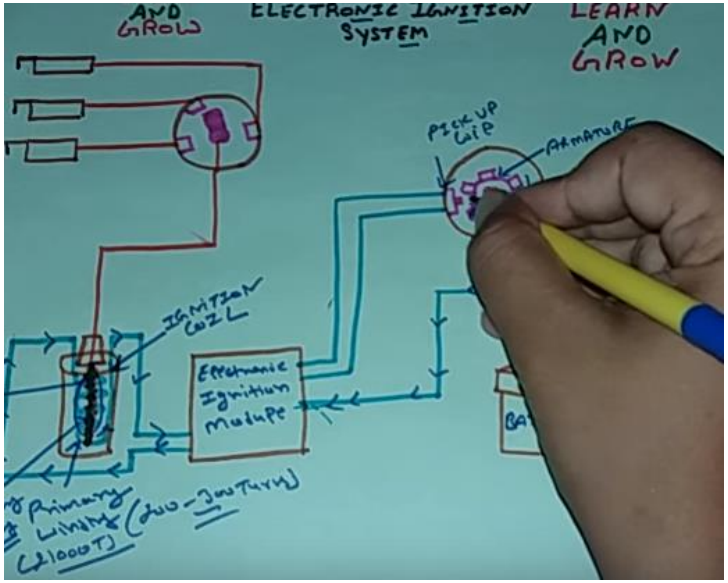
A coil pack is typically a set of coils all in one unit that can provide spark to each spark plug wire, while coil-on-plug systems would be one individual coil over each spark plug

1. Remove the negative battery cable.
2. Locate coil packs or ignition coil in the engine bay. If your car has a distributor, follow the wire that is in the center of the distributor cap to find the ignition coil. Cars with coil packs usually have them mounted near a valve cover. Coil on plug ignition coils are typically placed near or directly over each spark plug. Remove any plastic engine covers or air intake tubes to gain access to the coils.
3. Unplug the wiring harness by pushing the tab and pulling off the electrical connector.
4. Remove the retaining bolts holding the coil in place. Once unbolted, the coil pack can be easily pulled out of the engine now, but be aware that some models have a locking tab that needs to be opened.
5. If it is time to change the spark plugs, do that now.
6. Apply dielectric grease inside the end of the coil-on-plug style, as this prevents the boot from sticking to the spark plug and helps keep water out of the connection.
7. Slide the coil into place, pressing firmly so the boot clicks onto the spark plug. Reattach the electrical connection and the coil pack retaining bolt.
8. Proceed to the next coil pack until all units have been replaced. Finally, reconnect the negative battery cable.

For more detailed information, please visit https://shop.advanceautoparts.com/r/advice/car-technology/three-types-of-vehicle-ignition-systems-and-how-they-work and https://www.aa1car.com/library/copign.htm also visit https://shop.advanceautoparts.com/r/car-projects/how-to-replace-ignition-coils

Videos:

	**How to - Replacing Contact Breaker Points // Supercheap Auto** **https://youtu.be/Y9wZvcr3v2c**
	**How Electronic Ignition System Works** **https://youtu.be/QYx8J_5l5wY**

	**Electronic Ignition System** https://youtu.be/uWIAD3oQXa8
	**Coil on Plug Ignition System Diagnostics** https://youtu.be/Xid1szp5a-g

	**Coil on Plug quick Test** https://diy-auto-repair.wonderhowto.com/how-to/quickly-test-functionality-coil-plug-system-almost-any-vehicle-396573/

AUTOMOTIVE MECHATRONICS

Module-9

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 9: 071400954 Maintain Fuel Control System-I

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to Maintain Fuel Control System-I.

Duration: 50 Hrs **Theory:** 12 Hrs **Practical:** 38 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Maintain Electronic Fuel Injection (EFI) System	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Check performance of Electronics Control Unit (ECU) Check performance of Mass Air Flow (MAF) Sensor Check performance of Oxygen Sensor Check performance of Throttle Valve Position Sensor Check performance of Intake Air Temperature Sensor Ensure housekeeping	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the functions of electronic fuel injection system (EFI). Describing how EFI system plays important role in fuel economy and enhancing engine efficiency Explaining the importance of Electronics Control Unit (ECU) in EFI system. How it can reads the sensors and controls the actuators of vehicle Defining the function of all sensors (Mass Air Flow Sensor, Oxygen Sensor, Throttle Position Sensor and Intake Air Temperature Sensor) of fuel metering system Defining the function of all actuators (Idle air control valve and injectors) of fuel metering system Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set Electric Tester Socket Spanner OBD-II Scanner

	after completion of task		
LU 2: Maintain Common Rail Direct Injection (CRDI) System	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Service and Cleaning of Diesel Injectors Check fuel pressure at fuel rail inlet and outlet Check Fuel Pressure Sensor Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the function of diesel injectors in diesel fuel system. Describing the purpose of servicing diesel injectors. Explaining the function of fuel rails in diesel fuel system. Describing the procedure to check fuel pressure at inlet and outlet ports. Explain the function of fuel pressure sensors and how to check them using Multimeter. Explaining the procedure to connect OBD-II Scanner to perform fault diagnoses and rectification of faults. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set Electric Tester Socket Spanner OBD-II Scanner
LU 3: Maintain Motronic Control Unit for CNG System	**The trainee will be able to:** Select appropriate tools and equipment. Ensure work safely at all times, complying with health and safety	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the working of CNG system. Describing the function	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush

	precautions, regulations and other relevant guidelines. Check performance of solenoid valve for fuel selection (CNG / Gasoline) Maintain solenoid valve at CNG kit. Adjust the CNG regulating screw. Maintain pressure setting of CNG Check performance of oxygen Sensor Check performance of throttle valve position sensor Ensure housekeeping after completion of task	and importance of Motronic Control Unit. Describing the function of solenoid valves and how to check it using Multimeter. Describe the procedure to adjust the CNG regulating screw to desired value. Explaining the working of CNG reducer kit. Explain the function of all sensors (Oxygen Sensor, Throttle Position Sensor, Camshaft and Crankshaft Position Sensors) and how to check them using OBD-II Scanner. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Combination Spanner Set RPM Meter Multimeter Allen Keys set Electric Tester Socket Spanner OBD-II Scanner

Examples & Illustrations:

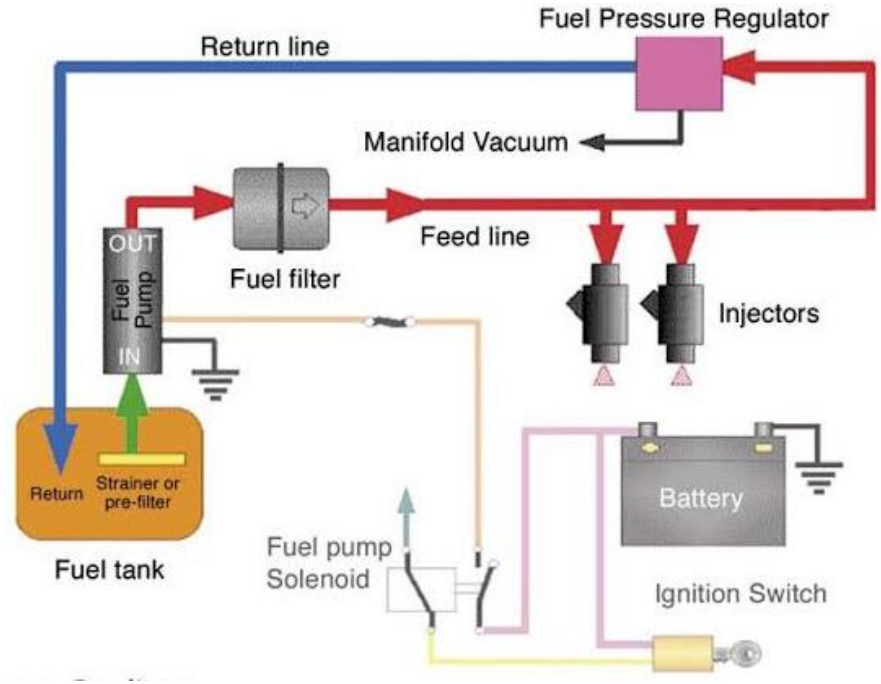
Fuel Injection ECU (Engine Control Unit) System

A fuel injection ECU system is an important part of a fuel injected engine because it serves several functions aside from regulating and maintaining the amount of fuel and air that the engine needs to increase horsepower.

Electronic Fuel Injection System

The Electronic Control Unit is an integral part of the EFI or the Electronic Fuel Injection, which is a type of fuel injection system that is now commonly used among cars. EFI can be divided into 3 sub-systems: air induction system, fuel delivery system and the electronic control system.

The electronic control system of an EFI is where you will find the ECU. Aside from the ECU, this is also where you will find various sensors, fuel injector assemblies and any related fuel injection wiring.



Functions of a Fuel Injection ECU System
A fuel injection ECU system has several functions. Probably one of the most important function of the ECU is it controls the fuel mixture used by the engine. The Engine Control Unit or ECU determines the amount of fuel that should be injected into engine. This computer program receives several data and computes them to come up with the appropriate amount. The ECU of an Electronic Fuel Injection also determines when is the right time to deliver the air and fuel ratio to the engine. This process is called injection duration or injection pulse width.

Most cars also have a built in control system in their ECU for idle speed. Idle speed is controlled through the programmable throttle stop. Aside from idle speed, an ECU controls the ignition timing of an engine. This is done by adjusting the time when the spark ignition plug should be sparked, resulting in better power.

The ECU system also controls the variable valve timing. This simply means that it controls when the valves will open. This is done to increase performance and power of the car since the flow of air into the cylinder is maximized.

Based on the data gathered by the ECU sensors, it can basically control the engine's speed, coolant temperature, throttle angle and exhaust oxygen content.

System Operation of a Fuel Injection ECU System
A fuel injection ECU works by pulsing or controlling the fuel injectors in the engine. This is done by switching the injector ground circuit on or off depending on what is required by the engine. If the injector ground circuit is turned on the fuel is sprayed at the back of the intake valve.

When the fuel is sprayed, it mixes with the air. Due to the low pressures in the intake manifold, the fuel and air mixture then vaporizes. This is where the fuel injection ECU sensor works. It gives a signal to the ECU to provide the right air and fuel ratio. The ratio of air and fuel mixture is determined by the volume of air taken in by the engine and the engine's rpm. The sensors also provide the ECU with several other data including workload, exhaust gas composition as well as engine and ambient temperatures. All of these data gathered by the ECU sensor determines the amount of fuel needed to be injected and mixed with the incoming air.

Function of sensors:

The ECU, though, is useless without its sensors, just like our brains wouldn't be much good at interpreting the world around us without our senses. While there are dozens of sensors in a car that feed information to the ECU like the one that triggers that annoying "Check Engine" light, we'll just list the ones that create the fuel map.

- **Mass Air Flow (MAF) Sensor:** This sensor measures the amount of air coming into the engine. Less air is drawn into the engine when it's idling, so less fuel is needed. More air is drawn into the engine once the car's in motion, so more fuel is needed from the injectors.
- **Oxygen (O2) Sensors:** Located in the exhaust system, these sensors detect the amount of unburned oxygen and fuel coming from the engine. The ECU can adjust the amount of fuel injected into the engine to increase efficiency.
- **Throttle Position Sensor (TPS):** This sensor tells the computer how hard and how quickly the driver pushes on the gas pedal. The farther and faster the pedal is pushed, the wider open the throttle moves, increasing the amount of fuel that needs to be added to the engine for speed.
- **Manifold Absolute Pressure (MAP) Sensor:** This sensor measures changes in the engine's manifold pressure, which tells the ECU how much load the engine needs to bear (towing or going uphill) and how fast it needs to happen (speeding up or slowing down). If the sensor reads high pressure, the ECU will lower the engine vacuum and add more fuel. If there is low pressure, the ECU will raise the vacuum and dial down the fuel injection.
- **Vehicle Speed Sensor (VSS):** This tells the ECU how fast the car is moving and adjusts the fuel accordingly. This sensor also sends signals to the speedometer and the cruise control computer.

For more detailed information, please visit https://auto.howstuffworks.com/fuel-efficiency/fuel-consumption/fuel-mapping-computer1.htm and https://www.carsdirect.com/used-car-buying/how-a-fuel-injection-ecu-system-works-engine-control-unit also visit https://jalopnik.com/how-electronic-fuel-injection-works-499902815 and https://www.howacarworks.com/basics/how-a-fuel-injection-system-works

CRDI (Common Rail Direct Injection)

It is direct injection of the fuel into the cylinders of a diesel engine via single, common line, called the common rail which is connected to all the fuel injectors.

The main advantages of the common rail direct fuel injection can be summarized in reduction of exhaust and noise emissions, better fuel efficiency and improved overall engine performance. The system consists of a high-pressure pump, injectors, a rail, and an electronic control unit.

Fuel tanks

There are many different types and shapes of fuel tanks. Each size and shape is designed for a specific purpose. The fuel tank must be capable of storing enough fuel to operate the engine for a reasonable length of time. The tank must be closed to prevent contamination by foreign objects. It must also be vented to allow air to enter, replacing any fuel demanded by the engine. Three other tank openings are required--one to fill, one to discharge, and one to drain.

Fuel lines

There are three types of diesel fuel lines. These include heavyweight lines for the high pressures found between the injection pump and the injectors, medium weight lines for the light or medium fuel pressures found between the fuel tank and injection pump, and lightweight lines where there is little or no pressure.

Fuel filters

Diesel fuel must be filtered not once, but several times in most systems. A typical system might have three stages of progressive filters--a filter screen at the tank or transfer pump, a primary fuel filter, and a secondary fuel filter. In series filters, all the fuel goes through one filter and then through the other. In parallel filters, part of the fuel goes through each filter.

Fuel transfer pumps

Simple fuel systems use gravity or air pressure to get fuel from the tank to the injection pump. On modern high speed diesel engines, a fuel transfer pump is normally used. This pump, driven by the engine, supplies fuel automatically to the diesel injection system. The pump often has a hand primer lever for bleeding air from the system. Modern injection pumps are almost all jerk pumps which use the plunger and cam method of fuel injection.

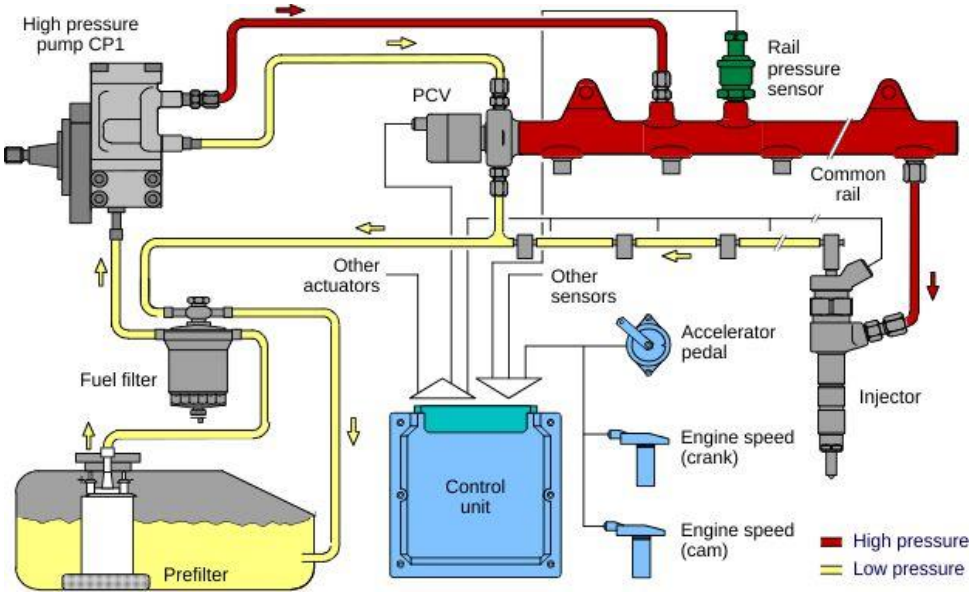
Fuel injection systems

There are four primary systems for injecting fuel:

1. Individual pump and injector for each cylinder

2. Combined pump and injector for each cylinder (*unit injector type*)
3. One pump serving injectors for several cylinders (*distributor type*)
4. Pumps in a common housing with injectors for each cylinder (*common rail system*)

The common rail system is rapidly gaining popularity for on-road applications. The in-line and distributor types are used on off-road vehicles and industrial machines.



