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AUTOMOTIVE MECHATRONICS

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LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

NAVTTC

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Introduction

Welcome to your Learner's Guide for the *Pipe Fitter Lev 4*. It will help you complete the training and go on with further study or go straight into employment.

The *Pipe Fitter Lev 4 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 in a level-5, 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 in Pakistan?	This certificate is based on the nationally standardized and notified 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

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Modules

Module 1: Contribute to Work Related Health and Safety (WHS) Initiatives

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to contribute to work related health and safety (WHS) Initiatives.

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Contribute to initiate work-related health and safety measures	**The trainee will be able to:** Compile database on work-related health and safety Identify measures that address legal obligations. Consult with individuals/ parties to formulate measures and initiatives Consult with individuals/parties to identify factors impacting on work-related health and safety Participate in consultative meetings.		
LU 2: Contribute to establish work-related health and safety measures	**The trainee will be able to:** Assist in planning of work-related health and safety measures Contribute to the development of work-related health and safety		

	measures Identify to implement work-related health and safety measures i.e. • resourcing requirements, • timelines • responsibilities Assist to implement work-related health and safety measures and initiatives i.e. • scheduling • liaison • administering resources • communication		
LU 3: Contribute to ensure legal requirements of WHS measures	**The trainee will be able to:** Identify WHS legar requirements Apply knowledge of all aspects of WHS measures to • Consultation • workplace policies • participation processes Ensure, WHS measures are in accordance with legal requirements		

LU 4: Contribute to review WHS measures	**The trainee will be able to:** Develop effective practices to review work-related health and safety measures Assist individuals and parties related to WHS measures in following activities • preparing reports • communicating review • evaluating outcomes		
LU 5: Evaluate the organization's WHS system	**The trainee will be able to:** Assess ongoing compliance with OHS (Occupational Health and safety) Take feedback from concerned persons regarding WHS measures. Assess the overall effectiveness of WHS management practices Assist the development process of WHS measures in following ways • Suggest amendments • Document amendments		

	• Implement amendments Take feedback from concerned persons regarding WHS measures. Communicate improvements in WHS Measures		

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Module-2

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Module 2: Analyze Workplace Policy and Procedures

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

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Manage work timeframes	**The trainee will be able to:** Complete work tasks within deadlines in according to order of priority Supervisors are informed of any delays in work times or projects		
LU 2: Manage to convene meeting	**The trainee will be able to:** Develop agenda in line with meeting purpose Select participants and notify them accordingly Carryout meeting arrangements according to the time Record the minutes of the meeting		
LU 3: Decision making at workplace	**P1.**		
LU 4: Set and meet own work priorities at instant	**The trainee will be able to:** Take initiative to prioritize and		

	facilitate competing demands to achieve organizational goals and objectives Use technology efficiently and effectively to manage work priorities and commitments Maintain appropriate work-life balance		
LU 5: Develop and maintain professional competence	**The trainee will be able to:** Assess personal knowledge and skills against competency Participate in networks to enhance personal knowledge, skills and work relationships Seek feedback from employees, clients and colleagues to develop and improve competence		
LU 6: Follow and implement work safety requirements	**The trainee will be able to:** Identify and report emergency incidents Practice organizational policy and procedures for responding to		

	emergency incidents Identify and implement workplace procedures and work instructions for controlling risks		

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Module-3

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Module 3: Perform Advanced Communication

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

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Demonstrate professional skills	**The trainee will be able to:** Use different modes of communication to communicate • Speaking • Reading • Writing • Listening • Presentation • Visual representation etc. Develop CV Skills according requirements Upgrade professional skills by attending trainings, webinars, conferences etc. Perform Continuous professional development as required at		

	workplace Develop interview skills		
LU 2: Plan and Organize work	**The trainee will be able to:** Identify task requirements. Plan steps to complete tasks. Review planning and organizing process. Organize work.		
LU 3: Provide trainings at workplace	**The trainee will be able to:** Assess the need for training Prepare trainees for the learning experience Present training session Support trainees in managing their own learning Facilitate group learning Provide opportunity for practice Provide feedback on progress on trainees Review delivery experience		

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Module-4

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Module 4: Develop Advance Computer Application Skills

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

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Manage Information System to complete a task	**The trainee will be able to:** Perform Data Entry in MS office Manage File/folder in MS office Perform Scanning of document Maintain Office Record in drives Perform Printing of document Search required Files/Folders Convert Files in required format. Manage sizes of Files/Folders • Compress • Zip /Unzip		
LU 2: Prepare Presentation using computers	**The trainee will be able to:** Prepare presentation as per requirements, i.e. • Open blank presentation and add text / graphics • Create a simple design for a presentation		

	• Apply existing styles within a presentation • Use presentation template and slides to create a presentation • Use various tools to improve the look of the presentation • Save presentation to the appropriate storage device and folder with required name Customize basic settings to meet user requirements Format presentation as require • Develop organizational charts • Add objects and manipulate to meet presentation purposes • Modify slide layout, including text and colours, to meet presentation requirements • Save presentation in another format • Save to storage device and close presentation Add slide show effect into presentation		

	as required to enhance the presentation • Incorporate pre-set Animation • Apply Multimedia effects • Record Narration • Apply hyperlink • Apply video • Rehearse Timings • Test presentation for overall effect Print the presentation • Select appropriate print format for presentation • Select preferred slide orientation • Add notes and slide numbers • Preview slides and run spell check before presentation • Print selected slides and submit presentation to appropriate person for feedback Practice verbal presentation		

	Practice presentation through AV Aids		
LU 3: Use Microsoft Access to manage database	**The trainee will be able to:** Collect the data using a standard data base package. Start access to manage database .i.e. • identify problem statement of Data • Develop a table with fields /attributes according to database usage/ user requirements • Create a primary key and establish an index for each table • Modify table layout and field attributes as required • Create a relationship between the two tables • Add data in a table according to information requirements • Add records as required • delete records as required • Save database to storage area		

	• close down database to storage area • Apply criteria in the following Query • SQL view of Query • Wildcards of query • Query Criteria Customize basic settings: • Adjust page layout to meet user requirements • Open and view different toolbars • Format font as appropriate for the purpose of the database entries • Create reports • Design reports to present data in a logical sequence • Modify reports to include or exclude additional requirements • Distribute reports to appropriate person in a suitable		

	format Create forms • Use a wizard to create a simple form • Open existing database and modify records through a simple form • Rearrange objects within the form to accommodate information requirements		
LU 4: Develop graphics for Design	**The trainee will be able to:** Develop graphic design concepts based on a thorough understanding of the communication need Use design techniques confidently to produce designs Integrate design tools skillfully to produce designs Evaluate the success of completed designs to meet objectives evaluate feedback from client / peers		

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Module-5

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Module 5: Manage Human Resource Services

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to manage human resource services.

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Determine strategies for delivery of human resource services	**The trainee will be able to:** Analyze business strategy and operational plans to determine human resource requirements Review external business environment that likely impact on organization's human resource requirements Consult line and senior managers to identify human resource needs in their areas Review organization's requirements for diversity in the workforce Deliver human resource services that comply with business goals Develop strategic action plan for delivery of human resource services		

	Develop roles and responsibilities of human resource team Develop quality assurance policy		
LU 2: Manage the delivery of human resource services	**The trainee will be able to:** Communicate human resource strategies and services to internal and external stakeholders Develop and negotiate service agreements between • The human resource team, • Service providers • Client groups Document service specifications, performance standards and timeframes Document /communicate service • Specifications, • Performance standards • Timeframes Monitor Quality assurance processes Ensure that services are delivered by appropriate providers, according to service agreements and operational plans		

	Identify underperformance of human resource team or service providers		
LU 3: Evaluate human resource service delivery	**The trainee will be able to:** Establish Management information system for human resource services Conduct survey to determine level of satisfaction Analyze feedback of survey Recommend changes to service delivery Support agreed change processes across the organization		
LU 4: Manage integration of business ethics in human resource practices	**The trainee will be able to:** Ensure ethics in personal behavior Ensure code of conduct is observed across the organization, Observe confidentiality requirements in dealing with all human resource information Deal promptly with unethical behavior Ensure all persons responsible for human resource functions understand		

	requirements regarding their ethical behavior		

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Module-6

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Module 6: Develop Entrepreneurial Skills

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

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Develop a business plan	**The trainee will be able to:** Conduct a market survey to collect following information • Customer /demand • Tools, equipment, machinery and furniture with rates • Raw material • Supplier • Credit / funding sources • Marketing strategy • Market trends • Overall expenses • Profit margin Select the best option in terms of cost, service, quality, sales, profit margin, overall expenses Compile the information collected through the market survey, in the		

	business plan format		
LU 2: Collect information regarding funding sources	**The trainee will be able to:** Identify the available funding sources based on their terms and conditions, maximum loan limit, payback time, interest rate Choose the best available option according to investment requirement Prepare documents according to the loan agreement requirement Include the information of funding sources in the business plan		
LU 3: Develop a marketing plan	**The trainee will be able to:** Make a marketing plan for the business including product, price, placement, promotion, people, packaging and positioning Include the information of marketing plan in the business plan		
LU 4: Develop basic business communication skills	**The trainee will be able to:** Communicate with internal customers e.g.: labor, partners and external		

	customers e.g.: suppliers, customers etc., using effective communication skills Use different modes of communication to communicate internally and externally e.g.: presentation, speaking, writing, listening, visual representation, reading etc. Use specific business terms used in the market		

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Module-7

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Module 7: 071400959 Maintain Fuel Control System-II

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

Duration: 50 Hrs **Theory:** 09 Hrs **Practical:** 41 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Maintain Gasoline Direct Injection (GDI)	**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 the Scanner and select engine parameters. Monitor fuel pressure sensor during Key on Engine Off (KOEO) position Monitor desired & actual fuel Pressure with engine parameters during Key On Engine Running (KOER) position. Monitor low pressure pump or high pressure pump control circuit.	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Describing Gasoline Direct Injection (GDI) System and its advantages, function, and structure Explaining working principle of pressure control circuit of Gasoline Direct Injection (GDI) system Defining components of Gasoline Direct Injection (GDI) System, their location and function for better understanding Defining pressure controlled circuit and its working principle Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Scanner OBD-II Repair Manual Socket Set Screwdriver Set Combination Spanner Set/ Spanner set Pressure Gauge Digital Multimeter WD 40 Petrol Kerosene Oil Grease Cotton Rug Fender Covers Floor Mats Creeper Trolley Tool Trolley

	Ensure housekeeping after completion of task		Lamp
LU 2: Maintain Common Rail Direct Injection (CRDI)	**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 Low Pump Pressure Test Ports using Pressure Gauge Check High Pump Pressure Test Ports using Pressure Gauge Check Pressure Control Valve Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Explaining common rail direct injection system (CRDI) to better understanding of its function, structure and method Describing components of common rail direct injection system (CRDI), their location and function Working principle of pressure control valve Servicing and replacement procedure of pressure control valve Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Scanner OBD-II Repair Manual Socket Set Screwdriver Set Combination Spanner Set/ Spanner set Pressure Gauge Digital Multimeter WD40 Diesel Kerosene Oil Grease Cotton Rag Fender Covers Floor Mats Creeper Trolley Tool Trolley Lamp
LU 3: Maintain	**The trainee will be able**	Understanding of appropriate tools and equipment	Teaching materials

Eco-idle 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 Start/Stop function and ensure ECO symbol display. Ensure all given parameters (Battery, Temperature, Starter Motor , Coolant, etc.) are correct before operating Start/Stop ECO system Check performance of all running modes of ECO system (Start/Stop, Crossing, Slope Assist, Traffic Jam, and Parking System). Ensure housekeeping after completion of task	Explaining the safety precautions regarding personal health and workplace Explaining eco-idle system and its components (i.e. gasoline engine, electric starter/ generator, battery etc.) Describing working parameters of eco-idle system's components and their location Diagnosing eco-idle system with the help of OBD – II scanner for troubleshooting Importance of housekeeping	White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Scanner OBD-II Repair Manual Socket Set Screwdriver Set Combination Spanner Set/ Spanner set Pressure Gauge Digital Multimeter WD 40 Petrol Kerosene Oil Grease Cotton Rug Fender Covers Floor Mats Creeper Trolley Tool Trolley Lamp

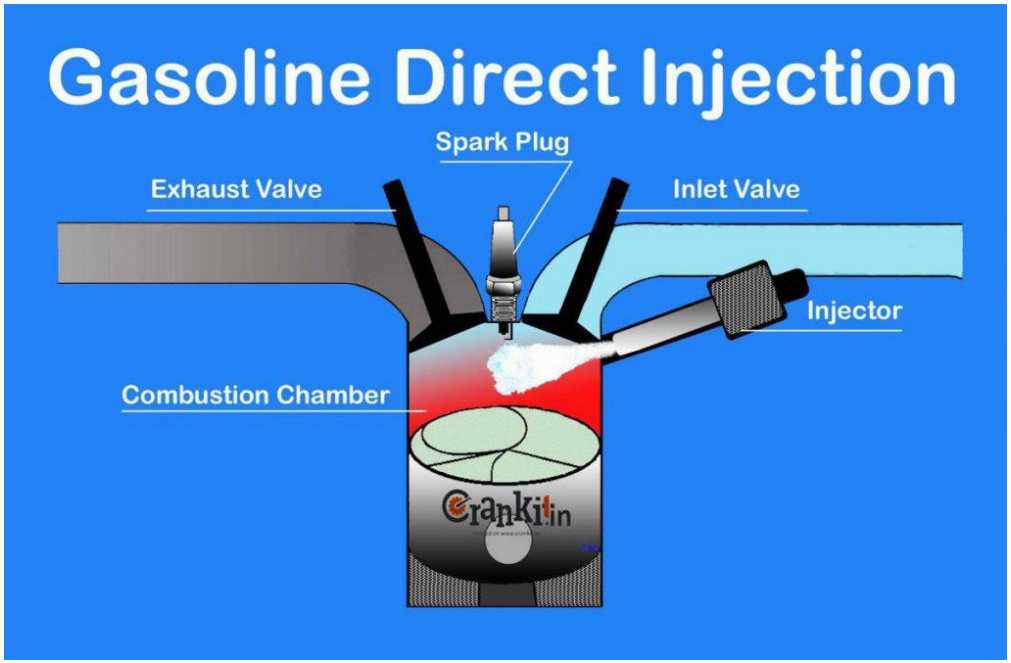
Examples and illustrations:

Fuel System:

Most modern engine's fuel systems use an advanced technology known as CRDI or Common Rail Direct Injection. Both petrol and diesel engines use a common 'fuel-rail' which supplies the fuel to injectors. However, in diesel engines, manufacturers refer to this technology as CRDI whereas Petrol engines term it as Gasoline Direct Injection (GDI) or Fuel Stratified Injection (FSI). Both these technologies have a similarity in design since they consist of “fuel-rail” which supplies fuel to injectors. However, they considerably differ from each other on parameters such as pressure & type of fuel used.