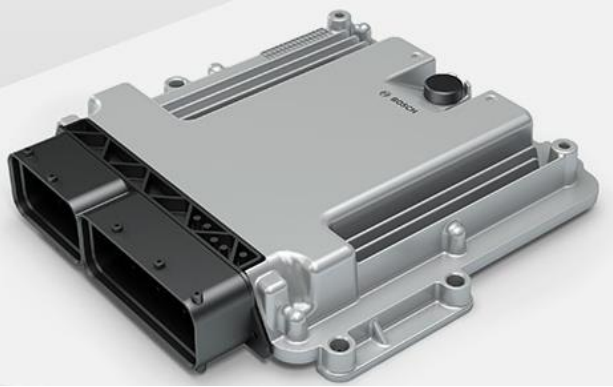
Fuel injectors

Diesel fuel injectors are arguably the most important fuel system component. The job of the injectors is to deliver a precise amount of atomized and pressurized fuel into each cylinder. Highly atomized, pressurized fuel distributed evenly throughout the cylinder results in increased power and fuel economy, decreased engine noise, and smoother operation.

For more detailed information, please visit https://www.slideshare.net/YashwadhanSahi/common-rail-direct-injection and https://www.farinia.com/automotive/common-rail/what-is-common-rail also visit https://www.ezoil.com/resources-diesel-engines-diesel-fuel-system-basics and http://vu67.ucoz.ru/toplivnaja_sistema_dvigatelja_evro-3.pdf

Motronic control unit for CNG system

The Motronic control unit for CNG controls the mixture formation (air mass, injected CNG mass and time of the injection), ignition and exhaust-gas treatment. CNG-specific functions in the CNG system are the actuation of the CNG injectors, the pressure regulator, the tank shut-off valves as well as the monitoring of the high-pressure and medium-pressure sensor. In bi-fuel systems, Motronic controls the engine operation with CNG and gasoline. If the tank runs out of CNG, it automatically switches to gasoline operation.



How does CNG Work

For an inside look at how a CNG/gasoline bi-fuel system works, here are the step by step details:

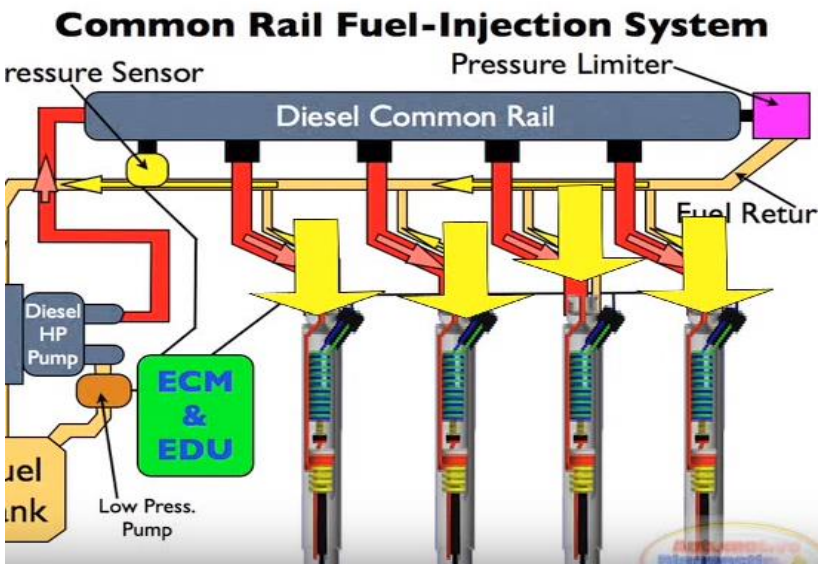
- CNG is fed into the high pressure cylinders through the natural gas receptacle at fueling station.
- CNG leaves the storage cylinders (Gas Tanks) and passes through the master manual shut-off valve.
- CNG enters the engine area via high pressure tubes.
- The pressure regulator accepts the CNG and reduces its pressure from 3,600 psi to appropriate manifold intake pressure.
- The natural gas solenoid valve lets the natural gas flow from the regulator into the fuel injectors. This same solenoid valve also shuts off the natural gas when the engine is off.
- CNG mixes with air as it enters the engine's combustion chambers.

For more detailed information, please visit https://www.bosch-mobility-solutions.com/en/products-and-services/passenger-cars-and-light-commercial-vehicles/powertrain-systems/compressed-natural-gas/motronic-electronic-control-unit-for-cng-systems/

And https://www.team-bhp.com/forum/diy-do-yourself/159662-diy-pictorial-guide-tuning-cng-lpg-systems.html also visit https://www.cngunited.com/how-does-cng-conversion-work/

Videos:

	**How to Clean Fuel Injectors in Your Car (Without Removal)** **https://youtu.be/bKGI9N_yWd0**
	**Working of Electronic Fuel Injection System** **https://youtu.be/7xHrk_YI1WQ**

	**Diesel Common Rail Injection Facts 1** **https://youtu.be/cIkMtnd3LGQ**
	**CNG kit maintenance part 1. Car CNG gas kit repair and maintenance** **https://youtu.be/ljWZ-heKuAI** **Also visit** **CNG kit maintenance part 2. Car CNG gas kit repair and maintenance** **https://youtu.be/OTYfoclNtwg** **and** **CNG kit maintenance part 3. Car CNG gas kit repair and maintenance, setting and tuning** **https://youtu.be/jZDFO1bxhg0**

AUTOMOTIVE MECHATRONICS

Module-10

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 10: 071400955 Service Comfort & Safety System-I

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to maintain Suspension System, Power Window & Central Locking System, Seat Belt and Heat Ventilating and Air Conditioning system.

Duration: 50 Hrs **Theory:** 15 Hrs **Practical:** 35 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Maintain Suspension System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Maintain tie rod Maintain ball Joint Maintain shock absorber coil spring Maintain link rod Maintain lower/upper arm bushing Maintain hub bearing or stud Maintain inner/outer CV joint Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace. Describing main components of Suspension System (Leaf springs/Coil springs, Shock Absorbers, Suspension Arms & Trailing Arms, Tie rods, Torsion bars, Lateral Rods etc.).Describing types of tie rods, their inspection procedure, Describing types of ball Joint, their inspection procedure, proper removal and refitting procedures Describing types of coil springs according to load capacity and shapes, their inspection procedure, proper removal and refitting procedure Explaining stabilizer bars and their links, their inspection procedure, proper removal and refitting Describing types of rubber bushing used in lower and upper arms, their inspection procedure, proper removal and refitting procedure Explaining different types of hub/wheel bearings (Ball Bearings with or without spacers, Roller Bearing and Taper roller bearings). Explaining wheel studs repairing and replacing. Explaining different types of CV Joints,(Tripod CV joint, Rzeppa CV joint and Cross Groove CV Joint) their internal parts(Inner and outer race, tripod, cage, balls, boots and their clamps) and	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set WD-40 Grease Oil Gun Electric Tester Socket Spanner

		inspection procedure, proper removal and refitting Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	
LU 2: Maintain Power Window & Central Locking System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Diagnose failure in power window system Diagnose failure in central locking system. Service and re-assemble power window system. Service and re-assemble central locking system. Check fuse, relays, electrical wire harness and connector of power window and central locking system. Check actuator assembly of central locking system. Check motor of power window system.	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing different components and their working of power window system (Switches, wiring harness, motors, etc.) Explaining different components and their working of central locking system (Remote Switches, wiring harness actuators, etc.) Servicing/replacing the components of power window system (Switches, motors, etc.) Servicing/replacing the components of central locking system (Remote Switches, actuators, etc.) Checking/replacing procedure of fuses, relays, wiring harness, connectors of power window and central locking system. Checking/replacing procedure of actuator assembly of central locking system. Describing procedure for checking motors of power window system Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set WD-40 Grease Oil Gun Electric Tester Socket Spanner OBD-II Scanner

	Ensure housekeeping after completion of task		
LU 3: : Verify Seat Belt	**The trainee will be able to:** Select appropriate tools and equipment. Observe occupational health and safety precautions at all times Check seat belt indication lamp Check fuse, relays, electrical wire harness and connector. Check operation of seat belts. Check function of power seat switches. Check function of power seat motor and rectify failures. Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing the procedure to check seat belt indication lamp (for example; the indication lamp must be OFF when seat belt is fastened and it must go ON when seat belt is not fastened properly). Describing the procedure to check fuse, relays, electrical wire harness and connector by using Multimeter and test lamp. Importance of seat belt while driving. Describing procedures to check the locking of seat belt on jerk or emergency braking. Explaining the working of power seat switches and their location on seats. Explaining the function of ECU which controls adjusting motors of seats according to requirements Diagnosing the power seat motors for proper functioning (tilt, recline, and seat elevation) and replace faulty motors. Describing procedure for cleaning and storing of tools and equipment at workplace. Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set RPM Meter Multimeter Allen Keys set WD-40 Grease Oil Gun Electric Tester Socket Spanner OBD-II Scanner
LU 4: Service	Select appropriate tools	Understanding of appropriate tools and equipment for performing	Relevant PPEs

Heat Ventilating system	and equipment. Observe occupational health and safety precautions at all times Check performance of radiator and rectify failures. Check leakages of heater hoses and rectify failures. Check blower fan and rectify failures. Check electrical system of heat ventilation and rectify failures. Check performance of thermostat and rectify failures. Check leakages of heater core and rectify failures. Check performance of heater control valve and rectify failures. Ensure housekeeping after completion of task	this task Explaining the safety precautions regarding personal health and workplace Describing various parts of radiator (Radiator neck, tubes and fins, upper & lower tanks). Explaining how to test leakage and condition of radiator. Defining the procedure to perform leakage test of hoses and cooling/heating systems using leakage tester. Describing importance and working of blower fan, procedure to test blower fan motor by using Multimeter and replacing the faulty parts. Describing working of electrical system of heat ventilation using Multimeter and voltage tester and replacing the faulty parts. Explaining the procedure for testing thermostat operation.(thermostat starts to open at about 83 degree Celsius and completely opens at 90 degree Celsius) Explaining the procedure to perform leakage test of heater core using leakage tester and repair/replace the heater core. Explaining the procedure check heater control valve from dashboard knob/switch and repair/replace the faulty knob/switch Describing procedure for cleaning and storing of tools and equipment at workplace Importance of housekeeping	Philips/Flat Screw Driver Set Cotton Rags Emery Paper Wire Brush Combination Spanner Set Socket Spanner Multimeter Allen Keys set WD-40 Grease Oil Gun Voltage Tester
LU 5: Service Air-Conditioning (AC) System	Select appropriate tools and equipment. Observe occupational health and safety	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and	Relevant PPEs Philips/Flat Screw Driver Set

	precautions at all times Check performance of AC compressor and rectify failures. Check performance of AC condenser with fittings and rectify failures. Check radiator fan and rectify failures. Check performance receiver/dryer or accumulator and rectify failures. Check blower fan and rectify failures. Check performance of expansion valve and rectify failures. Check leakages of evaporator and rectify failures. Perform refrigerant leak test. Re-charge AC refrigerant. Check electrical system of air conditioning and rectify failures. Ensure housekeeping	workplace Explaining different types of A/C Compressors and their internal parts(Reciprocating AC Compressor, Scroll AC Compressor, Screw AC Compressor, Rotary AC Compressor, Centrifugal AC Compressor) Describing the procedure of pressure testing of AC condenser and its repairing/replacing. Explaining the procedure of checking radiator fan and its motor using Multimeter and replacing faulty motor. Describing the procedure to check receiver/dryer or accumulator through sight glass Describing importance and working of blower fan. Explaining the procedure to test blower fan motor using Multimeter and replacing the faulty parts. Describing importance and working of expansion valve. Explaining the procedure to test expansion valve and replacing the faulty expansion valve. Describing the procedure to check evaporator leak, refrigerant will collect in the evaporator case, and pass into the passenger compartment through the a/c vents on the dash. Test the vent nearest the evaporator with an electronic leak detector. Explaining dye-based air conditioning leak-down test which uses a colored dye to find Freon leaks in A/C system. In this test, a colored dye is injected into the A/C system which will be visible under ultra-violet light at the point of a leak anywhere in the system. Describing the procedure for repairing leakages and re-charging A/C refrigerant into the system (30 to 40 psi on Low pressure side.) While the high pressure reading 225 to 250 psi for 134 a, When the system is fully charged. Explaining the electrical system checks of car A/C system and their rectification procedure. (Electrical Checks include A/C Compressor clutch testing, Blower fan Testing, Condenser fan,	Cotton Rags Emery Paper Wire Brush Combination Spanner Set Socket Spanner Multimeter Allen Keys set WD-40 Grease Oil Gun Voltage Tester Manifold Gauge Set with Hose and Manual Couplers A/C Recovery & Recycling Machines A/C Flushing Equipment A/C Vacuum Pumps A/C Manifold Gauge Sets A/C Charging Scales A/C Retrofit Adapters & Gaskets A/C Orifice Tube Tools

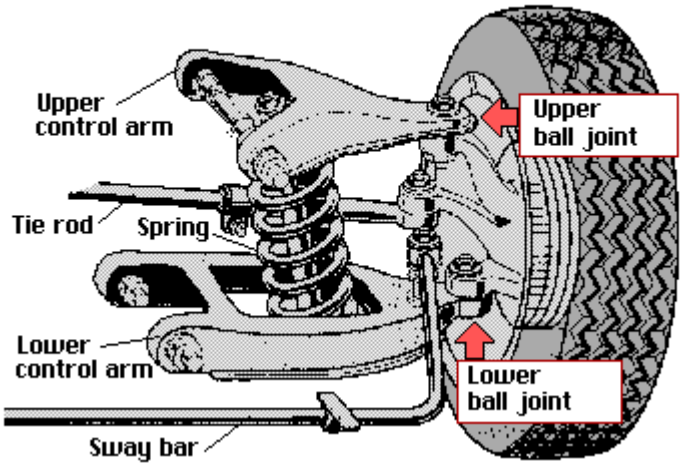
	after completion of task	Pressure switch testing using Multimeter). Explaining the procedure of pressure testing of evaporator for leakage finding and repairing/replacing the evaporator. Importance of housekeeping	Clutch A/C Holding Tool Line Disconnect Tools Refrigerant Identifiers Diagnostic Leak Detection Valve Core Remover/Installer

Examples & illustrations:

Ball Joints

Ball joints are chassis parts that connect the steering knuckles to the control arms. The ball and socket design of the joint allows it to swivel so the knuckles can pivot as the wheels are steered, and to arc so the knuckles can follow the vertical motions of the suspension as it reacts to changes in the road surface.

Ball Joint Locations in a Short-Long Arm (SLA) Suspension



Vehicles with short-long arm (SLA) front suspensions have four ball joints (two uppers and two lowers), while most strut equipped vehicles have only two lower joints in the front suspension (except those with "wishbone" strut suspensions such as Honda that have four). Rear ball joints are also used in some front-wheel drive cars with independent rear suspensions.

Types of Ball Joints

Ball joints that are "loaded" carry or support weight (for example, the lower joints on rear-wheel drive cars and trucks with SLA front suspensions). Ball joints that are "unloaded" carry no weight. These include the lower joints in front-wheel drive cars with MacPherson struts,

and the upper joints on rear-wheel drive cars and trucks with SLA suspensions where the coil spring is on the lower control arm. On SLA applications where the coil spring is over the upper arm, the upper ball joints are loaded and the lower ones are unloaded.

Ball Joint Inspection

Ball joints should be replaced when the amount of play or movement in the joint exceeds the maximum allowed by the vehicle manufacturer. A loose ball joint can cause misalignment, uneven tire wear, sometimes a steering pull to one side, and/or suspension noise.

When to Replace Ball Joints

Ball joints may last 70,000 to 150,000 miles or more. Their lifespan depends on usage, road conditions and exposure to road splash and salt. If a joint is worn, it has reached the end of its service life and should be replaced.

Ball Joint Replacement Tips

As a rule, replacement ball joints will often be the same type (greaseable or low friction) as the original. For some applications (such as trucks), you may want to upgrade to a stronger or greasable aftermarket ball joint if the original equipment ball joint failed at low mileage.

If a broken ball joint is being replaced, the tapered hole in the steering knuckle should also be inspected for damage (a worn taper can cause a repeat failure).