Gasoline Direct Injection (GDI) System:

It is a fuel-delivery technology that allows gasoline engines to burn fuel more efficiently, resulting in more power, cleaner emissions, and increased fuel economy. Gasoline Direct Injection (GDI) engines can provide an optimum combination: fuel efficiency and high performance. Instead of injecting the fuel on the back side of each intake valve for each cylinder GDI sprays directly into each cylinder. GDI uses high pressure to deliver fuel at any point on the compression stroke.



GDI Components

High Pressure Fuel Pump

GDI systems require a high pressure fuel pump. This pump is cam shaft driven, and uses engine speed to pump and compress the incoming low pressure fuel and deliver the high pressure fuel to the injectors. The high-pressure fuel pump is a single piston pump that runs off of a lobe on the camshaft and uses a pressure regulator built into the pump itself.

Injectors

It needs to have a special type of injector that can inject fuel under the high pressure requirements of cylinder compression.

PCM

One of the most important pieces of the GDI system is the PCM. A GDI compatible PCM is capable of forty percent more functions and almost twelve million more measurements than a standard PCM.

Turbo charger

Most GDI engines add a turbo charger to the system to raise the compression ratio and run a lean mixture. Due to the high fuel pressures, GDI can inject fuel even under high compression.

Catalytic converters

Most GDI cars use multiple catalytic converters that are larger than those found on conventional fuel systems.

Piston and Spray Design

The piston design is unique and enhances the cylinder's fuel charge.

Fuel Pressure

GDI equipped vehicles use a standard fuel pump and fuel tank to deliver the fuel to the high pressure pump. Fuel pressure on the low side ranges from 50 to 60 psi. The high pressure pump, which is camshaft driven, produces the pressures needed to overcome the high compression pressures. The pump is capable of producing as low as 60 psi during certain modes and as much as 2900 psi at wide

Advantages of Direct Fuel Injection

Combined with ultra-precise computer management, direct injection allows more accurate control over fuel metering, which is the amount of fuel injected and injection timing, the exact point when the fuel is introduced into the cylinder. The location of the injector also allows for a more optimal spray pattern that breaks the gasoline up into smaller droplets. The result is more complete combustion. In other words, more of the gasoline is burned, which translates to more power and less pollution from each drop of gasoline.

Disadvantages of Direct Fuel Injection

The primary disadvantages of direct injection engines are complexity and cost. Direct injection systems are more expensive to build because their components must be more rugged.

For more detailed information, please visit https://www.autonerdz.com/yabbfiles/Attachments/GDI_Operation.pdf
Also visit https://www.liveabout.com/direct-fuel-injection-533861

Common Rail Direct Injection (CRDI) System

Common rail is a fuel injection system found in modern diesel engines. Common rail systems provide a level of flexibility which can be exploited for class leading emission control, power and fuel consumption. This enables Original Equipment Manufacturers (OEMs) to design for optimum performance and exceptional end-user value across a range of machines and applications.

In Common Rail Direct Injection, the combustion takes place directly into the main combustion chamber located in a cavity above the piston crown.

Working process of CRDI

The working process of CRDI is very simple to understand as given below-

- In the process of CRDI a pump is used to pressurize the fuel.
- After the compression of fuel in the high pressure pump, the fuel is supplied to the common fuel rail.
- Then the fuel will be distributed to the different injectors.
- Injectors will finally inject the fuel in the engine cylinders.

Advantages of CRDI System

The vehicle engines with CRDI technology offers following advantages-

- The engine with CRDI produces more power and torque then conventional direct injection system
- It has the ability to increase the power and torque of engine by 25%.
- It increases the power and efficiency and reduces the emission.
- It decrease the noise and vibration and provides improved pick up.

It increase the fuel efficiency and decrease the fuel consumption i.e. mileage of the engine would be increased.

Disadvantages of Common Rail Direct Injection System

This technology also have some cons as other technologies.

- Its cost of vehicles with this technology is high.
- This technology cannot be implemented in all type of engines.
- The cost of maintenance is also high because its spare parts are expensive.

For more detailed information, please visit http://www.mechanicalclasses.com/2016/10/what-is-crdi-common-rail-direct.html

And https://www.perkins.com/en_GB/resources/useful-information/common-rail.html also visit https://carbiketech.com/common-rail-direct-injection-crdi/

Eco-Idle system

A car is said to be in “car idling” state when it’s not in motion and the engine is still running. This means that when you are waiting in a car, and the engine is running, your car is in car idling state.

Keeping a car idle for a long period can waste a lot of fuel. Another misconception is that people recommend warming a car up by keeping the engine idle, this is not true, the best way to warm up a car is to drive it without revving the engine too much. When an engine is at optimum temperature, starting and stopping it does not use excessive fuel. That’s where the concept of start-stop system comes in.

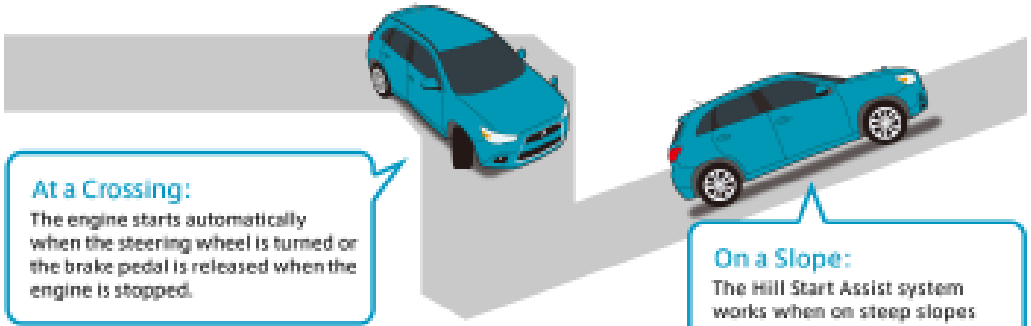
Keeping a car idle for a long period can waste a lot of fuel. Another misconception is that people recommend warming a car up by keeping the engine idle, this is not true, the best way to warm up a car is to drive it without revving the engine too much. When an engine is at optimum temperature, starting and stopping it does not use excessive fuel. That’s where the concept of start-stop system comes in.

In start-stop system, when the car comes to a stop, the engine stops the spark plug and fuel. When the driver lifts his foot off the brake, or presses the clutch, the engine automatically fires up. A car with start-stop system must have a strong starter motor, so that it can withstand the on-off cycle of the car. A good battery with enough amperes is also required, in order to satisfy the car’s entire electrical needs, when the engine is off.

For more detailed information, please visit https://www.pakwheels.com/blog/what-is-start-stop-system-eco-idle-and-how-does-it-work/

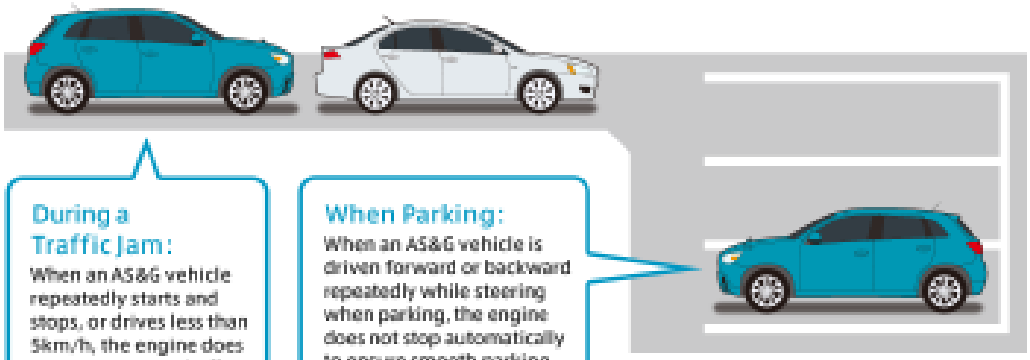
At a Stop:
The engine stops automatically at a vehicle stop by stepping on the brake pedal.

At a Start:
The engine starts automatically when taking one's foot off the brake pedal.



At a Crossing:
The engine starts automatically when the steering wheel is turned or the brake pedal is released when the engine is stopped.

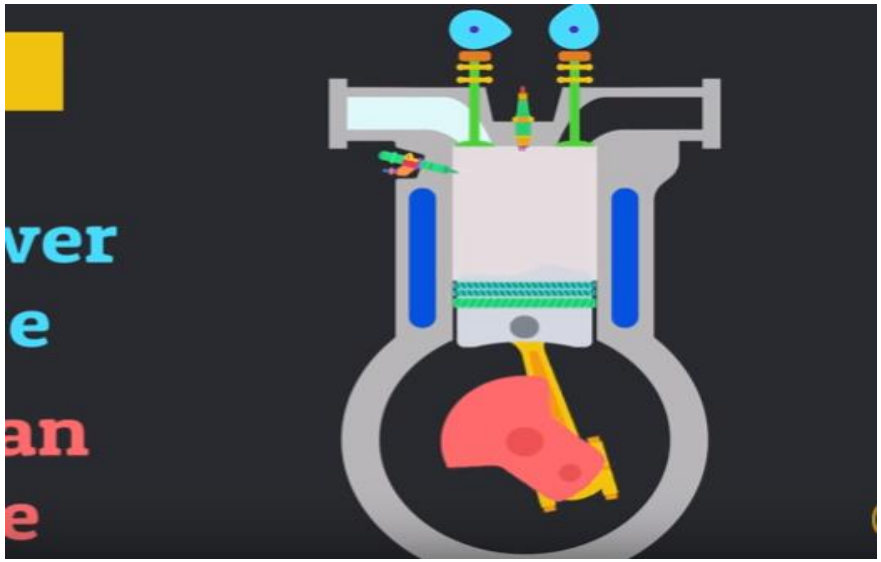
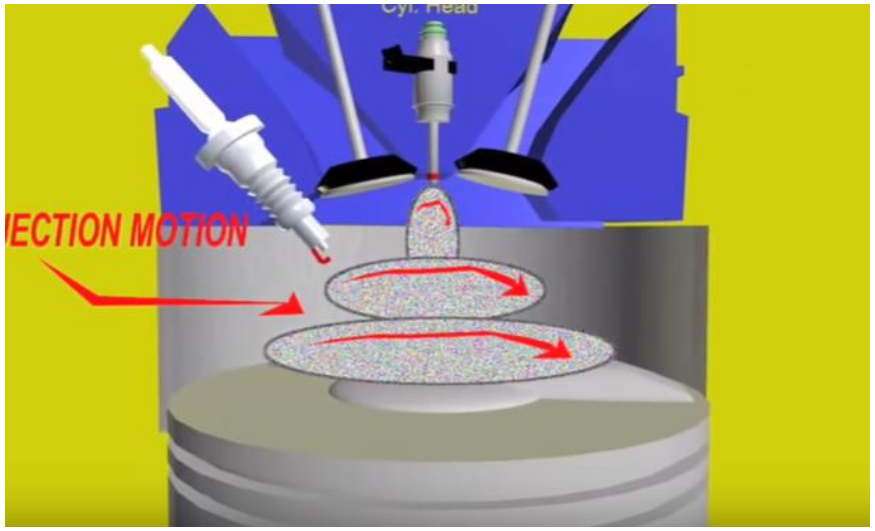
On a Slope:
The Hill Start Assist system works when on steep slopes and prevents the vehicle from rolling backward*.
*The engine does not stop when on steep slopes.

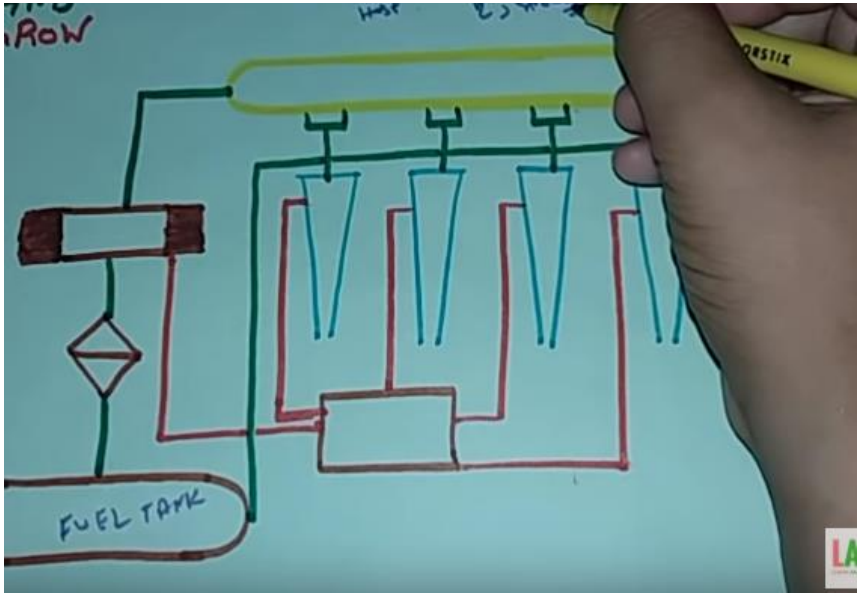


During a Traffic Jam:
When an AS&G vehicle repeatedly starts and stops, or drives less than 5km/h, the engine does not stop automatically.

When Parking:
When an AS&G vehicle is driven forward or backward repeatedly while steering when parking, the engine does not stop automatically to ensure smooth parking.

VIDEOS:

	**How GDI system Works? Gasoline Direct Injection** **https://youtu.be/sqPDeVf7DH8**
	**GDI Injector Operation** **https://youtu.be/4FG8tSWrCl8**

	**How CRDI Fuel Injection System Works?**
	**How CRDI Fuel Injection System Works?** **https://youtu.be/5AQ07-LF5JA**

	**ECO/IDLE - AUTO START STOP Explained in URDU/HINDI** **https://youtu.be/w4d6Ru4vLtE**
	**When ECO/IDLE - AUTO START STOP does not work in URDU** **https://youtu.be/DdoUqwULPLI**

AUTOMOTIVE MECHATRONICS

Module-8

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

Module 8: 071400960 Maintain Emission Control System

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

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Analyse Exhaust Gas Operation	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Test vehicle for exhaust gas analyses Inspect Catalytic convertor for damages Inspect Charcoal canister & Purge valve for secure connection Check Positive crankcase ventilation (PCV) valve Check Fuel tank & lid gasket for proper sealing	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Defining main components of emission control system (e.g. catalytic converter, EGR valve, and charcoal canister and purge valve, PCV valve), their location and functions Explaining how to use tools and equipment for servicing emission control system i.e. catalytic converter, EGR valve Describing the chemistry of toxic gases (e.g. nitrogen oxide, carbon mono oxide, nitrogen di oxide, carbon di oxide) in exhaust system. Describing how to reduce these toxic gases, soot particles, and noise in exhaust system Describe how to reduce fuel consumption in gasoline engine/ GDI Inspecting catalytic converter for damages to understand its faults Describing the function of catalytic convertor Explaining the cleaning method of catalytic converter with a cat cleaner Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Scanner OBD-II Digital Multimeter Wheel skids wooden Jack/ trolley jack Jack stands different size/height Ratchet and Sockets Set Screwdriver Set Pliers Hammer Ramps Hand Cleaner Exhaust Gas Analyser Combination Spanner Set/ Spanner set

	Check Exhaust gas recirculation (EGR) valve by vacuum gauge Check Heated oxygen sensors (O_2 Sensor) Ensure housekeeping after completion of task		Fire extinguisher WD 40 Petrol Kerosene Oil Grease Cotton Rug Creeper Trolley Tool Trolley Lamp
LU 2: Adjust Exhaust Gas Recirculation (EGR) System	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Check vacuum-controlled EGR valves on gasoline engines Check EGR valves with a potentiometer Check mechanical pressure transducers Check electro-pneumatic pressure transducers Check electrical pressure	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Describing the function and location of exhaust gas recirculation (EGR) valve Defining the types of EGR valve (for example vacuum controlled valve) for better knowledge Explaining the cleaning method EGR valve Diagnosing the faults of (EGR) valve with the help of OBD – II scanner Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Scanner OBD-II Digital Multimeter Wheel skids wooden Ratchet and Sockets Set Screwdriver Set Pliers Hand Cleaner Potentiometer Combination Spanner Set/ Spanner set WD40 Petrol Kerosene Oil

	transducers Check electric change-over valves Check thermo valves Check the EGR system with OBD-II Scanner Ensure housekeeping after completion of task		Cotton Rag Tool Trolley Lamp
LU 3: Perform Re-generation Process for Diesel System	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Prepare vehicle/engine for regeneration process Connect OBD-II Scanner Perform Regeneration process in Diesel EFI System Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Explaining Ad-blue chemical for neutralizing the toxic gases of diesel engines with their functions. Explaining the importance, function and location of diesel particulate filters (DPF) in diesel engines Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Scanner OBD-II Repair Manual Digital Multimeter Ad-blue Diesel Cotton Rag Fender Covers Tool Trolley Lamp

Examples & illustrations:

Emission Control System

In automobiles, emission control system, means limitation of emission of noxious gases from the internal-combustion engine and other components.

There are three main sources of these gases: the engine exhaust, the crankcase, and the fuel tank and carburetor.

In the crankcase combustion gases are combined with ventilating air. These gases are leaked from the portion of the engine block below the cylinders (where the crankshaft is located). These combustion gases then returned to the intake manifold for re-burning in the combustion chamber. The device that performs this function is known as the positive crankcase ventilation valve, or PCV valve.

Systems to control exhaust emission

To control exhaust emissions, which are responsible for two-thirds of the total engine pollutants, two types of systems are used: the air-injection system and the exhaust gas recirculation (EGR) system.

EGR System

In EGR a certain portion of exhaust gases are directed back to the cylinder head, where they are combined with the fuel-air mixture and enter the combustion chamber. The recirculated exhaust gases serve to lower the temperature of combustion, a condition that favors lower production of nitrogen oxides as combustion products (though at some loss of engine efficiency).

Air-injection system

In a typical air-injection system, an engine-driven pump injects air into the exhaust manifold, where the air combines with unburned hydrocarbons and carbon monoxide at a high temperature and, in effect, continues the combustion process. In this way a large percentage of the pollutants that were formerly discharged through the exhaust system are burned (though with no additional generation of power).

Catalytic converter

Another area for additional combustion is the catalytic converter, consisting of an insulated chamber containing ceramic pellets or a ceramic honeycomb structure coated with a thin layer of metals such as platinum and palladium. As the exhaust gases are passed through the packed beads or the honeycomb, the metals act as catalysts to induce the hydrocarbons, carbon monoxide, and nitrogen oxides in the exhaust to convert to water vapor, carbon dioxide, and nitrogen.
These systems are not completely effective: during warm-up the temperatures are so low that emissions cannot be catalyzed. Preheating the catalytic converter is a possible solution to this problem; the high-voltage batteries in hybrid cars, for example, can provide enough power to heat up the converter very quickly.

Fuel tank and carburetor
In the past, gasoline fumes evaporating from the fuel tank and carburetor were vented directly into the atmosphere. Today those emissions are greatly reduced by sealed fuel-tank caps and the so-called evaporative control system, the heart of which is a canister of activated charcoal capable of holding up to 35 percent of its own weight in fuel vapour. In operation, fuel-tank vapours flow from the sealed fuel tank to a vapour separator, which returns raw fuel to the tank and channels fuel vapour through a purge valve to the canister. The canister acts as a storehouse; when the engine is running, the vapours are drawn by the resultant vacuum from the canister, through a filter, and into the combustion chamber, where they are burned.

Exhaust Gas Recirculation (EGR)

It is a system that allows the exhaust gases to be recirculated back into the intake manifold. This process leads to a significant reduction in nitrogen oxides (NOx) emissions because it reduces the two elements underlying its production: oxygen in excess and combustion temperature.

There are two types of EGR:

- **internal exhaust gas recirculation (iEGR)**: the exhaust gases are sucked back in the cylinder by overlapping the opening time of the intake and exhaust valves
- **external exhaust gas recirculation EGR**: exhaust gases are recirculated back into the intake manifold by using and external duct and an additional valve (EGR valve)

  For more detailed information, please visit https://www.britannica.com/technology/emission-control-system and https://x-engineer.org/automotive-engineering/internal-combustion-engines/ice-components-systems/exhaust-gas-recirculation-egr-complete-guide-introduction/

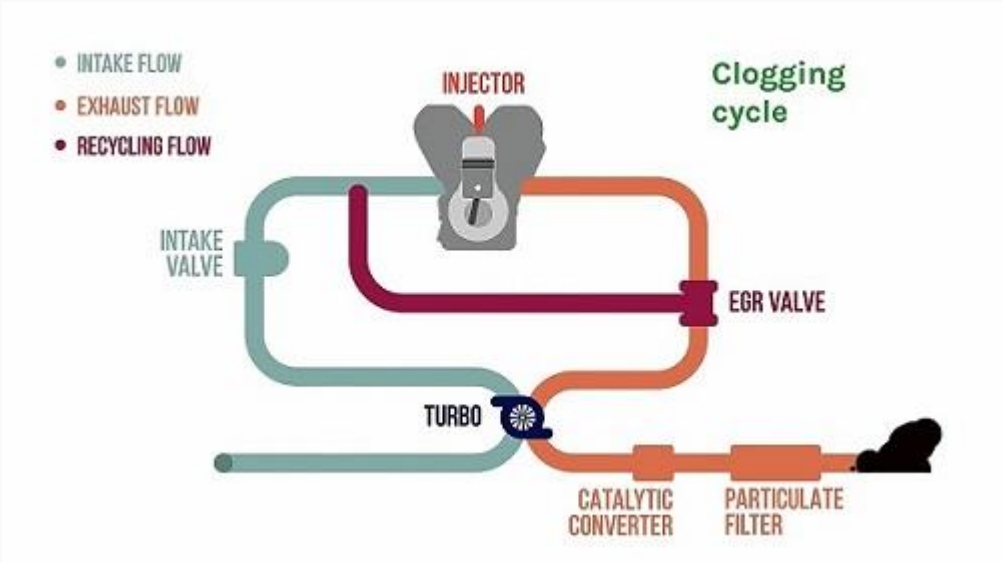
The EGR Valve

EGR stands for Exhaust Gas Recirculation. The valve directs a small portion of exhaust gasses back into the inlet air charge and lowers the maximum temperature of the burning fuel. The valve makes sure that the EGR system is off at idle, where it would lead to erratic and loping idle, and at peak power, since adding exhaust gasses robs power from the engine.

Functional principle of the EGR valve.

When a diesel engine runs at reduced power or slowly, part of the exhaust gas does not get burned. The engine emits an excess of nitrogen oxide and tiny particles into the atmosphere, violating European emissions standards. In an attempt to reduce such emissions, manufacturers

install a component with a flap which redirects exhaust gas back into the injection in order for it to get burned a second time. This is the functional principle of the EGR valve. This system, while ingenious, has its downside. Indeed, the EGR valve can become clogged along the injection system.



The EGR valve itself can end up completely covered in soot. If the flap of a clogged valve remains closed, your vehicle will function normally, but it will be polluting more. On the other hand, a flap that remains permanently open can seriously damage your intake system. Thus, it is important to properly maintain your diesel vehicle's EGR valve. In the event of reoccurring problems, in certain cases, you may also consider removing it with the help of your mechanic.

For more detailed information, please visit https://itstillruns.com/functions-egr-valve-5047751.html and https://www.flexfuel-company.com/en/egr-valve

Positive Crankcase Ventilation (PCV)

The Positive Crankcase Ventilation (PCV) system reduces blowby emissions from the engine. About 20% of the total hydrocarbon (HC) emissions produced by a vehicle are blowby emissions from gases that get past the piston rings and enter the crankcase. The higher the mileage on the engine and the greater the wear on the piston rings and cylinders, the greater the blowby into the crankcase.

How PCV works

The major component in the PCV system is the PCV valve, a simple spring-loaded valve with a sliding pintle inside. The pintle is tapered like a bullet so it will increase or decrease airflow depending on its position inside the valve housing. The movement of the pintle up and down changes the orifice opening to regulate the volume of air passing through the PCV valve.