On suspensions that use a pinch bolt to lock the ball joint stud in the knuckle, a new bolt should be used if the ball joint is replaced.

Some ball joints are difficult to replace because they are pressed into the control arm. This will require taking the control arm to a parts store or shop that has a hydraulic press for disassembly and reassembly.

Some ball joints are attached to the control arm with rivets. These must be chiseled or drilled out to replace the ball joint.

IF the ball joint is permanently attached to the arm, the whole control arm assembly must be replaced if the joint has worn out.

For more detailed information, please visit https://www.aa1car.com/library/ball_joints.htm and https://mobiloil.com/en/article/car-maintenance/car-maintenance-archive/front-suspension-and-ball-joint-maintenance-for-a-long-healthy-life

Constant-Velocity (CV) Joints

Constant-velocity joints, also known as CV joints, assist in transferring transmission power to the wheels underneath the vehicle. The flow of transmission power to the wheels is consistent with the rotational speed and there is very little friction. Most front-wheel-drive vehicles have CV joints in them. A rear-wheel-drive vehicle may have them too if it contains an individual rear suspension system.

Types CV Joints

There are different types of CV joints available which accommodate various types of vehicles, such as front-wheel drive and rear-wheel drive. Below are the 5 main types of CV joints.

1) Plunge/Fixed Joints
Standard front-wheel drive vehicle contains a plunge joint and fixed joint. The plunge joints are inboard joints and the fixed joints are outboard joints. Most of the performance is done by the fixed joint. When steer the wheel and turn around corners or angles, the fixed joint is what helps to do this. However, in a rear-wheel drive vehicle, the plunge joints are utilized more. And if a vehicle has a separate rear-wheel suspension system, there will be one plunge joint per axle shaft.

2) Tripod / Ball-Type Joints
Tripod joints basically have a tripod, or a spider, which has 3 trunnions. Each trunnion has a spherical roller that is connected to a needle bearing. Ball-type joints feature a cross groove or double-offset style. The tripod joint is the most popular type of plunge joint.

3) Rzeppa Joints
Rzeppa joints are used regularly in vehicles. In fact, they are considered to be the original CV joints because they were invented way back in 1920. Alfred H. Rzeppa was the engineer who invented the Rzeppa joint. They are outer CV joints that contain six spherical balls per joint. The gears have teeth which don’t allow torque to be transferred to the other side of the joint because the balls go on the tracks.

4) Fixed Tripod Joints
Fixed tripod joints are outer joints which can find in some front-wheel drive vehicle models. The outer housing is where the trunnion is mounted on the joint. The input shaft has an open tulip with 3 roller bearings, each one rotating against one another. The joint is locked together by a steel spider which secures it properly.

5) Inboard & Outboard Joints
In the average front-wheel drive vehicle, there is a drivetrain which has 2 CV joints for each half shaft. One CV joint is called the outer CV joint and the other CV joint is called the inner CV joint. You’ll find the inner CV joint located close to the transaxle, while the outer CV joint is located

close to the wheel. Although, if we're talking about a rear-wheel drive vehicle, then the outboard joint is near the wheel and the inboard joint is closer to the differential.

For more detailed information, please visit https://autocartimes.com/types-of-constant-velocity-joints/ and http://www.carkipedia.com/drive_axles_and_differentials/types_of_cv_joints.php

Car's Power Windows

Power windows are windows in a vehicle that can be opened and shut with the push of a button. Vehicles without power windows have a crank handle. Power windows are convenient as they let you focus on the road while opening or closing the window.

How Power Windows Work

Power windows have an electronic motor attached to a worm gear, which is attached to several other gears, to create torque to lift the window. A long arm is attached to a bar at the bottom of the window. One end of the arm slides into a groove as the window rises up. On the opposite end of the arm is a gear with teeth cut into it. The motor turns this gear to engage these teeth allowing the window to open.

How to Service Power Window Regulators and Motors

Power windows are a great convenience, but sometimes they stop working. Sometimes the fault is electrical, such as a bad power window switch, a blown fuse, a bad relay or a loose or damaged wire. Other times, the fault is a bad window motor or a broken part in the window regulator mechanism that actually raises and lowers the glass.

Single-Lift Drum and Cable Window Regulator

The window lift components inside the door usually include a small electric motor and a window regulator assembly. The motor and regulator can be replaced separately most of the time, though both require removing the inner door panel to replace the parts. Replacement typically takes an hour or so, but may require an extra set of hands to hold the glass while parts are aligned and maneuvered into place. The electric motors that drive power windows are compact and powerful and are similar to the motors used on power seats.

Double-Lift Window Regulator

The regulator assembly that raises the window is mechanical, and it is subject to wear over time whether it is power driven with a motor or is manual with a crank. Window tinting on some vehicles can cause extra stress on the motor and possibly cause stress on the regulator.

Some regulators use a steel cable and worm-drive gears to lift the window, while others use a notched plastic belt or plastic strip with teeth for the same purpose. Steel cables seldom fail, but plastic belts and strips often become brittle with age and exposure to heat. This leads to cracks and part failure, especially during cold weather.

For more detailed information, please visit https://www.yourmechanic.com/article/4-essential-things-to-know-about-your-car-s-power-windows and https://www.knowyourparts.com/technical-resources/electrical/how-to-service-power-window-regulators-and-motors/ also visit https://oards.com/causes-of-power-windows-not-working/

Central locking system:

The locking system in a vehicle must grant access only to authorized persons. It is the means via which the vehicle doors and boot lid are locked and unlocked and the engine is started. The locking system is operated with a key or remote control.

Differential Mechanical locking systems

Each door or lid had an independent mechanism which could be operated from the outside with a key or from the inside with a knob. Electric locking systems are commonplace in today's vehicles. Most of these combine a key with infrared or wireless remote control. This means that they can be triggered remotely, i.e. without contact between key and vehicle. Today, most vehicle manufacturers only fit a lock which can be operated with a key in one door, so the car can be unlocked in an emergency.

Components of central locking systems: The locking system comprises the following components:

Door handle/Handle strip: The door handle is the traditional means by which a vehicle is opened and closed from inside or outside. The external door strip usually houses the door lock. Door strips are increasingly used as design elements in modern cars. They can be chrome-plated or paint-finished in the same color as the vehicle.

Door lock/Actuator: The latching mechanism in a vehicle is installed directly in its doors. It contains both a latch and an electric motor (actuator) which controls the central locking. The latch opens or closes the doors, whereas the door lock locks or unlocks the vehicle. Today, all door latches are powered by electric drives.

Fuel filler cap: The fuel filler cap must securely seal the fuel tank. Some fuel filler caps have locks, others do not. Fuel filler caps with locks are usually found on vehicles which have either a fuel filler flap which does not lock or no fuel filler flap at all. Fuel filler caps without locks are found on vehicles whose fuel filler flap is locked automatically via the central locking system.

Transponder: The transponder is usually integrated inside the key bow. It is the means by which the electronic immobilizer identifies that the correct key is being used. The transponder's code is read out as the key nears the ignition lock. If the code is correct, the electronic immobilizer sends the start enable to the engine.

Remote control: Remote controls are being used with increasing frequency in small cars, replacing the functions of a conventional key to all intents and purposes. A signal transmitter sends a signal or a coded order instruction to a receiver inside the vehicle, which usually controls a number of functions.

Keys: The basic function of keys and remote controls is the locking and unlocking of doors, luggage compartments, fuel filler caps, etc. they are also used to control the

- interior lighting
- electronic immobilizer
- alarm system and the
- Window lifters

Start/stop system: Traditionally, a vehicle key was needed to unlock the steering lock and to start the engine. Subsequently, the vehicle key was enhanced with the addition of a transponder-based release mechanism for the electronic immobilizer.

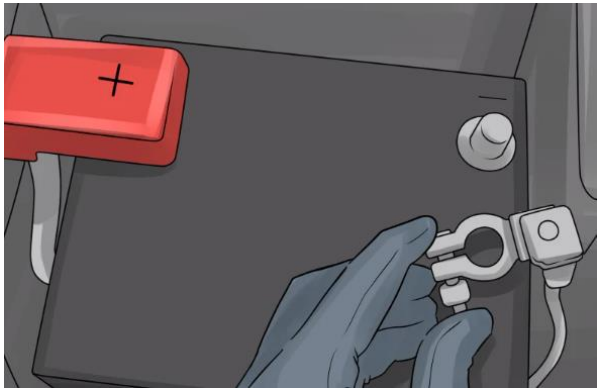
Steering lock: Steering locks have been a mandatory requirement set by insurance companies since 1969. They provide protection against theft. They are the means by which the steering column is unlocked and the engine is started – either electrically or in by conventional mechanical means.

For more detailed information, please visit https://www.my-cardictionary.com/zubehoer/schliessanlage.html and https://www.howacarworks.com/modifications/installing-central-locking

How to Replace a Power Seat Switch

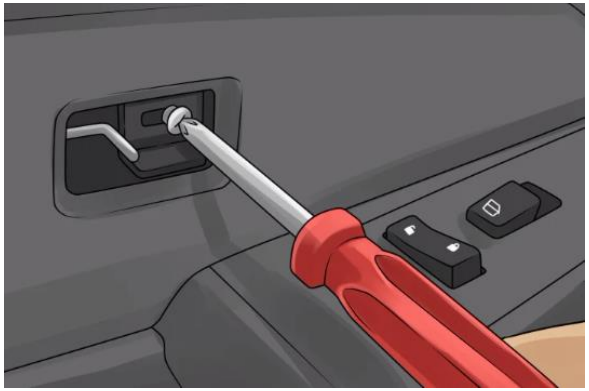
Power seat position and operation is controlled through the power seat switch. In most vehicles, when the occupant pushes the switch, the internal contacts are closed and current is allowed to flow to the seat adjustment motor. If the power seat switch is no longer working, it should be replaced.

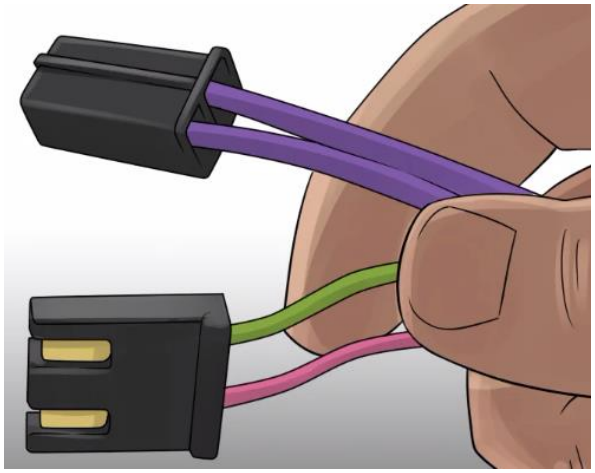
Part 1: Removing the power seat switch



Step 1: Disconnect the negative battery cable and set it aside.

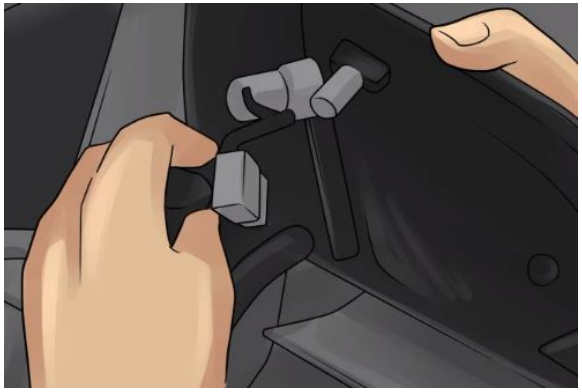
Step 2: Remove the trim panel retaining screws using a screwdriver. Then pull the seat trim panel away from the seat cushion in order to release the retaining clips. Using a trim panel removal tool is optional.





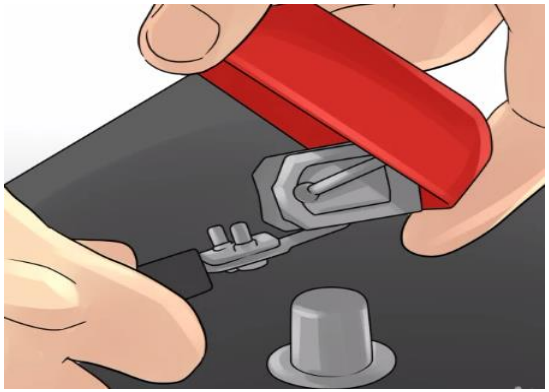
Step 3: Remove the switch’s electrical connector by pushing down on the tab and sliding it off. Then remove the switch itself.

Part 2: Installing the new power seat switch



Step 1: Mount the new seat switch in position. Reinstall the electrical connector.
Step 2: Using the same retaining screws you removed earlier, attach the new switch to the switch panel.

Step 3: Mount the seat trim panel in place. Then, insert the screws and tighten them down using a screwdriver.



Step 4: Reconnect the negative battery cable and tighten it down.

For more detailed information, please visit https://www.yourmechanic.com/article/how-to-replace-a-power-seat-switch and https://wrench.com/services/power-seat-switch-replacement-mobile-mechanic/ also visit https://www.autoblog.com/2016/01/11/symptoms-of-a-bad-or-failing-power-seat-switch/

How to Diagnose Power Seat Motor Issues

When you have a situation where your seat is not working, you should take a moment to determine what part of the seat is not working by focusing on the mechanical and electrical areas of the seat. There may be a couple motors in your seats, so you need to know if the problem is moving up and down or back and forth. Once you decide where the problem is, you can address the issue and repair it.

Diagnostic

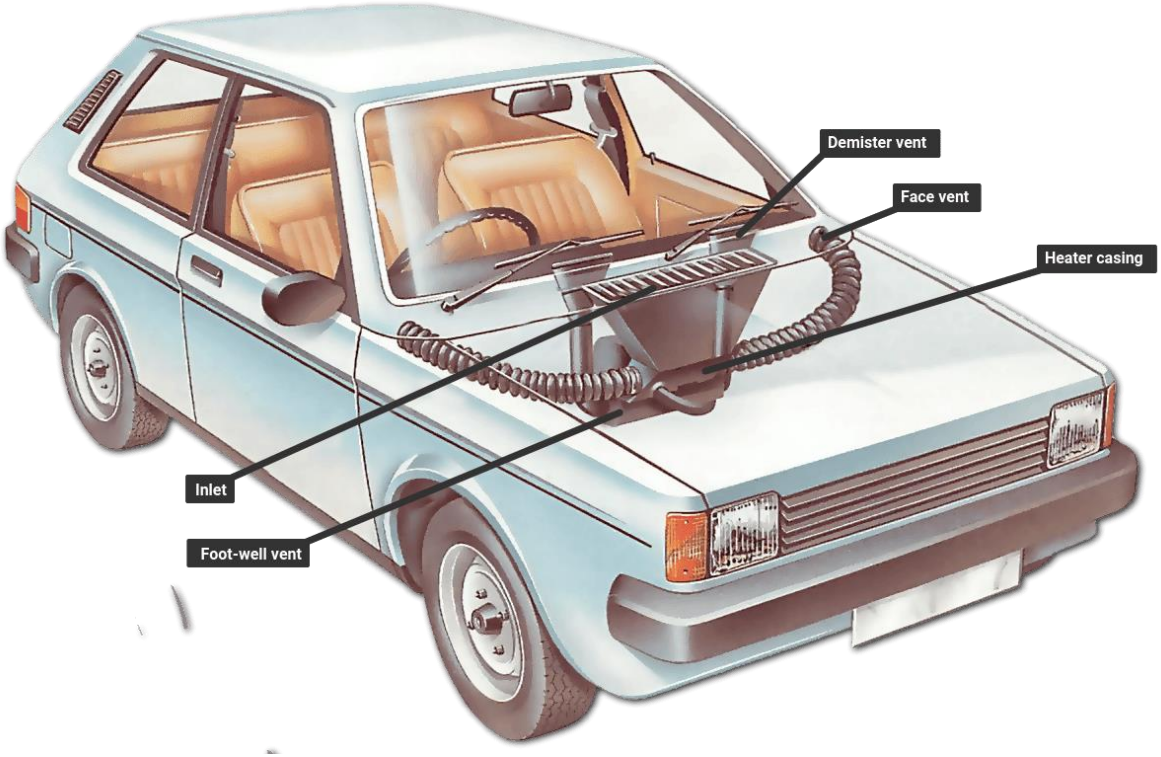
Before you start, if there is a problem with the seat moving forward and backwards, look for obstructions on the rails or under the seat. If the rail area is clear, you can move on to other diagnostic tests.