The PCV valve is typically located in a valve cover or the intake valley, and usually fits into a rubber grommet. The location of the valve allows it to pull vapors from inside the engine without sucking oil from the crankcase (baffles inside the valve cover or valley cover deflect and help separate droplets of oil from the blowby vapors).

A hose connects the top of the PCV valve to a vacuum port on the throttle body, carburetor or intake manifold. This allows the vapors to be siphoned directly into the engine without gumming up the throttle body or carburetor.

Because the PCV system pulls air and blowby gases into the intake manifold, it has the same effect on the air/fuel mixture as a vacuum leak. This is compensated for by the calibration of the carburetor or fuel injection system. Consequently, the PCV system has no net effect on fuel economy, emissions or engine performance -- provided everything is working correctly.

WARNING: Removing or disconnecting the PCV system in an attempt to improve engine performance gains nothing, and is illegal. EPA rules prohibit tampering with any emission control device. Disabling or disconnecting the PCV system can also allow moisture to accumulate in the crankcase, which will reduce oil life and promote the formation of engine-damaging sludge.

For more detailed information, please visit https://www.aa1car.com/library/pcv.htm

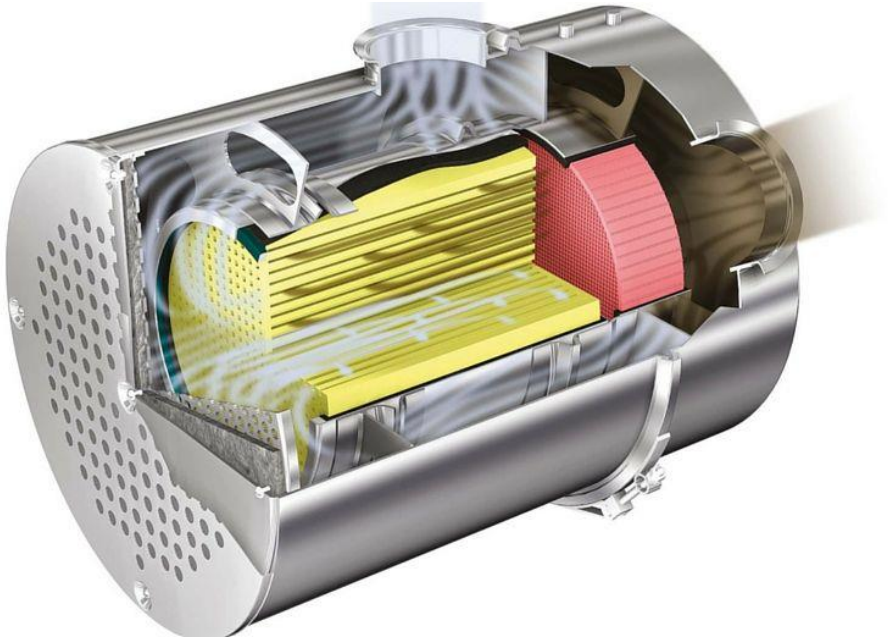
Re-generation Process

Regeneration is the process of burning off (oxidizing) the accumulated soot from the filter.

Diesel Particulate Filter

A diesel particulate filter (DPF) is a filter that captures and stores exhaust soot (some refer to them as soot traps) in order to reduce emissions from diesel cars. But because they only have a finite capacity, this trapped soot periodically has to be emptied or 'burned off' to regenerate the DPF. *This process of cleaning and emptying a Diesel Particulate Filter is called DPF regeneration*

This regeneration process cleanly burns off the excess soot deposited in the filter, reducing the harmful exhaust emission and helps to prevent the tell-tale black smoke you used to see from diesel vehicles, particularly when accelerating.



The soot created by the process of combustion which is collected in the filter is burnt off to make sure that the filter does not become blocked and that it can carry on trapping more soot. The Diesel Particulate Filter needs to be heated to a very high temperature in order to burn off the particles of soot. This can be achieved in one of two ways: active regeneration or passive regeneration.

There are two types of regeneration: passive and active.

Passive Regeneration

Passive regeneration occurs when the car is running at speed on long motorway journeys which allows the exhaust temperature to increase to a higher level and cleanly burn off the excess soot in the filter.

So it is advised that drivers regularly give their diesel vehicle a good 30 to 50 minute run at sustained speed on a motorway or A-road to help clear the filter.

However, not all drivers do this type of driving regularly – which is why manufacturers have designed an alternative form of regeneration.

Active Regeneration

Active regeneration means extra fuel is injected automatically, as part of the vehicle's ECU, when a filter reaches a predetermined limit (normally about 45%) to raise the temperature of the exhaust and burn off the stored soot.

Problems can occur, however, if the journey is too short, as the regeneration process may not complete fully.

If this is the case the warning light will continue to show the filter is still partially blocked.

In which case it should be possible to complete a regeneration cycle and clear the warning light by driving for 10 minutes or so at speeds greater than 40 mph.

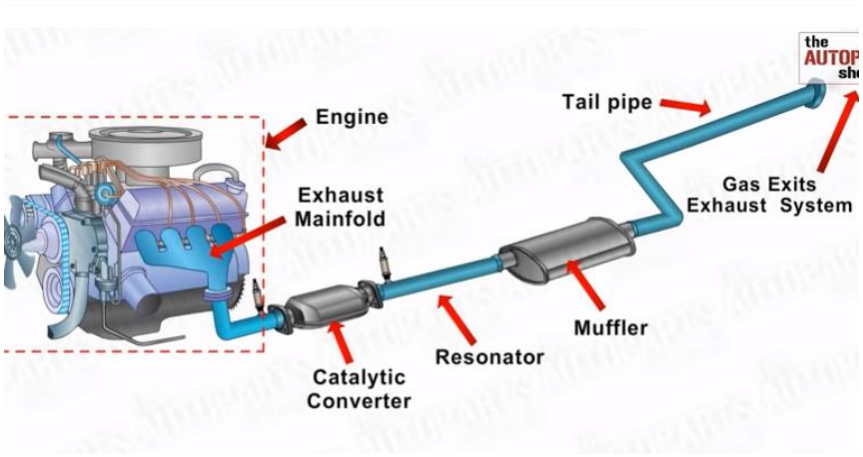
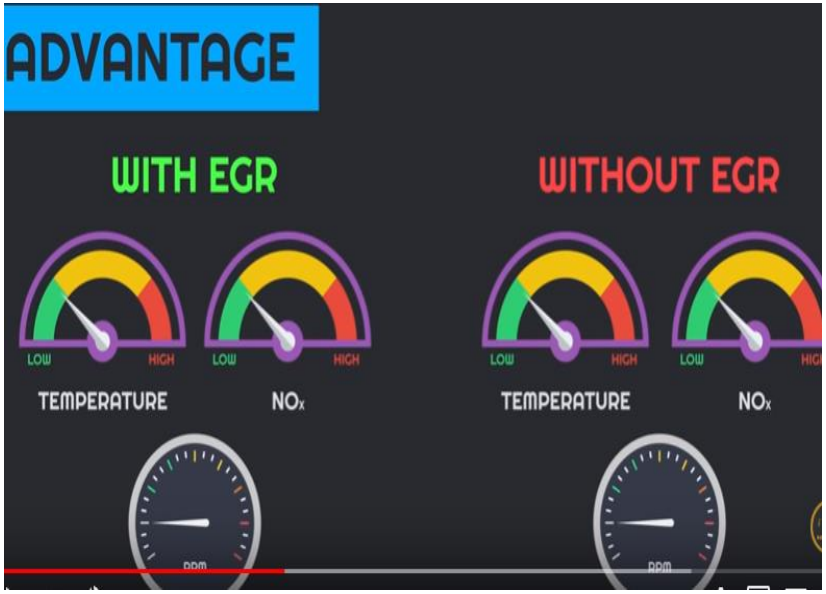
If the active regeneration process is initiated, but you reach your destination before it has had time to burn off all of the soot, there is a possibility that the DPF warning light will appear on your dashboard. You should be able to clear this partial blockage simply by driving your car faster than 40 mph for roughly a quarter of an hour or so.

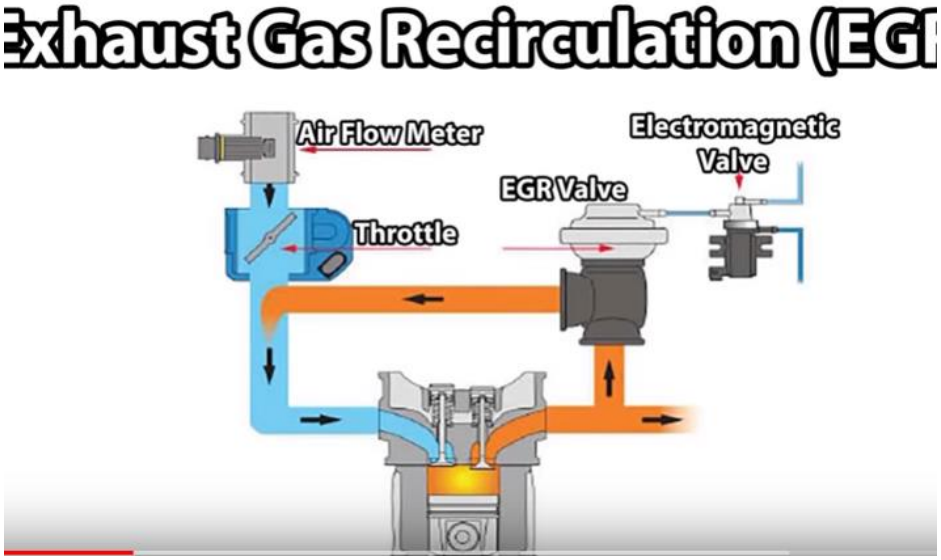
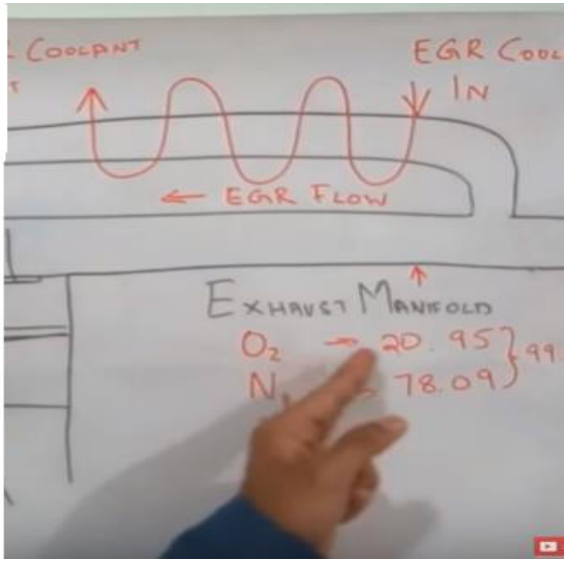
You will know whether active regeneration is taking place by the following symptoms:

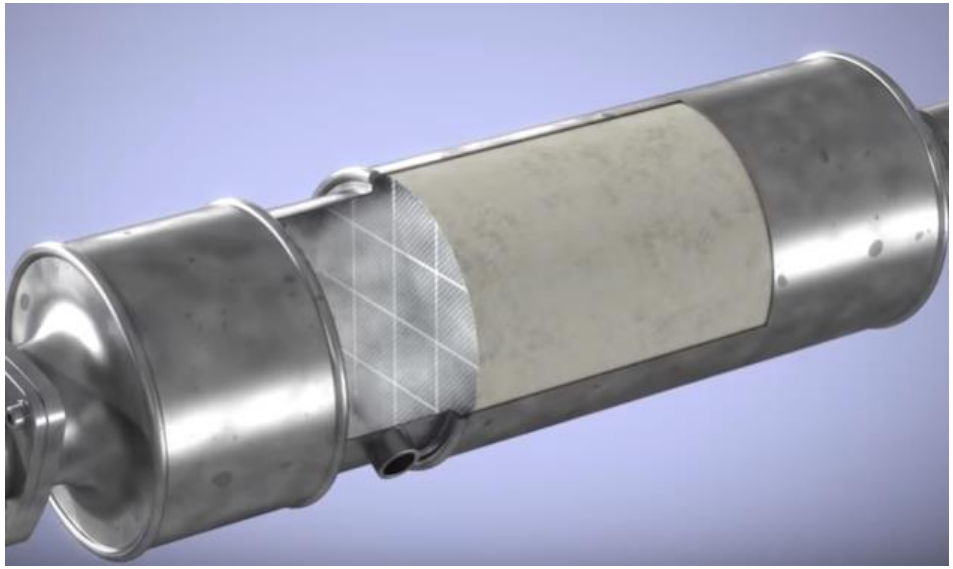
- Engine note change
- Cooling fans running
- A slight increase in fuel consumption
- Increased idle speed
- Deactivation of automatic Stop/Start
- A hot, acrid smell from the exhaust

For more detailed information, please visit https://www.autobutler.co.uk/wiki/dfp-regeneration and https://www.rac.co.uk/drive/advice/emissions/diesel-particulate-filters/