1. Check the fuses and circuit breakers to be sure that there is no loss of power to the seats. If you have two power seats, and they both are not working, it may be a fuse or circuit breaker. If one seat works and the other does not, it is probably not the fuse.
2. Turn your ignition to ON, but leave the engine turned off. Try to move the power seat that is not working and listen for the seat's motor. If the motor is quiet, lift the switch. It will be on either the door handle or the seat's side.
3. Use your test light to see if there is any voltage at the switch. If no voltage is indicated, then check the wiring to determine whether or not there is a short somewhere between the fuse panel and the switch.
4. Check for continuity by unplugging the switch and using the Multimeter. Should you find there is no continuity, then replace the switch.
5. If there is a relay between the switch and the motor, test it. Test the switch by operating it to make sure that the voltage is reaching the relay. Use a test light to determine whether there is voltage going from the relay to the motor. In order to do this, first ensure that the relay is grounded, and then move or remove the seat for the test. If you are missing one of the voltages, check the wire for a short. If you have no voltage outgoing, then test the relay to ensure that it is operating properly. If it is not, then replace the relay.
6. Use a test light to check for incoming voltage at the motor. Should you find that there is no incoming voltage, determine whether there is continuity between the motor and switch. Test the wires for a short or open.
7. Take the failed motor and conduct a test on it using the car battery and two jumper wires. If the motor does not respond, then replace it.
8. Lastly, do an inspection of the drive assembly-transmission, the tracks and the gears to ensure that the mechanism is in proper working condition. Repair any parts that are not.

   For more detailed information, please visit https://www.newgmparts.com/how-to-diagnose-your-chevy-power-seat-motor-issues

Heat ventilating system

Modern cars are designed to have a constant through-flow of fresh air that keeps the interior atmosphere pleasant even with all the windows shut. The incoming air can be heated by the engine to keep the windows clear of mist and the car interior at a chosen temperature.



How Vehicle Heating and Ventilation System Works

Vehicle heating and ventilation system works to regulate engine temperature. Below are the components that work together to get vehicle heating and ventilation system running:

- Radiator
- Hoses

- Thermostat
- Heater Core
- Blower Fan
- Control Panel

These parts work to heat vehicle and maintain engine temperature through a series of steps. Coolant circulates throughout the engine in hoses, where it gathers heat from the engine, and is sent to the radiator. It is then distributed to the heater core, where the blower fan pushes the warm air through the vents and into the car's cabin.

There are several different ways to recognize a problem or malfunction in vehicle heating and ventilation system. Here are some signs there may be something wrong with system:

Heater is blowing cold air. One of the most obvious signs of a problem with heating system is vents blowing cold air. This can be caused by several problems.

Heater is blowing no air. If heater is not blowing any air, there is likely an issue with blower motor or fan. Parts may need to be repaired or replaced. Vehicle needs proper airflow to function safely.

Strange smell. If a sweet smell coming out of vents, this may indicate there is a coolant leak inside the engine. Coolant leaks can also be recognized by a puddle of bright liquid under vehicle. If a smell of musty scent coming from the vents, then there could be mold or mildew within the system.

There is a lack of temperature control in cabin. If the temperature inside cabin cannot control, there could be a problem with thermostat. When thermostat is broken it cannot recognize the temperature inside of the engine and it will not be able to control the temperature in your vehicle's cabin.

Cabin fogs up. If cabin fogs up suddenly while driving, there could be coolant leaking in engine, evaporating, and then moving through the vents as steam. If this is happening, there may be a problem with heater core.

For more detailed information, please visit https://www.graffbaycity.com/service/seasonal-maintenance/fall-car-care/heating-and-ventilation and https://www.howacarworks.com/basics/how-car-heating-and-ventilation-systems-work

Air Conditioning system:

Air conditioning like it says 'conditions' the air. It not only cools it down, but also reduces the moisture content, or humidity. All air conditioners work the same way whether they are installed in a building, or in a car.

Components of a Car air conditioning system

It is best to get familiarized with the different components of the vehicle passenger cooling system to better understand the process of air conditioning.

Compressor

Many consider the compressor as the heart of the air conditioning system of the car. As the name suggests, it compresses the refrigerant so that it turns from a gaseous state into a liquid state. The compressor connects to the crankshaft via a drive belt.

Condenser

It is one of the most recognizable parts of the modern automotive AC system because it is very easy to check. This looks a lot like the radiator. It is also positioned right in front of the radiator.

Evaporator

Among all the components of the modern vehicle AC system, the evaporator is the only that’s located inside the passenger compartment. The evaporator looks like a very small radiator with fins and tubes.

Receiver

This component prepares the refrigerant for entry into the evaporator. It serves as a reservoir for the refrigerant while also removing any moisture that may be present in the refrigerant.

Expansion valve

The thermal expansion valve is the boundary between the high-pressure side of the system (including the compressor, condenser and receiver) and the low-pressure side of the system. As the name implies, the expansion valve allows the expansion of the high-pressure liquid refrigerant coming from the receiver-drive.

Refrigerant

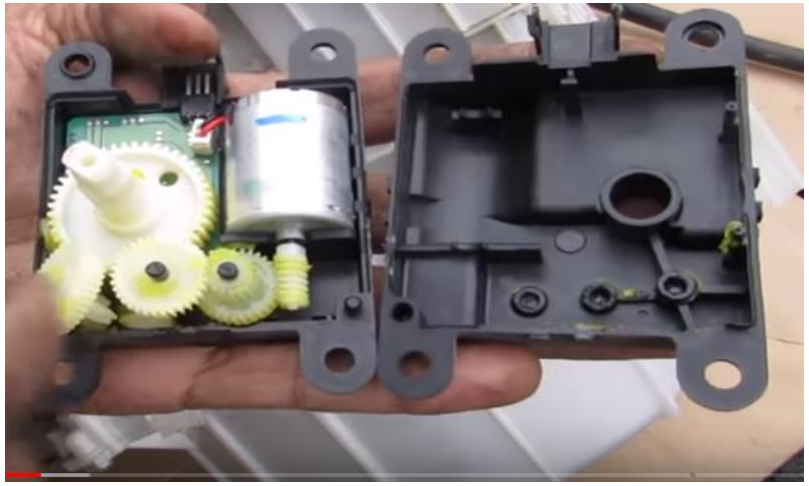
While not a “component” of an automotive air conditioning system, the refrigerant is the lifeline of the system. Without it , heat will not be able to move out from the system and bring cooling comfort to everyone in the passenger compartment.

For more detailed information, please visit https://www.carbibles.com/how-does-a-car-air-conditioning-work/ and https://auto.howstuffworks.com/automotive-air-conditioning.htm and http://www.airconcars.co.uk/html/how_it_works.html

Videos:

	**How steering and suspension systems work | ACDelco** **https://youtu.be/MCiwQb5sQ74**
	**Power Window Troubleshooting** **https://youtu.be/aT3GjpgmoGc**

	**How to repair broken central lock system in car.** **https://youtu.be/J88ARVMWIUw**
	**How to take apart repair a driver's car seat motor** **https://youtu.be/UNIJ6IyYTIU**

	**How a Car Automatic HVAC System Works** **https://youtu.be/eEuHyZoW8PM**
	**How a Car's HVAC System Works** **https://youtu.be/04MlTepEIz4**

AUTOMOTIVE MECHATRONICS

Module-11

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 11: 071400956 Maintain Controlled Brake System

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to maintain controlled brake system.

Duration: 45 Hrs **Theory:** 09 Hrs **Practical:** 36 Hrs

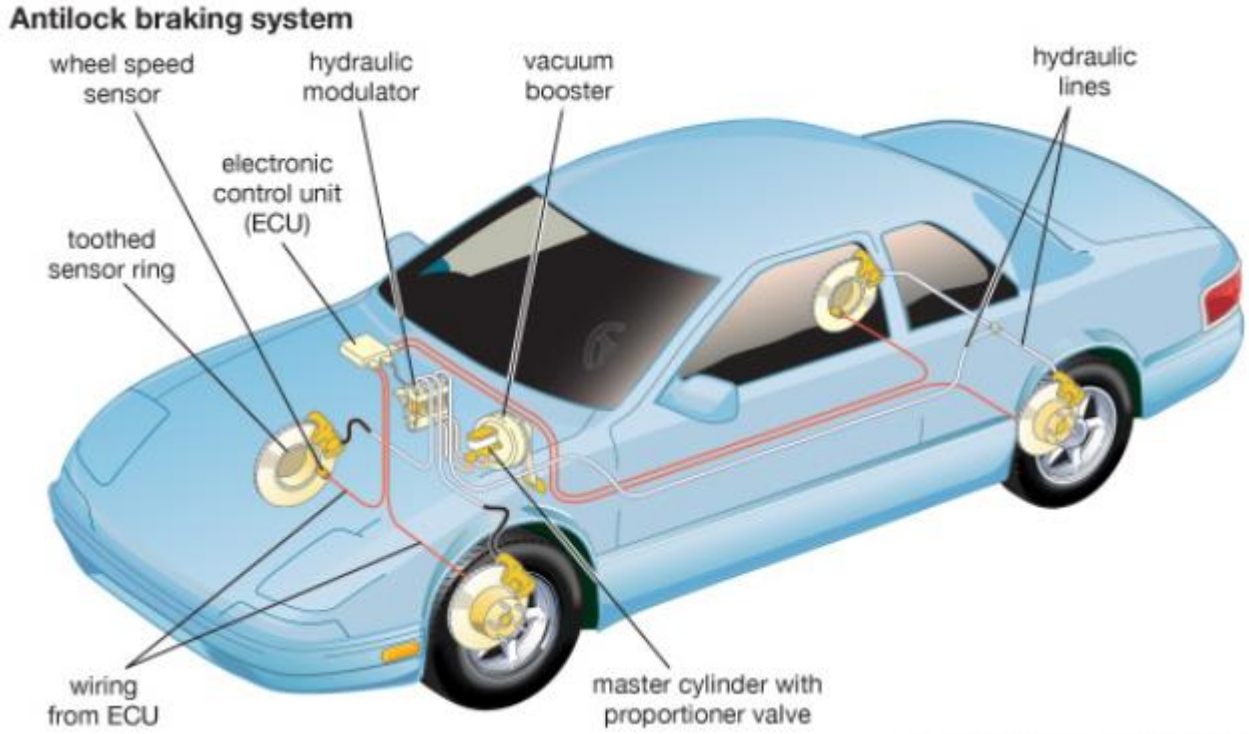
Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Maintain Anti-lock Braking System (ABS)	**The trainee will be able to:** Select appropriate Tools and equipment. Follow safety rules regarding the job. Apply OBD-II scanner to check faults in ABS. Check wiring harness of ABS system. Check ABS fuse and relay. Inspect brake lining. Check wheel speed sensors. Check pressure of ABS. Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describe usage of different tools and equipment for fault diagnoses e.g. screw drivers, combination spanner, Clip opener, socket set and DC tester etc. Knowledge of electric standards and relevant safety (for example electrical systems, protective devices and connection technologies Explaining the purpose of ABS system and its main components e.g. wheel speed sensors, gear pulsar, ECU and hydraulic pressure modulator Understanding the importance of ABS system in a vehicle Explaining the diagnosis of ABS system with the help of OBD II scanner. Finding Fault with the help of scanner and its rectification Describing procedure for cleaning and storing of tools & equipment at work place Importance of housekeeping	Relevant PPEs Brake Fluid Brake pads Brake shoe Philips/Flat Screw Driver Set Cotton Rags Needle Nose plier Car Lift Emery Paper Combination Spanner Set Multi Meter
LU 2: Maintain pressure Modulator	**The trainee will be able to:** Ensure safety precautions & adopt	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace	Relevant PPEs Brake Fluid Brake pads

	PPEs Select tools/equipment/material as per requirement Check the brake fluid inlet lines Check the brake fluid outlet lines Check the return motor connection Ensure housekeeping after completion of task	Describing usage of different tools and equipment for fault diagnoses e.g. screw drivers, combination spanner, Clip opener, socket set and DC tester etc. Explaining the inlet and outlet brake lines and figure out the leakages in these brake lines Explaining the working principle of hydraulic pressure modulator Explaining the the functions of solenoid valves and return motor of Pressure Modulator during braking. Importance of housekeeping	Brake shoe Safety Mask Philips/Flat Screw Driver Set Cotton Rags Coverall Needle Nose plier Ear plug/Ear Muff Car Lift Emery Paper Combination Spanner Set Multi Meter
LU 3: Maintain ABS- Electronic Control Unit (ECU)	**The trainee will be able to:** Select appropriate Tools and equipment. Follow safety rules regarding the job. Maintain ECU of ABS system Clean and refit the connector. Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing usage of different tools and equipment for fault diagnoses e.g. screw drivers, combination spanner, Clip opener, socket set and DC tester etc. Describing the knowledge of electric standards and relevant safety (for example electrical systems, protective devices and connection technologies) Explaining the working of ECU in ABS system. Describing the method how to remove, clean and refit the connector of ECU Explaining how ECU may be replaced if found malfunctioned after scanning by OBD II scanner. Importance of housekeeping	Relevant PPEs Brake Fluid Brake pads Brake shoe Safety Mask Philips/Flat Screw Driver Set Cotton Rags Coverall Needle Nose plier Ear plug/Ear Muff Car Lift Emery Paper Combination Spanner Set Multi Meter

Examples & illustrations:

Anti-lock Braking System

Anti-lock braking system also known as anti-skid braking system (ABS) is an automobile safety system which prevents the locking of wheels during braking and avoid uncontrolled skidding. The main advantages of using ABS system in vehicle is that it provides better control over the vehicle and decreases stopping distance on dry and slippery surface.



Principles of working

It works on the principle of threshold braking and cadence braking. These are techniques in which a driver applies the brakes and releases it before locking up the wheel and then applies the brakes and releases it again before locking. This process of applying and releasing the brakes on the wheel is done in pulse form to prevent it from locking and stop skidding of the vehicle.

Main components of ABS system

It has four main components

1. **Speed sensors:** It is used to calculate the acceleration and deceleration of the wheel. It consists of a toothed wheel and an electromagnetic coil or a magnet and a Hall Effect sensor to generate signal. When the wheel or differentials of the vehicle rotates, it induces magnetic field around the sensor. The fluctuation in this magnetic field generates voltage in the sensor. This voltage generated sends signals to the controller. With the help of the voltage the controller reads the acceleration and deceleration of the wheel.

2. **Valves:** Each brake line which is controlled by the ABS has a valve. In some of the systems, the valve works on three positions.

- **In position one**, the valve remains open; and pressure from the master cylinder passed through it to the brake.
- **In position two**, the valve blocks the line and separates the brake from the master cylinder. And this prevents the further rise of the pressure to the brakes. Valve operates in second position when the driver applies the brake harder.
- **In position three**, some of the pressure from the brake is released by the valve.

The clogging of the valve is the major problem in ABS. When the valve is clogged, it becomes difficult for the valve to open, close or change position.

3. **Pump:** Pump is used to restore the pressure to the hydraulic brakes after the valve releases the pressure. When the controller detects wheel slip, it sends signals to release the valve. After the valve releases the pressure supplied from the driver, it restore a desired amount of pressure to the braking system. The controller modulates (adjust) the status of the pump so as to provide desired amount of pressure and reduce slipping of the wheel.

4. **Controller:** The controller used in the ABS system is of ECU type. Its main function is to receive information from each individual wheel speed sensors and if a wheel loses its traction with the ground, a signal is sent to the controller, the controller than limit the brake force (EBD) and activate the ABS modulator. The activated ABS modulator actuates the braking valves on and off and varies the pressure to the brakes.

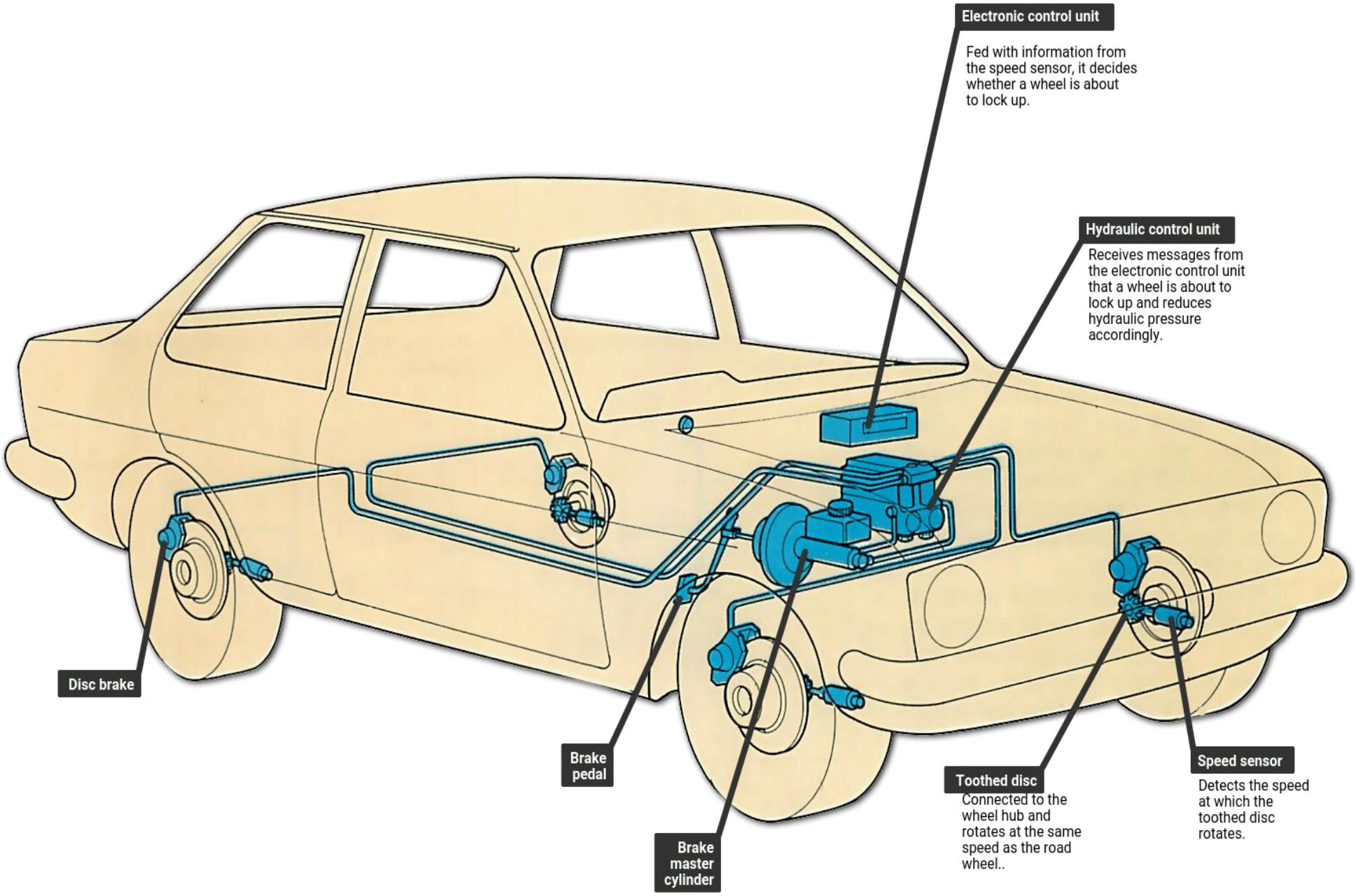
Working of Anti-lock Braking System (ABS)

- The controller (ECU-Electronic Control Unit) reads the signal from each of the speed sensors of the wheel.
- As the brakes are suddenly applied by the driver, this makes the wheel to decelerate at faster rate and may cause the wheel to Lock.
- As the ECU reads the signal which indicates the rapid decrease in the speed of the wheel, it sends signal to the valve which makes the valve close and the pressure to the brake pad reduces and prevents the wheel from locking.
- The wheel again starts to accelerate, again the signal sends to the controller, this time it opens the valve, increasing the pressure to the brake pad and brakes are applied, this again reduces the speed of the wheel and tries to make it stop.
- This process of applying brakes and releasing it happens 15 times in a second when a driver suddenly applies the brake harder. Due to this the locking of the wheel is prevented and the skidding of the vehicle eliminated. During braking with ABS system, the driver can steer the vehicle and reduces the risk of vehicle collision.

For more detailed information, please visit https://www.mechanicalbooster.com/2017/08/anti-lock-braking-system.html and https://www.saga.co.uk/magazine/motoring/cars/using/2016/anti-lock-braking-system-abs also visit https://www.scienceabc.com/innovation/abs-sensors-anti-lock-breaking-system-technology-cars-work.html

Hydraulic Pressure Modulator:

The **Brake Pressure Modulate Valve** is a part of your vehicle's anti-lock braking system (ABS). It is a device that is controlled by the electric signal that is generated by the ABS module. The brake pressure modulate valve regulates the pressure that is supplied to each ABS controlled brake in the wheels. The modulate valve has a set of solenoid valves, usually one for each wheel, that are controlled by the ECU. In normal braking conditions, the brake master cylinder provides a constant pressure to all four wheels of the vehicle. When the ABS system senses that a wheel is about to lock up, it sends the appropriate signal to the Pressure Modulator.


Electronic control unit
Fed with information from the speed sensor, it decides whether a wheel is about to lock up.
Hydraulic control unit
Receives messages from the electronic control unit that a wheel is about to lock up and reduces hydraulic pressure accordingly.
Disc brake
Brake pedal
Brake master cylinder
Toothed disc
Connected to the wheel hub and rotates at the same speed as the road wheel..
Speed sensor
Detects the speed at which the toothed disc rotates.

In response, the valve corresponding to the faulty wheel is opened or closed to either supply more pressure to the affected wheel or to cut off the pressure supply to the wheel. Once all the four wheels are back to spinning at the normal speeds, the ABS switches off, and all the valves on the brake pressure modulate system are made open again to supply an equal amount of braking pressure to all 4 wheels.

A faulty brake pressure modulate valve will cause your ABS system to fail, and cause abnormal braking behavior at low speeds. Corrosion and brake fluid contamination are usually the culprits in a brake pressure modulate valve failure. You should regularly change your brake to prevent your ABS system from failing. A visual indicator of a brake pressure modulate valve failure is the lighting up of the ABS warning light on your dashboard. At Buy Auto Parts we stock a wide variety of brake pressure modulate valves for every car make and model.

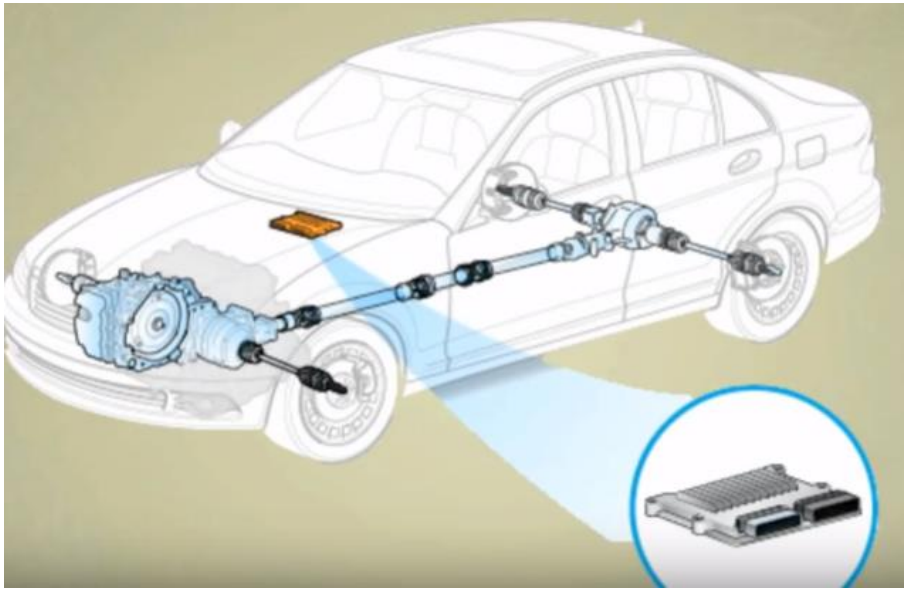
ABS- Electronic Control Unit (ECU)

An ECU is a computer with internal pre-programmed and programmable computer chips that is not much different from a home computer or lap top. The vehicle's engine computer ECU is used to operate the engine by using input sensors and output components to control all engine functions. There are different ECUs used for different systems on the vehicle. The different ECUs used can be for the transmission, traction control or ABS, AC, body functions and lighting control, engine, air bags, or any other system a vehicle may have. Some vehicles may incorporate more than one ECU into a single unit called a powertrain control module (PCM). These units can be an advantage by having more modules in one location but may be a disadvantage by adding longer wires to reach the component it operates.

For more detailed information, please visit https://www.howacarworks.com/technology/how-abs-works and https://www.liveabout.com/abs-brakes-and-the-facts-281470 also visit https://www.buyautoparts.com/autoparts/Brake_Pressure_Modulate_Valve and https://mechathon.com/anti-lock-braking-system/

Videos:

	**Anti-lock Braking System (ABS)** **https://youtu.be/ru4JlZ-x8yo**
	**Safe braking with ABS** **https://www.mechanicalbooster.com/2017/08/anti-lock-braking-system.html**

	**What is ECU? How car engine module controls and works?** **https://youtu.be/_lAqQ7uXQTY**

AUTOMOTIVE MECHATRONICS

Module-12

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 12: 071400957 Conserve Power Transmission-I

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to conserve power transmission.

Duration: 45 Hrs **Theory:** 09 Hrs **Practical:** 36 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Perform maintenance of Automatic Transmission	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Test automatic transmission Replace vehicle speed sensor Replace multi-plate clutches Replace transmission fluid strainer Check/replace valve body Replace torque converter Replace transmission oil seals Maintain/replace automatic transmission fluid Ensure housekeeping	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explaining the working principle of Automatic Transmission Describing the usage of different tools and pressure gauge to check oil pressure of automatic transmission Describing the procedure to replace vehicle speed sensor Explaining working of planetary gear set in reverse gear operation Explaining working of reverse clutch drum, its friction band and servo unit. Elaborating the components of Automatic Transmission and their functions e.g. Drive shaft, driven shaft, multi plate clutches, valve body, governor, oil cooler etc. Describing the purpose of transmission fluid strainer and procedure of its replacement Defining the main parts and their functions of torque converter (namely pump, turbine and stator). Describing procedure for cleaning and storing of tools & equipment at work place Importance of housekeeping	Relevant PPEs Transmission Oil Philips/Flat Screw Driver Set Cotton Rags Grip plier Car Lift Emery Paper Combination Spanner Set Multi Meter Allen Key Set Bearing Puller Housing Puller Tyre Lever Hammer

	after completion of task		
LU 2: Perform maintenance of Electronic Control Transmission (ECT) System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Test ECT fluid pressure Replace vehicle speed sensor Replace input shaft sensor Replace output shaft sensor Check/replace valve body Replace multi-plate clutches Replace transmission oil seals Maintain/replace ECT fluid Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing usage of multi meter and DC tester for testing sensors and solenoid valves. Describing the function of sensor used in automatic transmission Diagnosing the fault with the help of OB II sensor Explaining the procedure to replace the faulty sensor Importance of housekeeping	Relevant PPEs Transmission Oil Philips/Flat Screw Driver Set Cotton Rags Grip plier Car Lift Emery Paper Combination Spanner Set Multi Meter Allen Key Set Bearing Puller Housing Puller Tyre Lever Hammer
LU 3: Perform Diagnosis of Electronically Controlled	**The trainee will be able to:** Select tools and equipment according to	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and	Relevant PPEs Transmission Oil Philips/Flat Screw Driver

Transmission (ECT) System with OBD II Scanner	job requirement Observe occupational health and safety precautions at all times Connect OBD-II Scanner Monitor function of all sensors. Replace the faulty sensors Ensure housekeeping after completion of task	workplace Describe usage of different tools and equipment for fault diagnoses e.g. screw drivers, combination spanner, Clip opener, socket set and DC tester etc. Knowledge of electric standards and relevant safety (for example electrical systems, protective devices and connection technologies Describing the function of sensor used in automatic transmission Diagnosing the fault with the help of OBD II scanner Explaining the procedure to replace the faulty sensor Importance of housekeeping	Set Cotton Rags Grip plier Car Lift Emery Paper Combination Spanner Set Multi Meter Allen Key Set Bearing Puller Housing Puller Tyre Lever Hammer

Examples & illustrations:

Automatic transmission

Automatic transmission is a type of motor vehicle transmission that automatically changes the gear ratios as the vehicle start moving, thus freeing the driver from such hardships. The most common type found in automobiles is hydraulic automatic transmission. This type of transmission consists of several transmission components and systems that are particularly designed to work together in a symphony of electrical, hydraulic and mechanical energy.

Main components of automatic transmission:

The hydraulic system: This basically controls the clutches and bands so as to control the planetary gear sets. For the proper functioning, it uses special transmission fluid which is sent under pressure by the oil pump.

Planetary Gear Sets: Planetary gear sets is one of the important transmission components that provides the several forward and reverse gear ratios.

Seals and Gaskets: This component is used to prevent oil leaking by keeping it at the place where it is supposed to be.

The Torque Convertor: Another important component that makes the automatic transmission possible is the torque converter that acts like a clutch and stop the vehicle while the engine is still running.

The Governor and the modulator: These components are used in the non-computerized transmission and usually provide the inputs that instructs the transmission when to shift.

The Computer Controls: These are related to the computerized transmissions and use the sensor on engine to detect the things such as throttle position, vehicle speed, and engine speed, and engine load, switch position, stop light etc.
For more detailed information, please visit https://medium.com/@AVTECLimited/transmission-components-that-make-automatic-transmission-possible-63c9de49551 and https://cartreatments.com/some-common-parts-of-automatic-transmission/ and http://cf.linnbenton.edu/eit/auto/krolicp/upload/Automatic_Transmission_Basics.pdf

4 Common Symptoms of Automatic Transmission Problems

There are a number of symptoms of damage to the automatic transmission or have problems.

1. **Jerk when moving the automatic transition**

In general, the transition to the cars that use the automatic transmission system is already fairly modern and has a fairly smooth gearshift. If it still feels, still in the stage of a very tolerable. However, if during gear movement is felt discouraged early beat that feels compelled to make the car as suddenly, suspect that there is a problem in the system of car with automatic transmission?

The damage could be a malfunction of electronic or mechanical systems. This can be detected using existing OBD socket on the scanner engine. Usually the damage that occurs due to leakage in solenoid pressure, causing the transmission oil could not maintain the gear shift, which is why the beat.

2. **Vibration when the car is moving**

Possible when the car is moving and feel there is a common vibration is considered normal. However, if the vibration could be too intrusive in this case because a problem with the engine or the transmission. Usually vibrations also appear as canvas clutch on the car has started to wear or too charred. Thus canvas clutch is not smooth or flat and cause friction in the clutch sandpaper.

3. **Difficult if want to move the gears**

If transmission damage already started getting worse, symptoms will also increase. One of example is the gear for backward difficult for used. This is due to damage to the automatic transmission system of the car.

4. **The gear lever is difficult or cannot be moved**

This condition can also occur if the switch of car with automatic transmission has been damaged. This damage usually occurs when a new driver up the car realized if the position of the transmission is difficult to move or even cannot be moved at all.

For more detailed information, please visit https://cartreatments.com/some-symptoms-of-automatic-transmission-problems/

Electronic Control Transmission (ECT)

The electronic control transmission is an automatic transmission which uses modern electronic technologies to control the transmission. The transmission itself, except for the valve body and speed sensor, is virtually the same as a full hydraulically controlled transmission, but it also consists of electronic parts, sensors, an electronic control unit and actuators.

The electronic sensors monitor the speed of the vehicle, gear position selection and throttle opening, sending this information to the ECU. The ECU then controls the operation of the clutches and brakes based on this data and controls the timing of shift points and torque convert lock-up.

For more detailed information, please visit http://www.autoshop101.com/forms/h16.pdf

Sensors and modules which control transmission

Below is a list of various modules and sensors that regulate automatic transmission.

Transmission control module (TCM) or powertrain control module (PCM)

All automatic transmissions use a control module to regulate speed, gear changes, and clutch engagement. The TCM makes decisions based on the information it receives from the engine, making it the key to shifting gears and changing the speed. A TCM recognizes when the clutch is engaged and disengaged and reads RPMs, then executes an order based on driver feedback.