VIDEOS:

	**How Car Exhaust System Works** **https://youtu.be/W6dIsC_eGBI**
	**EGR System: Exhaust Gas Recirculation System | Working | Animation | Construction** **https://youtu.be/neU7RudLg-c**

	**How to Clean EGR Valve in Your Car (How It Works)** **https://youtu.be/8zLgmL7iBgI**
	**How exhaust gas recirculation system works** **https://youtu.be/nsutMQGaeo8**

	**How to clean a Diesel Particulate Filter (DPF)** **https://youtu.be/3F9riTOsNKE**

AUTOMOTIVE MECHATRONICS

Module-9

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

Module 9: 071400961 Conserve Power Transmission-II

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

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

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Perform Diagnosis of CVT with OBD-II	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Connect OBD-II Scanner Monitor function of all sensors. Replace the faulty sensor Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Explaining the components of continuous variable transmission (CVT) (i.e. steel belt, planetary gear assembly, forward clutch, reverse brake, start clutch, fly wheel, ATF pump, hydraulic control unit and electronic control unit) Defining bodies used in continuous variable transmission (CVT) (Manual, Governor, Main) Defining different types of Clutches in CVT Describing working, location and fault diagnosing of clutch in continuous variable transmission (CVT) Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Scanner OBD-II Digital Multimeter Wheel skids wooden Jack/ trolley jack Jack stands different size/height Ratchet and Sockets Set Screwdriver Set Pliers Hammer Ramps Hand Cleaner Combination Spanner Set/ Spanner set WD.40 Petrol Kerosene Oil

			Grease Cotton Rug Creeper Trolley Tool Trolley Lamp Appropriate PPEs
LU 2: Maintain Continuous Variable Transmission (CVT) 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 CVT oil pressure Check & Replace vehicle speed sensor Check & Replace Input shaft sensor Check & Replace Output shaft sensor Check & Replace CVT oil Check & Replace CVT belt Check & Replace	Understanding of appropriate tools and equipment Explaining the safety precautions regarding Explaining the safety precautions regarding personal health and workplace Describing working of pulleys in continuous variable transmission (CVT) Explaining different types of sensors in continuous variable transmission (CVT) (i.e. drive shaft sensor, driven shaft sensor, clutch control solenoid valve, Vehicle sped sensor (VSS). Defining the function of planetary gear system (i.e. Working principle, troubleshooting) Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Scanner OBD-II Digital Multimeter Wheel skids wooden Jack/ trolley jack Jack stands different size/height Oil pressure gauge Ratchet and Sockets Set Screwdriver Set Pliers Hammer Ramps Hand Cleaner Combination Spanner Set/ Spanner set WD.40 Petrol Kerosene Oil

	Transmission oil seal Check primary, secondary and manual valve body Check & Replace multi-plate clutches Replace shaft bearings, if required Ensure housekeeping after completion of task		Grease Cotton Rag Creeper Trolley Tool Trolley Lamp Appropriate PPEs
LU 3: Perform Road Test to check performance of CVT	**The trainee will be able to:** Perform final road test Accelerate the engine to check noise Check the performance of CVT during driving Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Explaining the final inspection of the continuous variable transmission (CVT) for noise, performance by the road test. Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Petrol Scanner OBD-II Digital Multimeter Appropriate PPEs

Examples & illustration:

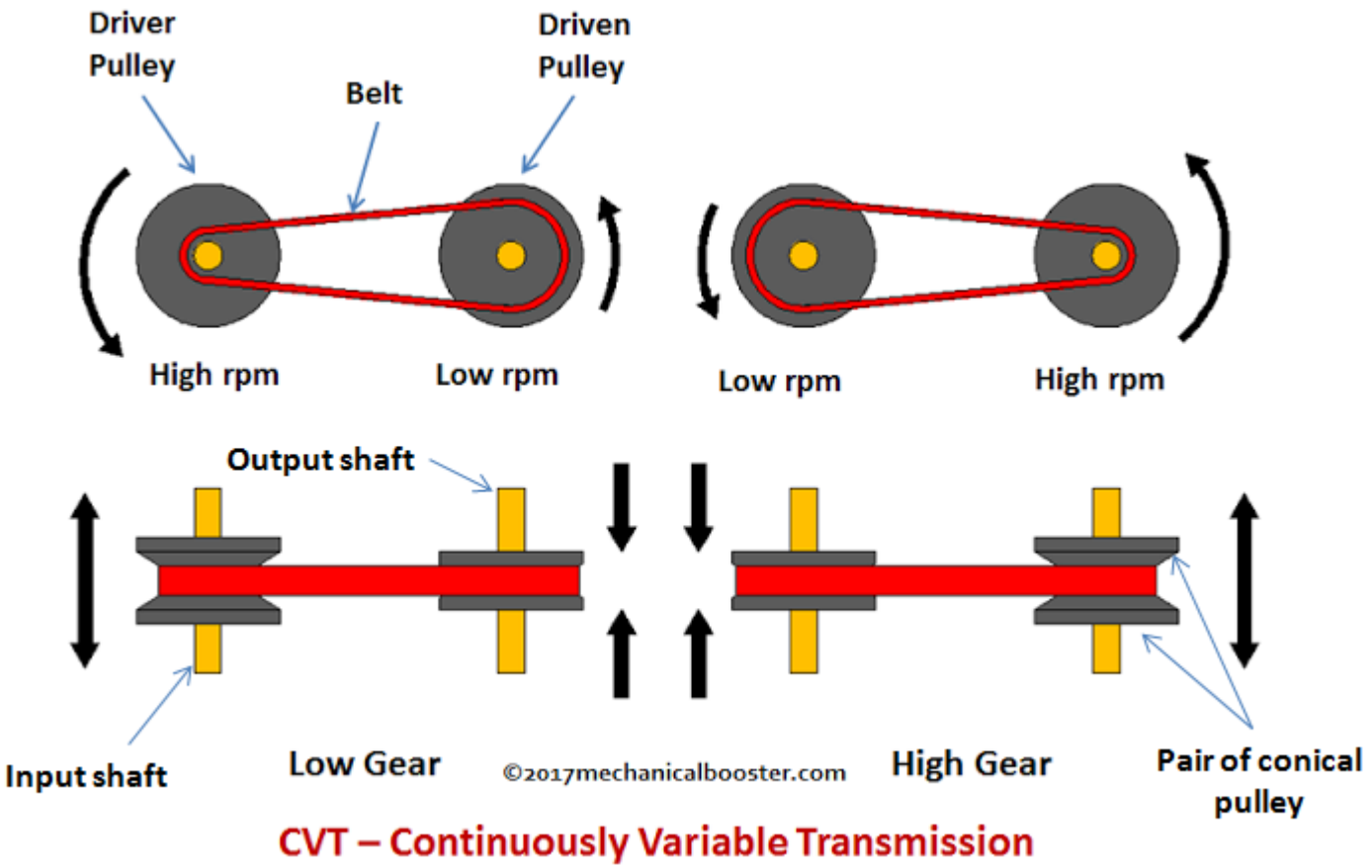
Continuously variable transmission (CVT) system

CVT (Continuously Variable Transmission) is a type of automatic transmission with “step less” gear transmission. It maintains optimum efficiency in engine rpm according to vehicle speed, resulting in improved vehicle fuel economy. At the same time, CVT is also characterized by its smooth acceleration. It provides more useable power, better fuel economy and a smoother driving experience than a traditional automatic transmission.

How CVT works

Conventional automatic transmissions use a set of gears that provides a given number of ratios (or speeds). The transmission shifts gears to provide the most appropriate ratio for a given situation: Lowest gears for starting out, middle gears for acceleration and passing, and higher gears for fuel-efficient cruising.

The CVT replaces the gears with two variable-diameter pulleys, each shaped like a pair of opposing cones, with a metal belt or chain running between them. One pulley is connected to the engine (input shaft) and the other to the drive wheels (output shaft). The halves of each pulley are movable; as the pulley halves come closer together the belt is forced to ride higher on the pulley, effectively making the pulley's diameter larger.



Changing the diameter of the pulleys varies the transmission's ratio (the number of times the output shaft spins for each revolution of the engine), in the same way, that a 10-speed bike routes the chain over larger or smaller gears to change the ratio. Making the input pulley smaller and the output pulley larger gives a low ratio (a large number of engine revolutions producing a small number of output revolutions) for better low-speed acceleration. As the car accelerates, the pulleys vary their diameter to lower the engine speed as car speed rises. This is the same thing a conventional transmission does, but instead of changing the ratio in stages by shifting gears, the CVT continuously varies the ratio -- hence its name.

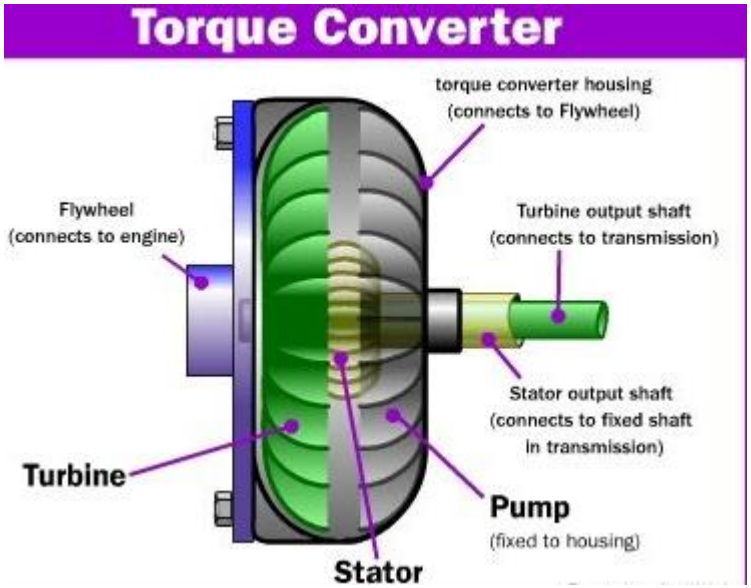
Main Components of CVT

- A high power/density belt.
- A set of Cone pulleys.
- Hydraulic Actuator.
- Mechanical torque sensor.
- Microprocessor.
- Torque Converter or Multi-layered clutch (replacing conventional clutches).

Torque Converter

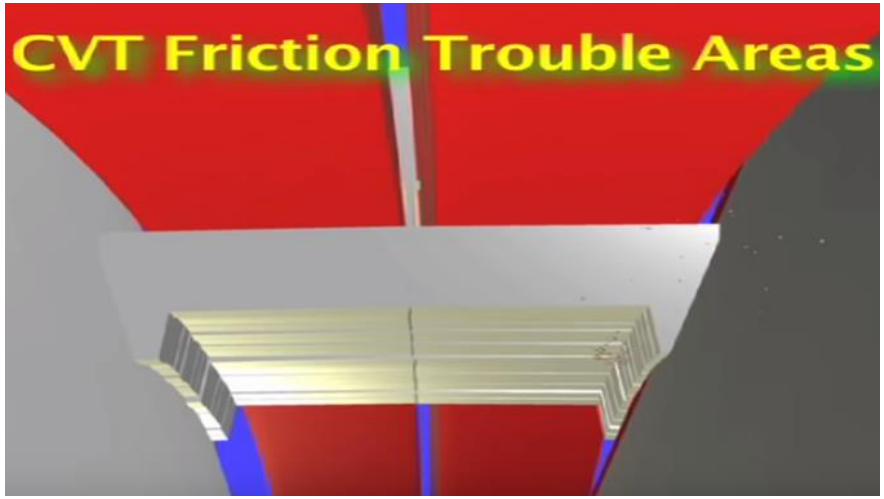
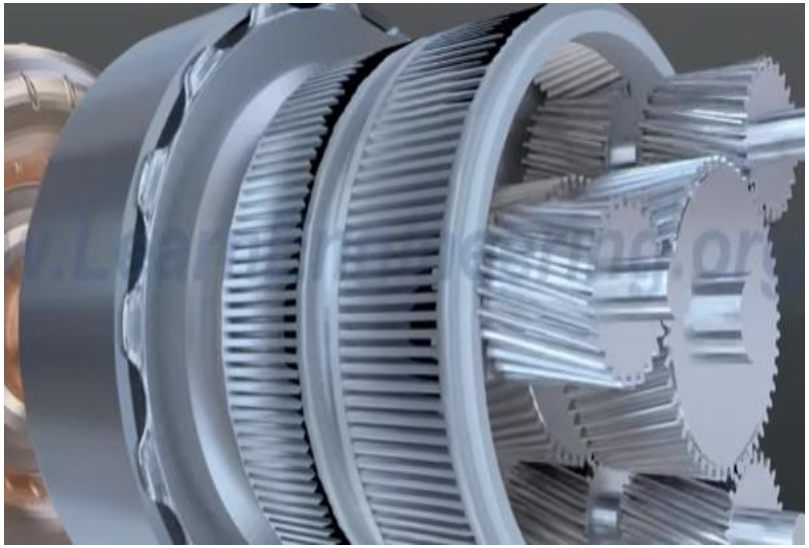
An engine is connected to a transmission by way of a clutch. Without this connection, a car would not be able to come to a complete stop without killing the engine. But cars with CVT have no clutch that disconnects the transmission from the engine. Instead, they use an amazing device called a torque converter. As shown in the figure below, there are four components inside the very strong housing of the torque converter: Pump, Turbine. Stator and Transmission fluid

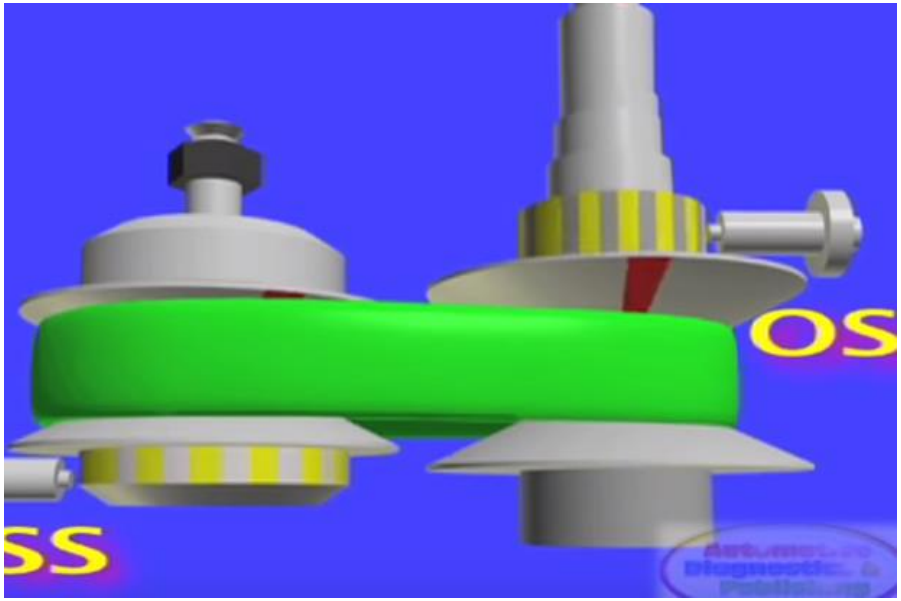
The housing of the torque converter is bolted to the flywheel of the engine, so it turns at whatever speed the engine is running at. The fins that make up the pump of the torque converter are attached to the housing, so they also turn at the same speed as the engine. The cutaway below shows how everything is connected inside the torque converter.



For more information, please visit https://www.liveabout.com/continuously-variable-transmission-533857 and https://ijettjournal.org/Volume-67/Issue-3/IJETT-V67I3P211.pdf

VIDEOS:

	**CVT Transmission Belt to Pulley Clamping** **https://youtu.be/qhk6jJ8VcUk**
	**Automatic Transmission, How it works?** **https://youtu.be/u_y1S8C0Hmc**

	**CVT Transmission Speed Sensors** **https://youtu.be/cazFz4cCjUQ**

AUTOMOTIVE MECHATRONICS

Module-10

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

Module 10: 071400962 Service Comfort & Safety System-II

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to service comfort & safety system-II.

Duration: 40 **Theory:** 06 **Practical:** 34

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Check Cruise Control 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 supply in ECU assembly. Check wiring harness, fuses and relays Inspect Cruise Control Main Switch Assembly. Inspect Cruise Control Actuator Assembly. Check Vacuum leakage in line at servo unit	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Explaining principal of cruise control system Explaining components of cruise control system (i.e. main relay, panel switch, cruise motor throttle body and wiring harness) Explaining fault diagnosing with the help of OBD – II scanner (i.e. location of components, repair and maintenance) Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Scanner OBD-II Digital Multimeter Screwdriver Set Socket Spanner Set Repair Manual Combination Plier Allen Keys set Star Keys set Hand Cleaner Combination Spanner Set/ Spanner set Ratchet and Sockets Set WD.40 Kerosene Oil Grease Cotton Rug Tool Trolley Lamp

	Adjust throttle linkage to maintain engine speed. Ensure housekeeping after completion of task		Appropriate PPEs
LU 2: Maintain Supplementary Restraint System (SRS)	**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 supply in ECU assembly. Check wiring harness, fuses and relays. Maintain Supplementary Restraint System (SRS) Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Explaining working principles of supplementary Restraint system (SRS). Describing components of supplementary Restraint system (SRS) (i.e. crash sensor, air bags, seat belts, inflator units, ECU) and their location Defining function of components of supplementary Restraint system (SRS) Describing installing procedure of seat belts and Air Bag Module assembly Explaining procedure of supplementary Restraint system (SRS) troubleshooting Explaining safety legal precautions of supplementary Restraint system (SRS) (i.e. operation and repair maintenance) Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Scanner OBD-II Digital Multimeter Screwdriver Set Socket Spanner Set Repair Manual Combination Plier Allen Keys set Star Keys set Hand Cleaner Combination Spanner Set/ Spanner set Ratchet and Sockets Set WD.40 Kerosene Oil Grease Cotton Rag Tool Trolley Lamp Appropriate PPEs

Examples & illustrations:

Cruise Control System:

The Cruise Control is a system that is capable of automatically maintaining the desired speed (i.e. speed set by the driver) of the vehicle without the need to press the accelerator pedal. This system is particularly useful while driving at a constant speed as it significantly reduces driver fatigue.

Main Assemblies of Cruise Control

The system is composed of three main assemblies.

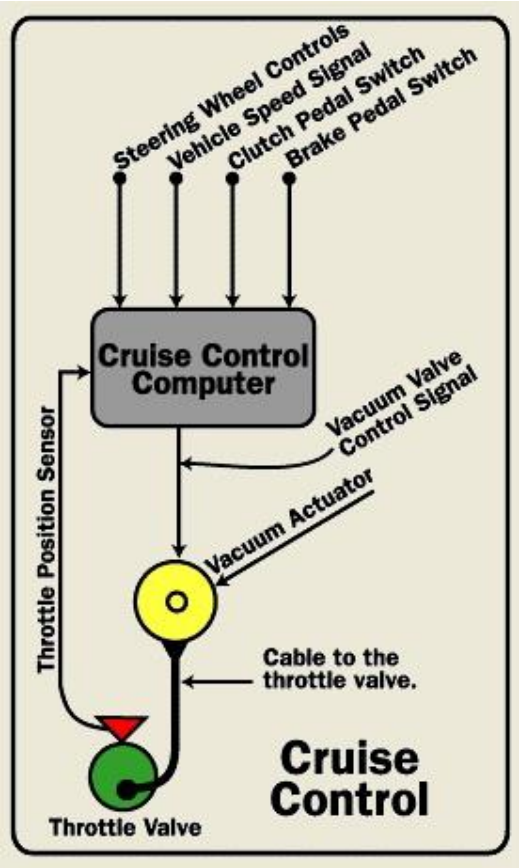
1. A driver's switch park.
2. A throttle actuator unit.
3. Cruise Control ECU

Components of Cruise Control:

The system uses many components for its operation. They are:

1. Steering Wheel Controls
2. Vehicle speed sensor
3. Clutch pedal switch
4. Brake pedal switch
5. Throttle position sensor
6. Vacuum valve control

7. Vacuum actuator
8. ECU



Working of Cruise Control

With the vehicle running above a minimum cruising speed (typically 40 kmph) the cruise control ON switch is pressed, and the system becomes operational. When the vehicle attains the desired cruising speed, the SET button is pressed. The ECU's speed control microprocessor then operates the vacuum pump, which in turn moves the throttle valve actuator diaphragm until the SET speed is maintained without the use of the accelerator pedal so that the driver can remove his foot from the pedal. The microprocessor continuously monitors the vehicle speed signal and constantly changes the throttle position taking account of variations in road gradients, wind resistance etc. and thereby maintains the

memorized cruising speed. To increase speed, the pump is operated for a short time to increase the vacuum, and to reduce speed the control valve is pulsed open to reduce the vacuum slightly.
In order to increase the cruising speed of the vehicle, the SET button is held down so that the ECU commands the vehicle to smoothly accelerate until the switch is released or maximum cruising speed is attained. At the instant the set switch is released the new cruising speed is stored in the microprocessor memory. To overtake another vehicle, the accelerator pedal is pressed in the normal way to increase speed. When the pedal is released the cruise control automatically takes over, and the system returns to the memorized speed.
Once the brake pedal is pressed,-the microprocessor detects the closure of the stop lamp switch and immediately opens the pressure release valve (dump valve) to rapidly decrease the vacuum to disengage the system. As a safety measure, the brake pedal uses a additional pair of switch contacts, which open to disconnect the positive supply from the solenoid valves, allowing them to open.

For more detailed information, please visit http://what-when-how.com/automobile/cruise-control-systems-automobile/ and https://carbiketech.com/cruise-control/ also visit https://www.scienceabc.com/innovation/what-is-cruise-control-system-cars-work.html and https://driving-tests.org/beginner-drivers/how-to-use-cruise-control/

Diagnose Cruise Control

Cruise Control is not working

Some common reasons for not working of cruise control are mentioned below:

- **Bad Fuse:** Like many electronically controlled systems in a car, the cruise control has a corresponding fuse which will blow to protect the system if it senses a short circuit. When the fuse of for the cruise control blows, the cruise control will stop working altogether.

- **Failing Brake Pedal Switch:** The brake pedal switch turns on the vehicles brake lights when it senses that the brake pedal has been pressed. Because cruise control systems have been designed to disengage when the brake pedal is pressed, the cruise control is wired to the brake pedal switch. If the brake pedal switch fails, the car may think the brakes are engaged and not allow the cruise control system to turn on.

- **Failing Speed Sensor:** A speed sensor has many purposes including indicating the speed of the vehicle, regulating flow of fuel and ignition timing, and operating the cruise control. If the speed sensor fails the cruise control may stop working. Speedometer has also stopped working and the engine has more difficulty when idling.

- **Damaged Vacuum Actuator/Hoses/Cable:** On older vehicles, cruise control speed is maintained using a vacuum actuator and a cable connected to the throttle. A vehicle's cruise control may stop working if the vacuum actuator has stopped working or if there is damage to the vacuum hoses. The system may also fail if the cable linking the actuator to the throttle is broken.

Inspection/Service

The mechanic will first want to connect to the vehicle's ECU through a code reader/scanner. This will allow the mechanic to read and trouble codes and better diagnose what component may have failed.

If the mechanic determines that there is a bad fuse, he or she will find the corresponding fuse for the cruise control system to see if it has failed. If the fuse has blown, the mechanic will remove it and replace it with a fuse rated for the correct amperage.

If the mechanic believes that the brake pedal switch has failed, he or she will examine the switch to check for any superficial damage. The mechanic should then check the wiring connected to the switch and change it if necessary. When the switch has been replaced, the mechanic should make sure that both the brake lights and the cruise control system are working properly.

To check the speed sensor, the mechanic will have to get underneath the vehicle. While underneath, the mechanic will find the sensor and examine it and the surrounding wires for damage. The mechanic will then replace the sensor and then check the wires going from the sensor up to the speedometer and cruise control switches to endure that they are not frayed.

If the mechanic believes that the vacuum actuator or the corresponding hoses and cable have failed, he or she will open the hood and locate the actuator. The mechanic will first check the hoses and cable to make sure that they are in good working order. He or she will then replace the actuator as necessary.

In all of these repair scenarios the mechanic will ask to test drive the vehicle to make sure that the cruise control is working properly. He or she should also use their code reader/scanner to clear any trouble codes that may have been produced when the cruise control system was not working.

For more detailed information, please visit https://www.yourmechanic.com/services/cruise-control-is-not-working-inspection and http://www.a2motors.ru/downs/sm-for03/for03_body_19.pdf also visit https://www.aa1car.com/library/cruise_control_diagnose.htm

Supplementary Restraint System (SRS) or “Air-Bag”

The Supplementary Restraint System (SRS) is basically an air-bag system. This works together with conventional 3-point seat belts and prevents impact of the driver’s chest and face with the steering wheel in the event of a collision. SRS may sometimes be installed to the passenger’s side to prevent impact with the dashboard. Side-impact air-bags are also fitted to protect the upper body and head during a sideways impact.

The main components of an air bag system are:

• Driver and passenger air-bags. • A warning light.
• Passenger seat switches. • A pyrotechnic inflator.
• An igniter. • Crash sensor(s).
• An electronic control unit often termed a “Diagnostic Module”

Airbag control unit or Diagnostic Module

The control unit is the heart of the airbag system and is installed centrally in the vehicle. It can generally be found in the dashboard area, on the center tunnel.

Crash sensors

Depending on the airbag system and the number of airbags installed, the crash or acceleration sensors are installed either directly in the control unit or as satellites in the vehicle front end or at the side of the vehicle.

Air-bag

The airbag is made from a highly durable polyamide fabric that resists aging. It has a low coefficient of friction to ensure it unfolds easily and makes gentle contact with the skin. The airbag is dusted with talcum powder to protect it and stop it sticking.

Seat belt tensioner

The purpose of the seat belt tensioner is to eliminate slack in the seat belt in the event of an accident. This slack can arise as a result of generously sized, loose clothing or a "relaxed" seating position.