A powertrain control module also controls engine and transmission functions. It is responsible for timing shifts, shift feel and engaging the clutch.

Mass airflow sensor (MAS)

The Mass Airflow Sensor measures airflow into the engine and uses that information to regulate air and fuel ratios and determine engine load.

Throttle position sensor (TP)

The Throttle Position Sensor measures throttle (gas pedal) position, having a direct impact on engine performance.

Manifold absolute pressure sensor (MAP)

The Manifold Absolute Pressure Sensor measures manifold pressure. It’s used to measure engine load. It also measures altitude and controls engine performance.

Intake air temperature sensor (IAT)

The Intake Air Temperature Sensor measures the temperature of the air while it enters the intake of the engine. It’s used to control the air/fuel mixture of the engine. It’s also part of the pressure control system for the transmission. As temperature changes, so do the sensor’s electrical resistance and voltage signal.

Differential speed sensor (DSS)

The Differential Speed Sensor measures vehicle speed. Failure may inhibit activation of overdrive and the converter clutch.

Overdrive switch (OD)

Overdrive is a function that allows you to cruise at a sustained speed, but reduced engine rpm. This provides better fuel economy, lower noise, and reduced wear on mechanical components. Engaging and disengaging overdrive requires a switch. When this switch fails transmission problems occur.

Vehicle speed sensor (VSS)

The Vehicle Speed Sensor measures vehicle speed. When it fails the transmission can stop shifting or shift late and harsh. A bad VSS may also inhibit overdrive and the converter clutch.

Air conditioner sensor (AC)

The Air Conditioner Sensor signals the PCM when the air condition is on or off. The AC switch will affect engine RPM at a stop. A malfunctioning AC switch can result in problems that feel as though they are transmission related.

Transmission range sensor (TR) / transmission position sensor

The Transmission Range Sensor tells the PCM the position of the transmission shifter. The PCM uses this information to control which gears of the transmission to enable or disable. When the TR sensor fails it can cause wrong gear starts, no upshifts, or what feels like a falling-out-of-gear condition.

Brake switch

The Brake Switch measures brake pedal position. Its primary function as it relates to the transmission is to release the converter clutch while braking. When it fails the converter clutch won't apply, or it may chuggle while coming to a stop.

Coolant temperature sensor (CT)

The Coolant Temperature Sensor measures engine coolant temperature. It's used to inhibit overdrive and the converter clutch when the engine is too cold. Failure will severly impact engine performance.

Turbine shaft sensor (TSS)

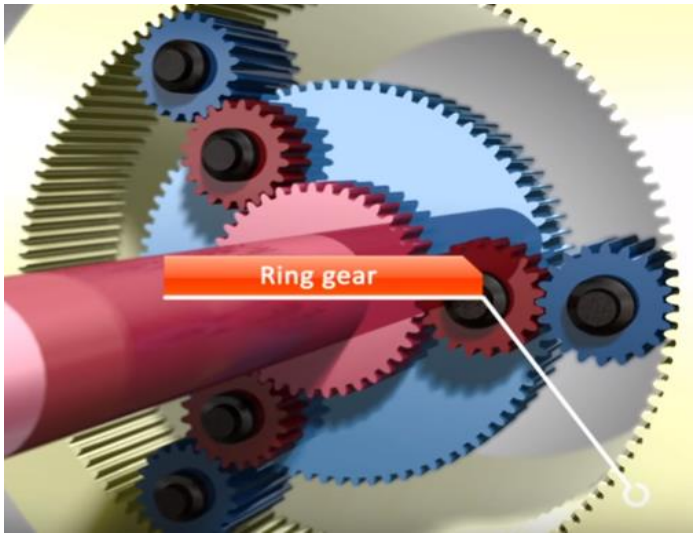
The Turbine Shaft Sensor measures input shaft speed. The PCM uses the information provided by the TSS to determine whether or not the transmission is slipping. When it fails it usually result in shift timing problems. Depending on the manufacturer, it can cause multiple shift-timing and shift-feel problems.

Transmission fluid temperature sensor (TFT)

The Transmission Fluid Temperature sensor measures the temperature of the transmission's oil (AFT). Its primary function is to inhibit overdrive and converter clutch operation when cold. On some models, it also inhibits certain gears based on the temperature (too hot or too cold).

For more detailed information about symptoms of transmission failure, please visit https://generaltransmissionreno.com/what-controls-your-transmission/

Videos:

	**How Torque Converters Work! (Animation)** **https://youtu.be/z5G2zQ_3xTc**
	**Ravigneaux Planetary Gear Set (Animation)** **https://youtu.be/7iTn8OWxVFU**

	**How to test a computer controlled solenoid (circuit ID with voltmeter)** https://youtu.be/pkcwNkkNWYA
	**Learn How to Do A Car Diagnostic Using an OBD 2 Scanner - Turn Engine Light Off** https://youtu.be/EXYcPuB_quY

AUTOMOTIVE MECHATRONICS

Module-13

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - October, 2019

Module 13: 071400958 Perpetuate Controlled Electric & Electronics System-I

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to perpetuate controlled electrical & electronics system.

Duration: 60 Hrs **Theory:** 15 Hrs **Practical:** 45 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Service Windshield wash system	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Check function of rain sensor. Check hoses of the system Check wire harness and connector. Check performance and service of shower nozzles. Check function of pump motor. Service faulty parts. Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing usage of multi meter and DC tester for testing sensors and actuators. Explaining working mechanism & location of rain sensor, troubleshooting of rain sensor with the help of OBD II Scanner. Understanding the connection of hoses and their location, nozzle, washer reservoir, along with motor driven centrifugal pump. Understanding of components of motor e.g. armature, magnet and carbon bushes etc. Functioning and servicing of shower nozzles Functioning and connections of Wiper switch and instrument panel wire harness Servicing and re-fixing of faulty parts at their desired location. Describing procedure for cleaning and storing of tools & equipment at work place. Importance of housekeeping	Washer Fluid WD 40 Multipurpose Grease Oil Gun Emery Paper Cotton rags Philips/Flat Screw Driver Set Combination Spanner Set Multi Meter Socket Set Relevant PPEs
LU 2: Service	**The trainee will be able**	Understanding of appropriate tools and equipment for performing	Relevant PPEs

Wiper System	**to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Check wire harness and connector. Disconnect wiper motor and its connector. Connect wiper motor with battery and check its functionality. Service of wiper motor Check wiper linkages Ensure housekeeping after completion of task	this task Explaining the safety precautions regarding personal health and workplace Explaining of main components of wiper system (wiper blade, wiper arm, pivot shaft, linkage, wiper switches etc.). Understanding of intermittent or delay mode and working of wiper motor. Testing wiper motor with the help of battery voltage. Checking the fuses and relays with DMM. Describing procedure for cleaning and storing of tools & equipment at work place. Importance of housekeeping	Philips/Flat Screw Driver Set Cotton Rags Emery Paper Multimeter Combination Spanner Set Socket Spanner Set
LU 3: Check Performance of Instrument Panel	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Check gauges of	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Understanding gauges of instrument panel, their functioning and troubleshooting with the help of OBD II Scanner Fixing and removing of CD player, radio and LCD, understanding of their functions and their performance level. Explaining of panel buttons and knobs of instrument panel Explaining the operation of all indicators and warning lights in instrument panel.	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Combination Spanner Set RPM Meter Multi Meter OBD II Scanner

	instrument panel cluster Check performance of CD player, Radio and LCD. Check function of switch buttons and knobs of instrument panel Check performance of indicators and wiring lights in instrument panel Ensure housekeeping after completion of task	Describing procedure for cleaning and storing of tools & equipment at work place. Importance of housekeeping	
LU 4: Demonstrate Function of Sensors	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Connect OBD-II Scanner	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Explain how to check sensor or troubleshoot the sensor problem with the help of OBD II scanner Monitoring function of all sensors with the help of multi meter and voltage tester Explaining the method how to replace the faulty sensor. Describing procedure for cleaning and storing of tools & equipment at work place Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Combination Spanner Set RPM Meter Multi Meter OBD II Scanner

	Monitor functions of all sensors. Replace the faulty sensor. Ensure housekeeping after completion of task		
LU 5: Maintain Electrical Motors	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Check wire harness and connectors of all motors. Monitor function of different motors. Disconnect and remove the faulty motors Connect with the battery and check for its function.	Understanding of appropriate tools and equipment for performing this task Explaining the safety precautions regarding personal health and workplace Describing usage of different tools and equipment for fault diagnoses e.g. screw drivers, combination spanner, Clip opener, socket set and DC tester etc. Understanding of electric standards and relevant safety (for example electrical systems, protective devices, connection technologies and) Understanding the connections of wire harness and their locations Monitoring the operations of all motors Functioning and location of all motors Explain the method how to replace the faulty motor. Describing procedure for cleaning and storing of tools & equipment at work place Importance of housekeeping	Relevant PPEs Philips/Flat Screw Driver Set Cotton Rags Emery Paper Combination Spanner Set RPM Meter Multi Meter OBD II Scanner

	Service and maintain/replace the motors. Ensure housekeeping after completion of task		

Windshield Wiper/Washer System Inspection Service

The windshield wiper and washer system help keep a windshield clean and free of rain, dirt, sleet or snow. This system is not only a convenience but a safety system as well. Limited visibility due to a dirty windshield can make safe driving difficult or impossible.

There are a number of components in the wiper/washer system that can malfunction and cause problems. Everything from a blown fuse to a bad pump can leave a windshield dirty.

How this system works:

Windshield wipers use two different technologies to keep the windshield clean. An electric motor using a worm gear provides the power to move the wipers while a linkage converts the rotational output of the electric motor into the familiar back and forth motion of the wiper blades.

The windshield washer system uses a washer pump that is installed at the base of the washer fluid reservoir. The pump is activated by a spring-loaded switch, this switch turns on the wipers as well. The fluid is pumped through a rubber or plastic hose that runs up to windshield and separates in two lines that feed the washer nozzles on the hood of the car.

Common reasons for this to happen:

Windshield Wiper Issues

- **Worn wiper blades**: Wiper blades need to be replaced on a regular basis. Worn wiper blades will not clean the windshield. Smearing or streaking are common symptoms of worn blades. If the blades chatter this can also indicate dirty or worn blades. Torn or cracking blades need to be replaced.

- **Bent or loose wiper arms**: Wiper arms can become bent, usually due to vandalism. If the wiper blades are not cleaning the windshield but still appear to be in good shape loose or bent wiper arms could be the problem.

- **Malfunctioning wiper arm linkage**: The linkage between the wiper motor and the blades can become damaged. The most common symptom of a broken linkage is one wiper arm not working.

- **Blown fuse**: A blown fuse will cut off the electric current to the wiper motor. If both blades fail to function when turned on, a blown fuse is usually the starting point for a diagnosis.

- **Bad wiper motor**: If the blades fail to operate at all, are operating slowly, only operate on one speed or do not stop in the correct position a bad or malfunctioning wiper motor could be the culprit. The motor will need to be repaired or replaced.

- **Defective wiper switch**: If the wipers do not turn on when the switch is flipped, keep running after being switched off or it is impossible to select the proper speed settings the switch may be defective and will have to be replaced.

Windshield Washer Issues

- **No washer fluid**: One of the most common reasons windshield washers fail to work is because the fluid reservoir is empty.

- **Blown fuse**: Fuses provide overcurrent protection to all of the vehicle’s electrical units and this includes the windshield washer system. If a fuse blows, the electrical current to the washer pump will be cut off and the washer system will not work.

- **Bad windshield washer switch**: The switch that turns on the windshield washer can malfunction and fail to send a signal to the pump. If this happens the pump will not work.

- **Broken washer pump**: The electric pump that sends the fluid from the reservoir to the nozzles can malfunction or break.
- **Leaky washer tubes or bottle**: The washer reservoir or the tubing that moves the fluid to the nozzles can crack or leak. This can lead to lost fluid on route to the nozzles, which can result in a weak spray or no spray at all.
- **Clogged washer tubes or nozzles**: The tubing or the nozzles themselves can become clogged with debris. The nozzles, which are quite small can easily get clogged by dirt, leaves or other debris.
- **Frozen washer fluid**: In extremely cold weather it is possible for washer fluid to freeze. If the fluid is frozen it should thaw as the car warms up.

https://www.yourmechanic.com/services/windshield-wiper-washer-system-inspection

How Windshield Wipers Work

The windshield wiper is moved by a motor at the base of the window to clear the window of rain. There are multiple ways for the windshield wipers to be configured. Most cars have two wipers which move in sync with each other

The Parts of a Windshield Wiper

Like most systems in a vehicle, the windshield wiper is made up of many parts. The main parts of the windshield wiper are:

- **Wiper Blades** - The wiper blades are what removes the moisture from the windshield

- **Wiper Arm** - The wiper arm connects the wiper blade to the wiper transmission, to allow for unhindered movement over a large patch of the windshield

- **Wiper Transmission** - The windshield wiper transmission controls the movement of the wiper arm

- **Wiper Motor** - The windshield wiper motor provides power to the wiper transmission and fluid pump

- **Windshield wiper fluid pump, tanks and tubes** - The windshield wiper fluid pump, tanks, and tubes are the system responsible for spraying out windshield wiper fluid, allowing the driver to clean a dirty windshield

- **Windshield Wiper Interior Controls** - The windshield wiper internal controls are located either on a control arm protruding from the steering wheel, on the steering wheel, or on the main dashboard panel, to the left of the main dash display

https://www.yourmechanic.com/article/how-windshield-wipers-work and https://carbiketech.com/windscreen-wiper-working/

Instrument Panel

A **dashboard** (also called **dash**, **instrument panel (IP)**, or **fascia**) is a control panel usually located directly ahead of a vehicle's driver, displaying instrumentation and controls for the vehicle's operation. The instrument panel–also called a gauge cluster–includes a speedometer and lots of little symbols that light up to provide information or warn of trouble. Some, like the seatbelt light, are self-explanatory. Others, like the infamous and often misunderstood check engine light, can mean any number of things.

Speedometer

Located on all instrument panels, the speedometer simply informs the driver, speed of the vehicle in miles per hour (mph) and in kilometers per hour (km/h).

Odometer

The odometer (also known as milometer) keeps track of vehicle's mileage. Often located within the speedometer. There are two variants of this. One odometer displays the overall miles the car has traveled from being manufactured and the other version is a trip-odometer which unlike the other version can be reset. The trip-odometer can be beneficial to the driver to calculate distances of trips and to calculate fuel consumption.

Tachometer

Inside the car engine, are component that spin, each complete spin being a cycle. Each cycle is termed as a rev. Tachometer or rev counter, measures the engine's revolutions per minute. It informs the driver of how many revs per minute (rpm) that the engine is running. The tachometer is especially helpful to those who drive a manual transmission, as keeping an eye on the rpm can assist with gear shifting and timing. When the engine is running, but idle, a typical rpm is around 1000 to 1500.

Warning and Information Lights

A variety of warning and alert lights are in the instrument panel. If a problem exists, a light is sure to notify you. For example, an exclamation point signifies "check engine," or an ABS light that stays on signifies an error with the anti-lock braking system.

Temperature and fuel gauge

It informs the driver that the engine is running at optimal temperature where the needle sites usually around midway on the gauge. If the needle begins to rise towards the red mark, it signals a problem.

All cars are fitted with a fuel gauge. This gauge informs the driver of how much fuel is remaining in the tank. Some modern vehicles may also display on a digital panel how many miles are possible with the remaining fuel.

For more detailed information, please visit http://knowhow.napaonline.com/know-your-dashboard-lights-and-gauges-infographic/ and https://itstillruns.com/names-instruments-dashboard-car-7334757.html also visit https://www.drivingtesttips.biz/driving-test-tutorials/car-instrument-panel.html

Figuring Out Why Dash Gauges and Lights Don't Work

Regardless of whether you're dealing with gauges or lights, the basic troubleshooting process will always be determined by the number of failures that happen at the same time. So if it's just one gauge or light that doesn't work, you'll follow one basic procedure, and you'll follow another if everything stops working at once.