SRS Component's Function			
S No.	**Component**	**Function**	**Remarks**
1	Air bag system warning lamp	Lamp illuminates or flashes if malfunction occurs in air-bag system.	Located in instrument cluster.
2	Air bag module	Deploys air-bag when current flows to integrate igniter.	Located in steering wheel hub.
3	Clock spring connector	Ensures uninterrupted connection to air bag module while allowing turning of steering wheel.	Part of combination switch.
4	Crash sensor	D-sensor: Activated (closed) when crash impact is detected, and with S-sensor, completes circuit to inflator.	Located in front part of vehicle (left, right and center).
5	S-sensor:	Activated (closed) when crash impact is detected, and with D-sensor, completes circuit to inflator.	Located on side of heater unit in passenger compartment.
6	SRS ECU or Diagnostic module	Monitors components and wiring harnesses in air-bag system. Indicates system malfunction by flashing or illuminating air-bag warning lamp. If warning lamp is burnt, sounds warning buzzer. Detects short circuit between air-bag module and ground or crash sensor malfunction and melts system down fuse to prevent unintended air-bag deployment.	Contains backup battery.

Remove airbag module

To remove your airbag module, follow these steps:

1. First find the SRS computer module. In most cars it is under the center console that is between the two front seats, or center of the dash on the floor. In most GM cars it is under the driver or passenger seat.
2. Disconnect the positive battery cable and wait 3 min.
3. You are now safe to unplug the airbag control module harness wiring plugs.

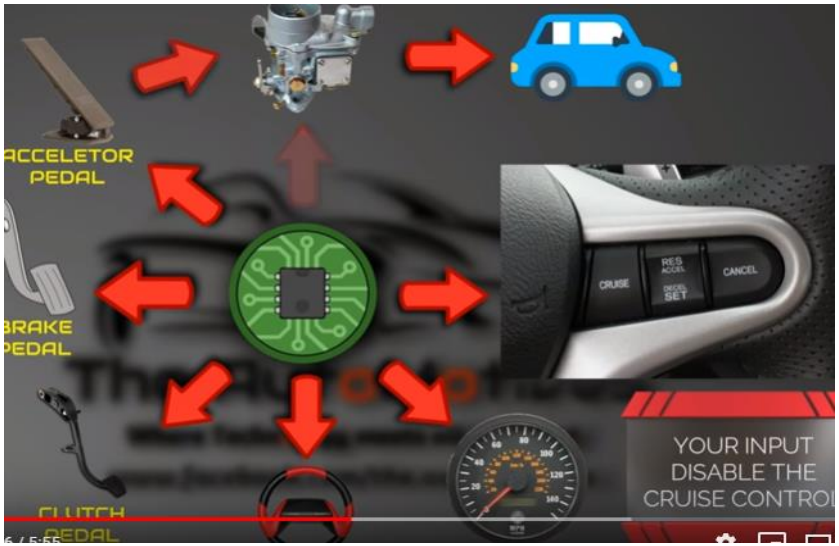
Install airbag module

To install your airbag module:

1. All airbag SRS components must be installed and connected properly before installing the airbag control module. This includes air bags, seat belts, clock spring and impact sensors.
2. Disconnect the battery and bolt down the module and then connect the harness wiring plugs.
3. Connect the battery and you are done!

For more detailed information, please visit http://what-when-how.com/automobile/supplementary-restraint-system-srs-or-air-bag-automobile/ and https://www.hella.com/techworld/au/Technical/Car-electronics-and-electrics/Car-airbag-system-3083/ also visit https://www.myairbags.com/how-to-install-remove-airbag-control-module-and-seat-belt-pretensioners/ and https://www.autozone.com/repairguides/Air-Bag-Supplemental-Restraint-System/General-Information/_/P-0900c1528026a904

VIDEOS:

	**Cruise control System: How does it work? | How to Use it?** **https://youtu.be/9Kj_tMQ06J0**
	**Honda Cruise Control Switch Fix the Right Way!** **https://youtu.be/MA-4Jc9j6sw**

	**How to Remove Front Seat Seatbelt Assembly SRS Retractor** **https://youtu.be/QwzDNz22nTc**
	**How to remove and Replace Seat Belt tensioner.** **https://youtu.be/b7WlaB22fmM**

AUTOMOTIVE MECHATRONICS

Module-11

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

Module 11: 071400963 Perpetuate Controlled Electric & Electronic System-II

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

Duration: 60 **Theory:** 12 **Practical:** 48

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Service Controlled Wiper & Washer 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 function of rain sensor. Check operation of wiper motors and arms. Check wiper motor connector and fuse. Check washer tank and washer motor. Inspect washer lines and nozzles. Remove, Service or refit of wiper motor. Check and replace	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognize and use proper PPEs for the activity Defining rain sensor system and calibration. Explaining wiper controlled system, including the washer system with the service requirement. Describing wind screen washer system and service requirement. Explaining the procedure of wiper motor service. Understanding of dismantling of wiper & washer system Explaining function of combination switch Describing how to keep the work area clean during and after the activity Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Fender cover WD-40 Cotton Rug OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley

	combination control switch. Ensure housekeeping after completion of task		
LU 2: Repair Electric Power Steering (EPS) System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Find faults in electric power steering system using OBD-II scanner Check fuse, relays of electric power steering system. Check wiring harness and connectors of electric power steering system. Remove, service and refit of electric power steering system motor. Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and using proper PPEs for the activity Defining electrical power steering system and its maintenance procedure Defining electrical power steering system's performance and system examination parameters Maintaining electrical power steering system Repairing electrical power steering system Performing work area cleans during and after the activity. Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Appropriate PPEs Fender cover WD-40 OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley
LU 3: Test Function of Sensors	**The trainee will be able to:** Select tools and	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health	Teaching materials White board, Markers, required piping layout

	equipment according to job requirement Observe occupational health and safety precautions at all times Check/replace oxygen sensor. Check/replace crank position sensor. Check/replace cam sensor. Check/replace Throttle position sensor. Check/replace Intake air temperature sensor. Check/replace Intake air flow sensor Check/replace of knock sensor.	and workplace Recognizing and use proper PPEs for the activity Describing different types of sensors in electric & electronic system Describing function of oxygen sensor Explaining function of crank positioning sensor Defining function of cam scanner Checking and replacing procedure of throttle position sensor Describing function of mass air flow and air pressure sensor Explaining function of mass intake air temperature sensor Performing work area cleaning during and after the activity Importance of housekeeping	Drawings. Multimedia projector Appropriate PPEs Fender cover WD-40 Cotton Rug OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley

Examples & illustrations

Wiper and Washer system

The wiper and washer system is a system that keeps the view clear by removing raindrops on the windshield glass and the back window glass when it rains. Used with washer, the system can clear dirt from the windshield glass. For these reasons, this is an essential system for driving vehicles safely. Recently, some models have functions in which the wiper speed changes in response to the vehicle speed, and the wiper automatically operates when it rains.

Wipers

The main purpose of the wiper system is to clean the windscreen sufficiently to provide suitable visibility at all times. The wiper system must perform the following tasks.

(a) Efficient removal of dirt, water and snow.
(b) Operation in the temperature range of 243 K to 353 K.
(c) The ability to pass the stall and snow load test.
(d) A service life of around 1500 000 wipe cycles
(e) Resistance to corrosion from acid, alkalis and ozone.

For meeting the above requirements, proper design and manufacturing with good quality components are required for both the wiper and washer systems.

Wiper/Washer System Components
The Wiper/Washer System consists of the following components:

- Windshield wiper/washer switch
- Body control module (BCM)
- WPR Relay
- WPR HI Relay
- Windshield wiper motor
- Windshield washer fluid pump
- Windshield washer fluid level switch
- Rain sensor module
- Instrument panel cluster (IPC)
- WPR Fuse 25 A
- WSW/PUMP Fuse 10 A
- RAP Fuse 10 A

Wiper arm / wiper blade these are the major components of the wiper system. The structure of the wiper is a blade rubber attached to a metal bar called the wiper blade. The wiper is moved circularly by the wiper arm.
Since the blade rubber is pressed on the windshield glass by the spring, the wiper can wipe the windshield glass by moving the wiper blade.
The circular movement is created by the motor and the link mechanism.
Since the blade rubber attached to the wiper blade degrades by use as well as by sunlight, temperature, etc., it is essential to replace the rubber periodically.

Semi-concealed wiper / full-concealed wiper the conventional wiper can be seen from the front of the vehicle.
However, for aerodynamics, flush surface and wider view, recent wipers are concealed under the engine hood.
The wiper of which even a part can be seen is called a semi-concealed wiper and that of which nothing can be seen is called a full-concealed wiper.
With the wiper fully concealed, if it is frozen by snow, or any other conditions, the wiper cannot be moved. Clearing the snow by operating the wiper system forcefully could break the wiper motor. To prevent this, most vehicle models are structured to manually change the full-concealed

wiper into the semi-concealed wiper.
After switching to the semi-concealed wiper, the wiper arm can be locked back by moving it in the direction indicated by the arrow in the illustration.

For more detailed information, please visit https://youronlinemechanic.com/wiper-and-washer-system/ and http://what-when-how.com/automobile/windscreen-wipers-and-washers-automobile/ also visit https://autoadvancetech.wordpress.com/wiperwasher-system/

Symptoms of a Bad or Failing Combination Switch Assembly

The combination switch is the electronic switch assembly that controls several vehicle functions. It is most commonly used to control the turn signals, the high and low beam headlights, and wipers. It is usually mounted on the left side of the steering column, where it is easily accessible to the driver. As the combination switch controls several functions that are important to safely operating the vehicle, when it has problems certain features can be disabled, which can cause a compromise in safety.

Problems operating the wipers:

Problems operating the wipers are another issue commonly associated with a bad combination switch. If the lever or knob that operates the wipers breaks or becomes worn it will not be able to properly activate the wipers. Depending on the exact problem, the wipers may function intermittently, only on certain settings, or not at all.

For more detailed information, please visit https://www.yourmechanic.com/article/symptoms-of-a-bad-or-failing-combination-switch-assembly

Why wipers don't work: troubleshooting tips

The first thing your mechanic would want to know is it a mechanical problem with a wiper transmission (linkage) or an electrical problem with a wiper motor circuit. How can you tell? Does the wiper motor run or at least make any noise when the wiper switch is on? If the motor runs or tries running, but the wipers don't work, it's a mechanical problem with the linkage, see common problems below. If the motor doesn't react when the switch is operated, it's an electrical problem. The wiper motor circuit will need to be tested

How the wiper motor circuit is tested.

You can find the proper testing procedure for the wiper motor circuit in the service manual for your car. For example, in this car in the photo, the wiper motor doesn't work. When the wiper switch is operated, the wiper relay clicks. This means the switch is working and the BCM operates the relay.
The diagnostic procedure for this car recommends checking the ground and ignition voltage at the wiper motor connector. We check the voltage with a Multimeter. It shows 12 V, see the photo. The connector looks OK, there is no corrosion. If there is 12V at the motor, but it doesn't run, the wiper motor is bad and needs to be replaced.

For more detailed information, please visit https://www.samarins.com/glossary/wiper-motor.html

How to Change a Windshield Wiper Motor

Wiper motor replacement is fairly easy with the right tools and safety considerations. Windshield wiper motors are capable of overcoming the binding effects of ice on the wiper blades and accumulated debris on the wipers.

Step 1

Locate the windshield wiper motor. It is usually mounted to the vehicle's firewall between the engine and driving compartment. If you have trouble locating it, consult the service manual for your year and model vehicle. The manual will show you the exact location of the wiper motor.

Step 2

Use a fused jumper wire to bypass the motor's relay once you have located the wiper motor. Use your service manual to locate the relay. Hook one side to the positive battery terminal and touch the other end to the positive on the wiper motor. If the motor works and the arms move, replace the relay.

Step 3

Use the positive lead on your jumper wire to touch the positive terminal on the relay. If the motor works, you will need to check the gear mechanism inside the motor assembly. If it does not work, continue with the removal and replacement procedures that follow.

Step 4

Locate the grounding strap. One end of the grounding strap is secured to the motor case with a bolt or screw. The opposite end is secured to one of the wiper motor mount bolts. Once you have located the grounding strap, remove the mount bolt it is grounded to using your open-end box-end wrench or ratchet set. Move the ground strap out of the way so it does not get stretched or damaged.

Step 5

Remove all other mount bolts (varies from car to car). Gently pull the washer motor away from the mount and remove from the engine compartment.

Step 6

Line up the mount holes on your new washer motor with the mount bolts on the firewall. Push the motor onto the mount bolts and secure in place with the mounting nuts. Tighten nuts in a star pattern so the washer motor is flush against the firewall. Reinstall the wiper motor grounding strap.

Step 7

Use your fused jumper wire to test the new motor's operation. The motor should turn freely. If not, the new part is defective. Return it to the vendor you bought it from and get a new one.

Disconnect the jumper wire leads. Install the connector to the relay. Check motor operation from the switches on the driver's console.