1. When all of the gauges or warning lights in your car stop working at once, the problem is something that all of the gauges and lights share in common.
    - Check the fuses first. The fuse may be labeled gauges, cluster, or something similar. This fuse should have power on both sides with the ignition in the on position.
    - If the fuses check out okay, then check for power at the instrument cluster.
    - If the instrument cluster has power, then check for ground. A bad ground connection can cause total failure or erratic readings.
    - When all else fails, the instrument cluster itself may have to be replaced.
2. When only one gauge or light stops working, the problem is either a bad sensor or a bad gauge.
    - Diagnosing a single bad gauge or warning light requires you to locate the sensor that connects to it.
    - Disconnecting the sensor is usually the first step. Depending on how the gauge works, disconnecting the sensor, or connecting it to ground, may allow you to test the operation of the gauge.
    - The diagnostic procedure for gauges and sensors differs from one application to another.
    - In some cases, you may find that the problem was caused by a loose connection.

3. When a speedometer with a physical cable doesn't work, the problem is a broken cable or bad speedometer.
    - If you can locate where the speedometer cable connects to the transmission, diagnosing this problem is very easy.
    - Manually turning the end of the cable that inserts into the transmission with your fingers should cause the speedometer to move.
    - If the speedometer doesn't move, disconnect the cable from the speedometer and turn it manually.
    - If you don't see one end turn when you manually rotate the other, the cable is broken internally. If it does turn, then the speedometer is bad.

      For more detailed information, please visit https://www.lifewire.com/gauges-in-car-not-working-4140224

Installing a Car DVD Player

While each car and each car DVD system is different there are still some basic items you will probably need to complete the installation process. For most projects you will need a flat-head and Philips-head screwdriver, pliers and a wire striping/crimping tool at the very least. You may also need a socket and ratchet set, utility knife, panel tool, drill and bit set and torque driver set as well. Again, this is a list of only the more basic tools and you are likely to need several other items as well.

Read the instructions carefully and study any schematics supplied with the DVD player to make sure you completely understand the process in installing that specific car DVD player correctly.

Installation

Each car model has a slightly different installation process. However, these general guidelines apply to any car capable of supporting this device.

1. First, open the hood.

2. Locate the car battery. Car batteries all have two metal clamps connected to them.

3. Use a wrench to loosen and disconnect the negative battery cable clamp. It’s the one with the negative symbol that looks like this

4. Next, you need to remove the old or original factory car stereo unit.

- First locate the vehicle service/repair manual or consult with a local professional for proper instructions. Note that removing the original stereo system might require special tools and could be difficult for beginners because it's necessary to disassemble some parts of the dash panel. Pull out the unit and disconnect the cables.

5. Some vehicles require a dash adapter faceplate, in order to fit the unit perfectly, seamlessly. If necessary install it now. Pull out the car stereo wire harness.

6. Connect an ISO wire harness connector and additional cables. If necessary install a car specific wire harness adapter. Refer to wiring diagram.

7. Slide the new car DVD player into the slot. Fix it into the bracket. Reinstall the dash panels.

8. Reconnect the battery cable.

https://www.chinavasion.com/Information_On_Installing_A_Car_DVD_Player.html

Car Sensors used in a Car Engine

Almost all modern car engines use a lot of different car sensors to gather the right information to calculate a perfect air fuel mixture for the best fuel economy in all situations. Below is the list of sensors used in a car engine.

Please visit https://mechanicbase.com/engine/car-sensors/ and https://www.automobilexyz.com/top-11-car-sensors-and-their-functions/ also visit https://shop.advanceautoparts.com/r/advice/cars-101/car-sensors-what-are-car-sensors-and-how-do-they-work

S. No	Type of Sensor	Function	Location
1	**Coolant temperature sensor**	Measures the temperature of the coolant	Coolant hose/Cylinder Head
2	**Intake Air Temperature sensor**	Measures the Air temperature flowing to the engine	Inside the MAF sensor or after the air filter box
3	**Mass Air Flow Sensor**	Measures the Air Mass going into the engine	Hose between air filter box and throttle body
4	**Manifold absolute pressure sensor**	Measures the pressure in the intake manifold	At the Manifold
5	**O2 Sensors (Lambda)**	Measure the Oxygen in the exhaust gases	At the exhaust pipe
6	**Knock Sensors**	Monitor detonations from the engine	On the engine block
7	**Crankshaft Sensor**	Measures the position of the crankshaft	Low fitted on the engine. Often in the engine block
8	**Camshaft sensor**	Measures the position of the camshafts	Often at the top of the head, near the crankcase cover
9	**Fuel Temperature Sensor**	Measures the fuel temperature	At the fuel rail or fuel line
10	**Fuel Pressure Sensor**	Measures the Fuel pressure	At the Fuel Rail/Pressure fuel line
11	**Voltage Sensor**	Measures the voltage	Often inside the control units
12	**Nox Sensor**	Measures the NOX in the exhaust	At the exhaust pipe
13	**Exhaust temperature sensor**	Measures the Exhaust Temperature	At the Exhaust Pipe
14	**Boost pressure sensor**	Measures the boost pressure	At the turbo pressure hoses/pipes
15	**Throttle position sensor**	Measures the angle of the throttle body	At the throttle body

starter motor

A car engine is what is known as a feedback system - a system that essentially uses the momentum from one part of the engine's phase to ignite the second part.

This means once the engine has started, the gas and air mixture in one set of cylinders ignites, pushing those cylinders down and drawing another mix of gas/air in and the cycle continues.

The starter motor is what gets all this moving and it is just a powerful electric motor.

Symptoms of a bad starter motor

1. If you twist the key and the dash lights come on dimly, the solenoid buzzes or clicks, or nothing at all happens, it may well be the battery or the cables, not the starter motor. Charge the battery. Your voltmeter should read at least 12.6 volts with no electrical drain on the battery and the charger disconnected for an hour.

2. Check the battery capacity. I use a resistance-type battery load tester. A good, charged-up battery should deliver 150 amps for 15 seconds without dropping below 10.5 volts, and should recover nearly to the aforementioned 12.6 volts within a minute.

3. If the battery checks out okay, look for poor electrical connections to the starter or solenoid, as well as the battery and chassis connections. Accept no more than a 0.5-volt voltage drop between the battery post and the starter hot post. Ditto between the battery negative post and the engine block.

4. Bottom line, there should be 9 to 10 volts at the starter motor hot post when cranking. Don't forget to put the car in neutral or park and block the wheels so you don't run yourself over.

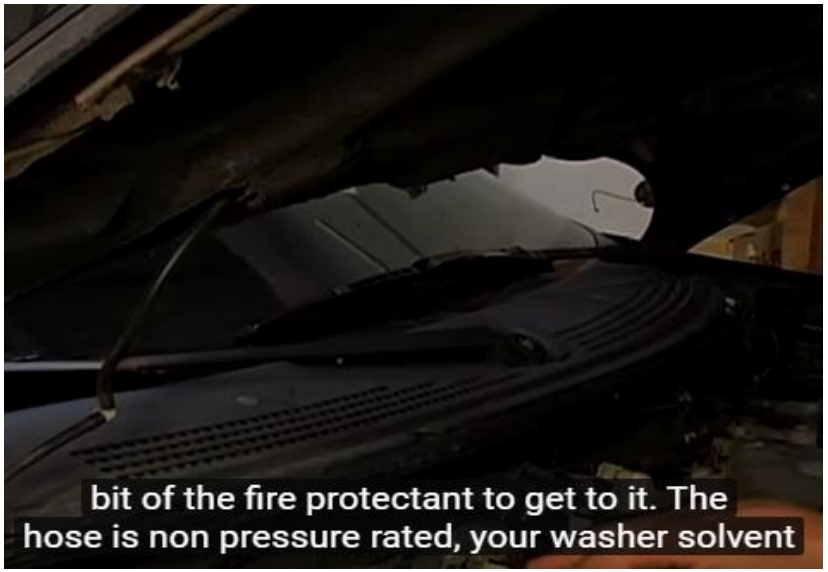
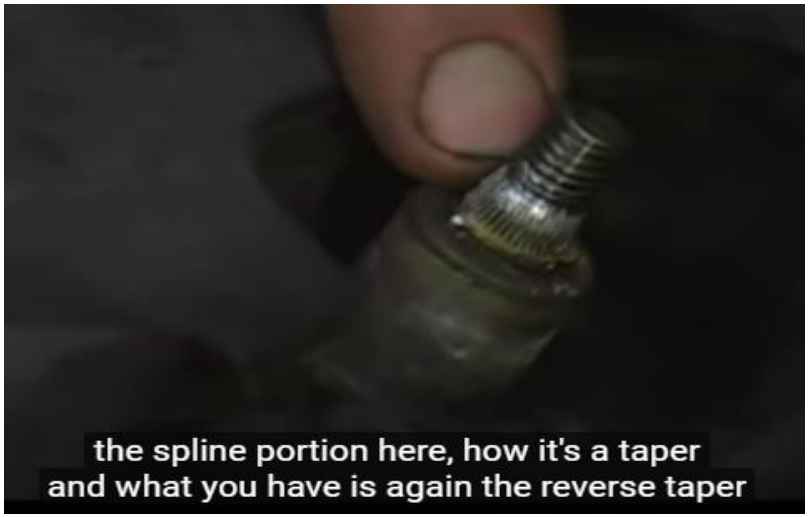
5. Battery cables okay? Try jumping—with jumper cables—directly from the battery positive terminal to the starter motor's solenoid post. If the solenoid pulls in and the starter turns over the engine, you've got a wiring problem.

6. If the solenoid doesn't pull in and energize the armature, try jumping directly to the motor's armature post, bypassing the solenoid. If the armature spins, the problem is in the solenoid or its wiring.

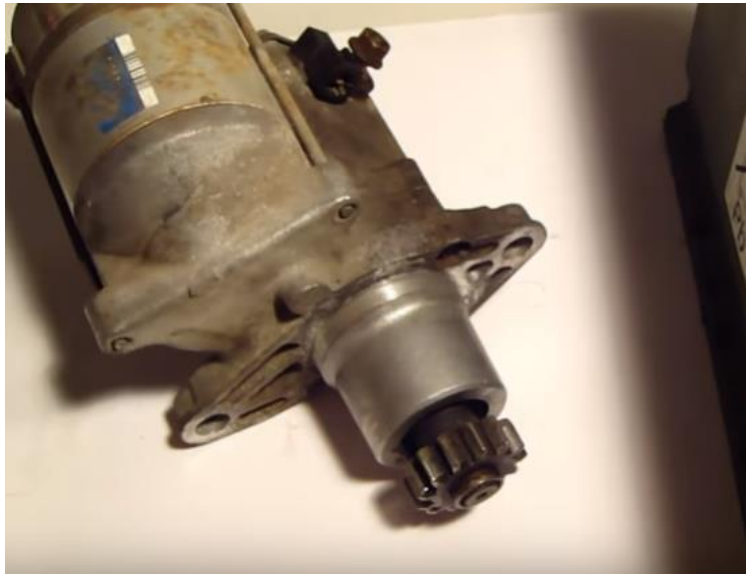
7. Don't forget that some antitheft systems will still disable the starter even if the crooks hot-wire the ignition key. And when something goes wrong with that alarm, you're stranded. It gets worse—it's usually difficult or impossible to disconnect the alarm, in order to keep the car thieves from doing so. Be prepared for serious reading of the factory shop manual or, if your alarm is aftermarket, a return to the alarm installer.

For more detailed information, please visit https://www.popularmechanics.com/cars/how-to/a5837/how-to-replace-a-cars-starter-motor/ and https://www.autoguru.com.au/car-advice/articles/how-do-i-know-my-starter-motor-is-faulty

Videos:

	**How to Repair Windshield Washing System: Hose Location in Windshield Washer System** **https://youtu.be/oybE-_FI47Y**
	**Windshield Wiper Motor Replacement: How to Access a Windshield Wiper Motor** **https://youtu.be/iVBAvvfc1FU**

	**Instrument Cluster Display-Digital dashboard on the car instrument panel** https://youtu.be/nGijFkag9FI
	**Car Sensors Used in Automobile Engine and Their Functions** https://youtu.be/X2K_y7AhfGg

	**How works car starter or start motor.** **https://youtu.be/Bv9-ZpP6HOk**

Module summary

Module	Learning Unit	Duration
Module 1: Apply Work Health and Safety Practices (WHS) **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to apply work health and safety practices (WHS)	**LU 1:** Implement safe work practices at work place **LU 2:** Participate in hazard assessment activities a work place **LU 3:** Follow emergency procedures at workplace **LU 4:** Participate in OHS consultative processes	30 Hrs

Module	Learning Unit	Duration
Module 2: Identify and Implement Workplace Policy and Procedures **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to Identify and Implement Workplace Policy and Procedures	**LU 1:** Identify workplace policy & procedures **LU 2:** Implement workplace policy & procedures **LU 3:** Communicate workplace policy & procedures **LU 4:** Review the implementation of workplace policy & procedures	20 Hrs
Module 3: Communicate at Workplace **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to Communicate at Workplace	**LU 1:** Communicate within the organization **LU 2:** Communicate outside the organization **LU 3:** Communicate effectively in workgroup **LU 4:** Communicate in writing	30 Hrs
Module 4: Perform Computer Application Skills **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to Perform Computer Application Skills	**LU 1:** Prepare In-page documents as per required information **LU 2:** Prepare Spreadsheets as per required information **LU 3:** Use MS Office as per required information **LU 4:** Perform computer graphics in basic applications **LU 5:** Create Email account for communications	40 Hrs

Module	Learning Unit	Duration
Module 5: Manage Personal Finances **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to Manage Personal Finances	**LU 1:** Develop a personal budget **LU 2:** Develop long term personal budget **LU 3:** Identify ways to maximize future finances	30 Hrs
Module 6: Perform General Inspection **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perform general inspection	**LU 1:** Inspect Mechanical Failure **LU 2:** Inspect Electrical Failure **LU 3:** Perform Road Test **LU 4:** Prepare Job Card/Report	40 Hrs
Module 7: Perform Engine Tuning **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perform engine tuning	**LU 1:** Clean/Replace Air filter **LU 2:** Adjust Engine Idle Speed **LU 3:** Adjust Air Fuel Ratio **LU 4:** Adjust Tappet Clearance **LU 5:** Clean/Adjust/Replace Spark Plugs **LU 6:** Clean/Adjust/Replace Contact Breaker Point	50 Hrs

Module	Learning Unit	Duration
Module 8: Maintain Ignition System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain ignition system	**LU 1:** Maintain Contact Breaker Ignition System **LU 2:** Maintain Electronic Ignition System **LU 3:** Maintain Coil--Plug (COP) System	50 Hrs
Module 9: Maintain Fuel Control System-I **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain fuel control system-I	**LU 1:** Maintain Electronic Fuel Injection (EFI) System **LU 2:** Maintain Common Rail Direct Injection (CRDI) System **LU 3:** Maintain Motronic Control Unit for CNG System	50 Hrs
Module 10: Service Comfort & Safety System-I **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to service comfort & safety system-I	**LU 1:** Maintain Suspension System **LU 2:** Maintain Power Window & Central Locking System **LU 3:** Verify Seat Belt **LU 4:** Service Heat Ventilating system **LU 5:** Service Air-Conditioning (AC) System	50 Hrs

Module	Learning Unit	Duration
Module 11: Maintain Controlled Brake System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain controlled brake system	**LU 1:** Maintain Anti-lock Braking System (ABS) **LU 2:** Maintain pressure Modulator **LU 3:** Maintain ABS-Electronic Control Unit (ECU)	45 Hrs
Module 12: Conserve Power Transmission-I **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to conserve power transmission-I	**LU 1:** Perform maintenance of Automatic Transmission **LU 2:** Perform maintenance of Electronic Control Transmission (ECT) System **LU 3:** Perform Diagnosis of Electronically Controlled Transmission (ECT) System with OBD II Scanner	45 Hrs
Module 13: Perpetuate Controlled Electric & Electronic System-I **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perpetuate controlled electric & electronic system-I	**LU 1:** Service Windshield Wash System **LU 2:** Service Wiper System **LU 3:** Check Performance of Instrument Panel **LU 4:** Demonstrate Function of Sensors **LU 5:** Maintain Electrical Motors	60 Hrs

Short Questions/Answers:

1. How can low tire pressure negatively affect driving? https://www.aarp.org/auto/car-maintenance-safety/info-2016/auto-maintenance-quiz.html#quest3	By Compromised cornering, braking and stability By Decreased fuel efficiency By Uneven wear and increased chance of tire failure
How often oil and oil filter should change? https://www.aarp.org/auto/car-maintenance-safety/info-2016/auto-maintenance-quiz.html#quest3	Depends on your driving style and conditions Depends on the car year and model
Which instrument do we use to check specific gravity of electrolyte?	Hydrometer
What are the main factors relate to non-starting of engine?	1. Fuel supply 2. Voltage supply in ignition system
What mandatory checkups to be done before starting an engine?	Mandatory check-ups are 1. Coolant Level 2. Engine Oil Level 3. Brake Fluid level 4. Electrolyte Level 5. Fuel Level 6. Tire Pressure
What is DTC stands for	Diagnose Trouble Code
Name different types of filter used in a vehicle?	1. Oil filter 2. Air filter 3. Fuel filter 4. Air-conditioning filter
At which stroke do we set tappet clearance and why?	We set tappet at compression stroke/power stroke, because both valves (Intake & Exhaust) are closed on these strokes
How to adjust engine idle speed?	Engine idle speed can adjust by turning the screw clockwise or anti clock wise on throttle body and also by OBD-II sensor.
What is the main purpose of ignition system	The main purpose of ignition system is to create a high voltage spark.

Which tools do we use to set tappet clearance?	Feeler gauge Flat screw driver Combination Spanner
How often should a car engine filter be changed? https://auto.ndtv.com/news/what-does-a-car-engine-air-filter-do-1248487	There is no simple answer as to how often a car engine air filter should be changed. It depends on a number of factors, such as how many miles the vehicle has been driven and the environment it is driven in.

How often should an air filter be replaced? https://blog.firestonecompleteautocare.com/maintenance/fags-about-your-cars-cabin-fuel-and-air-filters/	Generally, it's recommended that you get your filters replaced every 12 months or 12,000 miles, but check your owner's manual for specifics about your vehicle's filter replacement schedules.
What happens to air filters as they get older? https://blog.firestonecompleteautocare.com/maintenance/fags-about-your-cars-cabin-fuel-and-air-filters/	When your air filter is dirty, your engine is forced to work harder, resulting in poor fuel economy, higher emissions and, possibly, a loss of engine power.
What is the benefit of replacing an air filter? https://blog.firestonecompleteautocare.com/maintenance/fags-about-your-cars-cabin-fuel-and-air-filters/	**Air filter: Engine protection is the name of the game.** So is engine performance. Acceleration can improve up to 11% after an old, dirty air filter is replaced.
Name different types of Spark Ignition Systems?	1. Contact Breaker Ignition System 2. Breaker-less/Electronic Ignition System 3. Distribute less Ignition System 4. Coil-On-Plug Ignition System
What are the two windings used in ignition coil?	The two windings used in ignition coil are 1. Primary winding 2. Secondary winding
Name main components of ignition system?	Main components of ignition system are 1. Battery 2. Ignition Switch 3. Ignition Coil

	4. Ignition distributor 5. Spark Plug
What are the advantages of EFI System?	Advantages of EFI System 1. Improved fuel distribution 2. Engine power increases by average of 10 percent 3. Faster acceleration resulting from direct delivery of fuel to the cylinder 4. Leaner air/fuel ratios 5. better fuel economy 6. reduced exhaust emissions
What are different types of EFI sensor?	Types of EFI sensor are 1. Mass Air Flow sensor 2. Throttle position sensor 3. Manifold absolute pressure sensor 4. Camshaft position sensor 5. Crankshaft position sensor 6. Engine Coolant temperature sensor 7. Oxygen sensor 8. Knocking sensor
Name different types of EFI actuators?	Types of EFI actuators are 1. Fuel Injectors 2. Idle Air control valve
What MAF Stands for?	Mass Air Flow Sensor
What CMP stands for?	Camshaft position sensor
For how long does fuel line pressure remain? https://axleaddict.com/auto-repair/How-to-Test-a-Fuel-Pressure-Regulator	Fuel pressure decreases slightly after shutting off the engine. Then the pressure will hold for about five minutes then decrease slightly. But some pressure will remain steady usually after about 20 minutes.
What if the car just doesn't start and I've never had it running? How can the fuel pressure system be tested? https://axleaddict.com/auto-repair/How-to-Test-a-Fuel-	Locate the fuel pump relay; you may be able to connect battery power to it. Have a fuel pressure gauge connected to the test port. Check the specification for initial pressure on your vehicle repair manual.

Pressure-Regulator	The manual will help you locate the relay as well.
Name main components of Air-conditioning system?	Main components of Air-conditioning system are 1. AC compressor 2. AC condenser 3. AC Drier 4. Expansion Valve 5. Evaporator
How does AC clutch work?	AC system uses electromagnetic clutch which engages and disengage on requirement
What is the main function of thermostat in engine cooling system	Main function of thermostat is to reduce engine warm up time
What are the two pressure lines in AC system	Two pressure lines in AC system are 1. Low pressure line (30- 35 PS) 2. High Pressure Line (280 – 300 PSI)
What does expansion valve do in AC system?	It reduces high pressure AC fluid into low pressure which results in low temperature/cooling
What are the basic characteristics of a brake fluid? https://www.objectivebooks.com/2015/04/automobile-engineering_79.html	A high boiling point Low viscosity Compatibility with rubber and metal parts
ABS stands for?	Anti-Lock Brake System
What are the main components of ABS system?	The main components of ABS system are 1. Wheel speed sensor 2. Gear Pulsar Ring 3. Electronic Control Unit 4. Hydraulic Pressure Modulator

What is the main function of ABS Pressure modulator?	The main function of ABS pressure modulator is to regulate hydraulic pressure from brake master cylinder to wheel cylinders
What is the main function of ABS Return motor?	The main function of ABS Return motor is to return brake fluid pressure to master cylinder
Why do we have four wheel sensors instead of one?	In a circular path, outer wheel need high brake fluid pressure than inner wheel.
Enlist different types of clutches used in automatic transmission	Types of clutches used in automatic transmission are : 1. Forward Clutch 2. Reverse Clutch
Enlist main components of torque convertor	Main components of torque convertor are: 1. Fluid Pump 2. Turbine 3. Stator
How do you check oil pressure in automatic transmission	1. Install oil pressure tester in oil lines between transmission and oil cooler 2. Start the engine and note oil pressure reading (pressure should be in between 40 to 70 psi)
Enlist different types of sensors in ECT (Electronically Controlled Transmission)	1. Input shaft sensor 2. Output shaft sensor 3. Vehicle Speed Sensor
Explain purpose of Oil Cooler in automatic transmission	The purpose of the engine oil cooler is to allow the engine's cooling system to remove excess heat from the oil. These types of coolers are usually of the water-to-oil type of heat exchanger. The oil then flows through the tubes of the cooler while the engine coolant flows around the tubes
Define Motors and explain its types	An electric motor is an electrical machine that converts electrical energy into mechanical energy. Common type of Motors are AC Motors and DC Motors
Define Sensors and their types	A Sensor converts the physical parameter (for example: temperature, pressure etc.) into a signal which can be measured electrically.

	Common types of Sensors are Temperature, Pressure, Humidity, Speed, Proximity, etc.
Identify different indicators and warning lights	**Indicators:** 1. Side indicators 2. High beam indicator **Warning Lights:** 1. Engine oil light 2. Charging light 3. Brake light 4. Seat belt light 5. Air Bag
Enlist different types of gauges and meter used in instrument panel	**Gauges:** 1. Fuel Gauge 2. Temperature Gauge **Meters:** 4. Speedometer 5. Odometer 6. Trip meter 7. Tachometer
Enlist main components of windshield wash & wiper system	**Windshield Wash System:** 1. Washer fluid reservoir 2. Fluid Pump with motor 3. Fluid Lines 4. Washer Nozzle 5. Electric Switch **Windshield Wiper System:** 1. Wiper Motor 2. Wiper Links 3. Wiper Blades

Test Yourself (Multiple Choice Questions)

MODULE 6			
Question 1	To extend the life of tires, how often should rotate them?	A	Every 1,000 to 2,000 miles
		B	Every 5,000 to 8,000 miles
		C	Every 10,000 to 15,000 miles
		D	Rotating tires doesn't really extend their life
Question 2	A car's air filter should be inspected for signs of wear (e.g., oil or water soaked, leaking, torn or restricted) after every oil change, but how often should it be replaced even if it's not failing?	A	Once every 6 months
		B	Once per year
		C	Every two years
		D	Every 50,000 miles

Question 3 When should replace the belts that power alternator, water pump, power steering and cooling fans?

A Every time you have your car serviced

B During an oil change

C When the belts look greasy or glazed, have excessive cracks, or contain splits and chunking

D When the Check Engine light illuminates

Question 4 Is the following statement True or False?

A Battery is a series or parallel combination of electrolytic cells.

A True

B False

Question	**5**	In which term, the capacity of a battery is usually expressed?	A	Volts
			B	Amperes
			C	Weight
			D	Ampere hours
MODULE	**7**			
Question	**6**	What the condition called, if the air-fuel mixture ignites before the spark takes place at spark plug?	A	Detonation
			B	Ignition
			C	Pre-ignition
			D	Rumble

Question 7 Which of the following should be the first step in diagnosing an engine performance concern?

A Discussing concern with the vehicle owner

B Retrieve diagnostic trouble codes

C Check for symptoms in the on-line service manual

D Road test the vehicle

Question 8 How the valve tappet clearance is measured?

A By Screw pitch gauge

B By Engineering scale

C By Feeler gauge

D By Vernier caliper

MODULE	**8**			
Question	**9**	A NO START condition is being diagnosed on a vehicle with electronic fuel injection (EFI) and distributor less ignition. Technician A says you should only use a DMM (Digital Multimeter) to check voltage values on PCM (Powertrain Control Module). Technician B says you should use a tool to check for spark at one of the spark plugs. Who is right?	A	A only
			B	B only
			C	Both A and B
			D	Neither A nor B
Question	**10**	What the starting system includes?	A	A battery, a starter, and an ignition switch
			B	A battery, a distributor, and an ignition switch
			C	A battery, a starter, and a distributor
			D	A distributor, a starter, and an ignition switch

Question 11 What is the point gap in Contact Breaker Ignition System?

A 0.3 to 0.4 mm

B 0.4 to 0.5 mm

C 0.5 to 0.6 mm

D 0.6 to 0.7 mm

Question 12 What is the range of high voltage in ignition system?

A 20 to 40 volts

B 200 to 400 volts

C 2000 to 4000 volts

D 20000 to 40000 volts

Question 13 Why the ignition coil is used?

A To Step up current

B To Step down current

C To Step up voltage

		D	To Step down voltage

MODULE	**9**		
Question	**14** How engine oil effects, if the engine coolant leaks into the engine oil?	A	Appears milky
		B	Become foamy
		C	Turns black
		D	Turns sticky
Question	**15** What is the main purpose of a fuel pump in gasoline fuel system?	A	To filter the fuel
		B	To regulate the flow of petrol
		C	To transfer petrol from tank to carburetor
		D	To compress the petrol prior to deliverer

Question 16 What is the advantage of the fuel injection system over the carburetor system?

A Improved fuel efficiency

B Improved emission

C Improved power output

D All of these

Question 17 What is the maintenance cost in an electronic fuel injection?

A Very low

B low

C high

D Nil

Question 18 Is the following statement True or False?

The electronic fuel injection, eliminates majority of carburetor pressure loses and almost eliminates the requirement of manifold heating.

A True

B False

Question 19 What is the correct order in which fuel is injected?

A Fuel tank – Fuel filter – Fuel feed pump – Fuel injection pump – injector

B Fuel tank – Fuel feed pump – Fuel filter – Fuel injection pump – injector

C Fuel tank – Fuel filter – Fuel injection pump – Fuel feed pump – injector

D Fuel tank – Fuel injection pump – Fuel filter – Fuel feed pump – injector

Question 20 When the fuel is injected into the cylinder?

A At the end of suction stroke.

B At the end of compression stroke.

C At the end of expansion stroke.

D At the end of exhaust stroke.

Question 21 For which of the following injection system only one pump is sufficient for multi-cylinder engine?

A air

B mechanical

C Compression fuel

			D	Common rail
Module	**10**			
Question	**22**	Where the seat belt tensioners are built?	A	In the Front seats
			B	In the Shoulder anchors
			C	In the Seat belt retractor
			D	In the Seat belt buckles
Question	**23**	When replacing a lower control arm bushings on a short arm long arm (SLA) suspension, what should be the replacement?	A	Tightened and torqued in a vise
			B	Tightened using the torque turn method
			C	Torqued with vehicle weight on suspension
			D	Torqued with control arm resting on frame

Question 24 Which of the following conditions is likely to indicate a worn control arm bushing?

A Ball joint play

B Front suspension sag

C Fails the bounce test

D Rubber bushing is cracked

Question 25 During an air conditioning performance test, the technician notices that the compressor outlet is hot. Technician A says this is a normal condition. Technician B says the air conditioning system is overcharged. Who is right?

A A only

B B only

C Both A & B

D Neither A nor B

Module 11

Question 26 The brake shoe is moved outward to force the lining against which of the following, during braking?

A Wheel piston or cylinder

B Anchor pin

C Brake drum

D Wheel rim or axle

Question 27 What is the sequence in which the force is transmitted through a brake system when the brake pedal is depressed?

A Brake pedal, master cylinder, brake lines, vacuum servo mechanism, brake pads

B Brake pedal, vacuum servo mechanism, master cylinder, brake lines, brake pads

C Brake pedal, master cylinder, vacuum servo mechanism, brake lines, brake pads

D Brake pedal, brake lines, vacuum servo mechanism, master cylinder, brake pads

Question 28 What is the function of anti-lock brake system (ABS)?

A Reduces the stopping distance

B Minimizes the brake fade

C Maintains directional control during braking by preventing the wheels from locking

D Prevents nose dives during braking and thereby postpones locking of the wheels

Question 29 The ABS (antilock brake system) amber light does not go off after the engine is started. Technician A says a parking brake not fully released could be the cause. Technician B says when this happens the brakes will operate like a normal non-ABS brake system. Who is right?

A A only

B B only

C Both A & B

D Neither A nor B

Question 30 To which of the following the brake switch sends an electronic signal?

A Brake light

B Electronic control module

C Both A & B

D None of the above

Question 31 An automobile brake is only used to reduce the speed or bring the vehicle to hault.

A Yes

B No, it also be used to hold the car

			C	Brake acts only onmoving vehicles
			D	None of the mentioned
Module	**12**			
Question	**32**	What is the purpose of transmission in an automobile?	A	To vary the speed of automobile
			B	To vary the torque at the wheels
			C	To vary the power of automobile
			D	None of these
Question	**33**	Which of the following the torque converter does, when removing an engine from a vehicle equipped with an automatic transmission?	A	Stays with transmission
			B	Stays with engine
			C	Must be drained
			D	Must be flushed
Question	**34**	Which of the following will identify by an automatic transmission pressure test?	A	Defective Engine Shutoff (ESO) solenoid

			B	Defective torque converter
			C	Shift solenoid
			D	Dirty transmission filter
Question	**35**	Which of the following provides a smooth means of disengagement and engagement between the engine and the remainder of transmission system?	A	Clutch
			B	Gearbox
			C	Propeller shaft
			D	Differential
Module	**13**			
Question	**36**	By which of the following the starter motor is driven?	A	By chain drive
			B	By gear drive
			C	By flat belt drive

		D	By v-belt drive
Question	**37**	What is the main task of a battery in automobiles?	
		A	To Supply electricity to the alternator
		B	To Act as a reservoir or stabilizer of electricity
		C	To Supply electricity to the vehicle's electrical system at all times while the engine is running
		D	To Supply a large amount of power to turn the starter motor when the engine is being started
Question	**38**	Which of the following information is provided by the oxygen (O_2) sensor to the feedback control system?	
		A	About air fuel ratio
		B	About air flow speed
		C	About air temperature
		D	Exhaust gas volume
Question	**39**	What is the function of a governor in automobiles?	
		A	Limit the power

B Limit the vehicle speed

C Maintain constant engine speed

D Maximise the fuel economy

Question 40 What Tachometer measures, in a vehicle?

A Speed

B Distance

C Engine r.p.m

D Fuel consumption

Question 41 For which measurement, Odometer is used?

A Power

B Fuel consumption

C Engine r.p.m

D Distance

Question 42 When performing a load test on a battery, a technician finds that the battery voltage drops below specifications. Which of the following is the MOST likely action to perform?

A Recharge the battery and return it to service

B Recharge the battery and retest it

C Replace the battery

D Replace the voltage regulator

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