Tips

- Do not damage mount bolt threads when removing the motor or installing it. Thread damage will require an involved replacement process.
- Take care not to cross thread the mounting nuts for the same reason.
- Use a fender cover to prevent damage to the vehicle's paint finish.
- Check the wiper motor fuse before you begin this procedure.

Warning

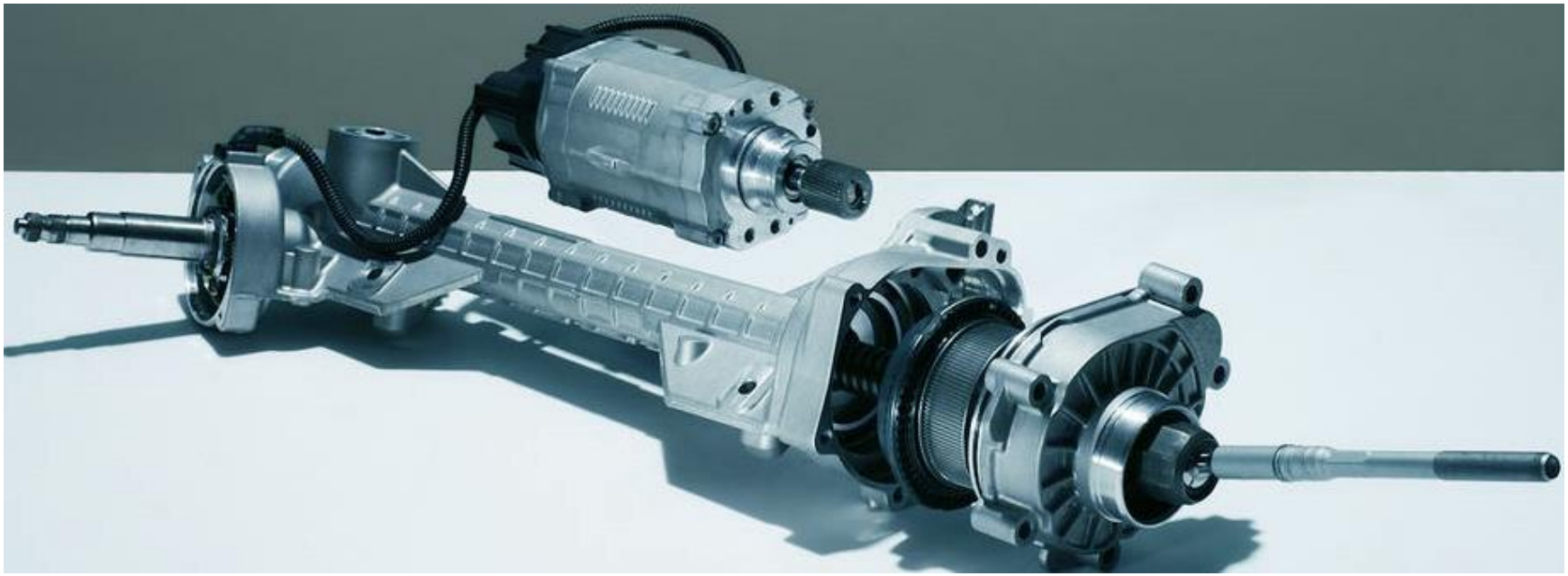
- Make sure the wiper arms are in their parked position and the new motor is in the parked position.

https://itstillruns.com/change-windshield-wiper-motor-4448916.html

Steering System

Automobile development is a constant process of evolution. As for steering system, the introduction of power assisted steering was considered a blessing as they add controlled energy to the steering mechanism, so the driver can provide less effort to turn the steered wheels when driving at typical speeds. These days, most automobile manufacturers are making cars with EPS (electronic power steering) systems, replacing the HPS (hydraulic power steering) systems.

Electric Power Steering (EPS)



Unlike hydraulic and electro-hydraulic systems, electric power steering (EPS) doesn’t use any form of hydraulic pressure to provide steering assistance. The technology is fully electronic, so it uses an electric motor mounted to the steering gear or rack to provide direct assistance.

Since there is no power lost generating and transmitting hydraulic power, these systems are typically more efficient than either hydraulic or electro-hydraulic steering.

Depending on the specific EPS system, the electric motor may be mounted either to the steering column or directly to the steering gear, or steering rack.

Sensors are used to determine how much steering force is required, and then it is applied so that the driver only has to exert a minimum amount of effort to turn the wheel.

Some systems have discrete settings that decide the amount of steering assist that's provided, and others work on a variable curve.

For more detailed information please visit https://www.lifewire.com/electric-power-steering-534807 and https://www.carspiritpk.com/2018/12/10/hydraulic-power-steering-vs-electric-power-steering/

What Is EPS Malfunction And Why Does It Occur?

When the steering wheel gets struck or disengages from the electric motor, EPS malfunctioning occurs. It usually happens because of the rust and water inside the arch or aging of the tightening rubbers. The Electric Power Steering works on electric motor attached with wheel axle to turn the car. But, the rubbers and motor get damaged after a certain period due to aging or by other means.

Let's talk about the reasons that cause **EPS malfunction**

1. Over Speed vs Bumpy Roads

Driving with higher speed over rough roads is another way to **EPS malfunction**. If one really wants to preserve the EPS system, then slowing down the car on rough roads would be an ultimate choice. In addition, the tightened rubber rings also get loose with over speed on the bumpy roads. One can easily notify the rusty steering arch if it starts making noises when turned. So, you must slow down the car while driving on the rough roads to treat your car with great care.

Ultimate revelation of EPS malfunction

2. Too Much Water – Flooded Roads

One must avoid going through the watery roads to stay away from EPS damage. This is because the electric motor of EPS is connected with the arch and it comes in direct contact with the water. The water can damage the electric motor in no time and you have to face the stuck EPS. The big catch about electric motor and arch is that it is non-repairable and one has to replace it with the new one.

3. Aging of the EPS System

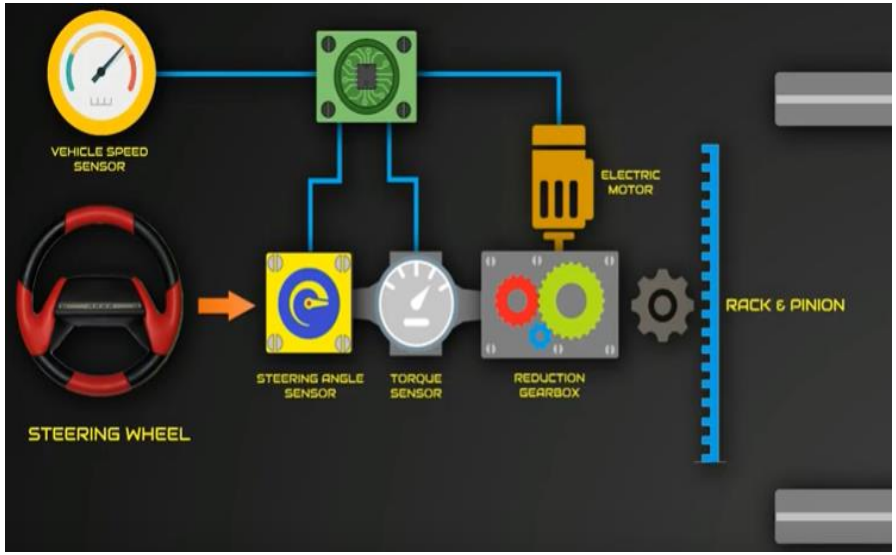
One must not forget to replace the aged parts of the EPS system from time to time for proper care of the vehicle. When the steering starts making unusual noises or the **EPS car light** starts blinking, it’s time to inspect the entire system properly. The suitable age of EPS system is five years and one must take care of it on time. This is quite helpful to protect the EPS system from malfunctioning.

Causes for EPS malfunction

https://carfromjapan.com/article/car-maintenance/possible-causes-of-eps-malfunction/

Videos:

	**How works windshield wiper motor** **https://youtu.be/Z_ImTqIiRR0**
	**How to Replace a Windshield Wiper Motor** **https://youtu.be/g5RLlz-lz84**

	**EPS System: Electronic Power Steering | Circuit | Animation | Working** https://youtu.be/tUgnCPWm22o
	**How to Replace Electric Power Steering Motor?** https://youtu.be/qmnZxDfVATA

AUTOMOTIVE MECHATRONICS

Module-12

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

Module 12: 071400964 Maintain Network System

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

Duration: 50 **Theory:** 10 **Practical:** 40

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Verify Navigation System	**The trainee will be able to:** Arrange Tools & equipment Ensure HSE requirements and fulfilled for the given task Locate navigation device Check electric connection of device Check connection of Antenna Remove LCD from Vehicle dashboard Check Navigation card Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and use proper PPEs for the activity Defining navigation system Explaining global positioning system (GPS) Describing navigation programming Performing work area cleaning during and after the activity Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Fender cover WD-40 OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Appropriate PPEs

LU 2: Maintain Control Area Network (CAN) System	**The trainee will be able to:** Select appropriate tools/ material as per SOP Follow safety rules Locate CAN connector Remove and service of connector Refit the CAN connector at its location Ensure housekeeping after completion of task	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and use proper PPEs for the activity Explaining Control Area Network (CAN) Describing location of CAN connector Servicing and refitting CAN connector Performing work area cleaning during and after the activity Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Fender cover WD-40 Cotton Rug OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel panner Service creeper Tool Trolley Appropriate PPEs
LU 3: Verify Electrical Parking System	**The trainee will be able to:** Select appropriate tools/ material as per SOP Check Diagnostic	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and using proper PPEs for the activity	Teaching materials White board, Markers, required piping layout Drawings.

	Trouble Codes (DTC) Check/ replace parking switch Check wiring harness and fuses Check function of electric parking motors Check Hill Assist system Check ABS Modulator Ensure housekeeping after completion of task	Understanding DTC for ABS System Verifying procedure of different component of electric parking system (e.g. parking switch, wiring harness, fuses) Explaining Hill Assist System and its functioning Describing ABS Modulator system and its verification method Performing work area cleans during and after the activity Importance of housekeeping	Multimedia projector Fender cover WD-40 Cotton Rug OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley Appropriate PPEs

Examples & illustrations:

Car Navigation

Car navigation allows an automobile driver to see where he or she is on a map at any given time. Automobile navigation can rely on GPS (Global Positioning System), or it can be DVD- or data-based.

Global Positioning System (GPS)

GPS is a worldwide radio-navigation system formed from the constellation of 24 satellites and their ground stations, which provides accurate, three-dimensional position, velocity and time, 24 hours a day, everywhere in the world, and in all weather conditions.

The Global Positioning System is mainly funded and controlled by the U.S Department of Defense (DOD). The system was initially designed for the operation of U. S. military. But today, there are also many civil users of GPS across the whole world. The civil users are allowed to use the Standard Positioning Service without any kind of charge or restrictions.

How GPS works in cars

GPS car navigation systems can be factory-installed on new autos or purchased as an add-on accessory. Combining the use of signals from the satellites with interactive on-board maps, GPS car navigation systems can plot routes of travel to a given destination based on a number of variables. Some GPS car navigation systems are interconnected with sources of traffic information, enabling them to automatically account for construction and congestion when determining the best route. If a driver misses a turn, GPS car navigation systems can quickly correct for the error with an updated routing. Providing voice or visual instructions, these units also can help drivers find the nearest gas station or their favorite restaurant.

Purpose of the GPS System & Why it Was Started

Global positioning systems, once solely for military use, have taken off as personal commercial devices, helping people do everything from find driving directions to map the earth. The short history of GPS pales in comparison to the potential future applications of this vibrant technology. It calculates the real-time position of a device using atomic clocks and orbital satellites. GPS satellites continuously broadcast signals that tell the satellite's location and time, accurate to a billionth of a second. A GPS unit in, say, an automobile uses the signals from up to four satellites to calculate its own relative position.

Main components of GPS

The global positioning system consists of three main components:

1. **GPS Ground control stations**
   the control segment uses measurements collected by the monitor stations to predict the behavior of each satellite's orbit and atomic clocks. The prediction data is linked up to the satellites for transmission to users. The control segment also ensures that GPS satellite orbits remain within limits and that the satellites do not drift too far from nominal orbits.

2. **GPS satellites**
   the space segment includes the satellites and the Delta rockets that launch the satellites from Cape Canaveral in Florida, United States. GPS satellites orbit in circular orbits at 17,440 km altitude, each orbit lasting 12 hours. The orbits are tilted to the equator by 55? to ensure coverage in polar regions. The satellites are powered by solar cells to continually orientate themselves to point the solar panels towards the Sun and the antennas towards the Earth. Each satellite contains four atomic clocks.

3. **GPS receivers**
   receiver requires signals from at least three satellites to determine your unique position on the earth's surface. With a fourth signal your altitude can also be determined. Receiving signals from more than four different satellites, the position of the GPS receiver can more accurately be determined. The ground stations send control signals to the GPS satellites, The GPS satellites transmit radio signals and the GPS receivers, receive these signals and use it to calculate its position.

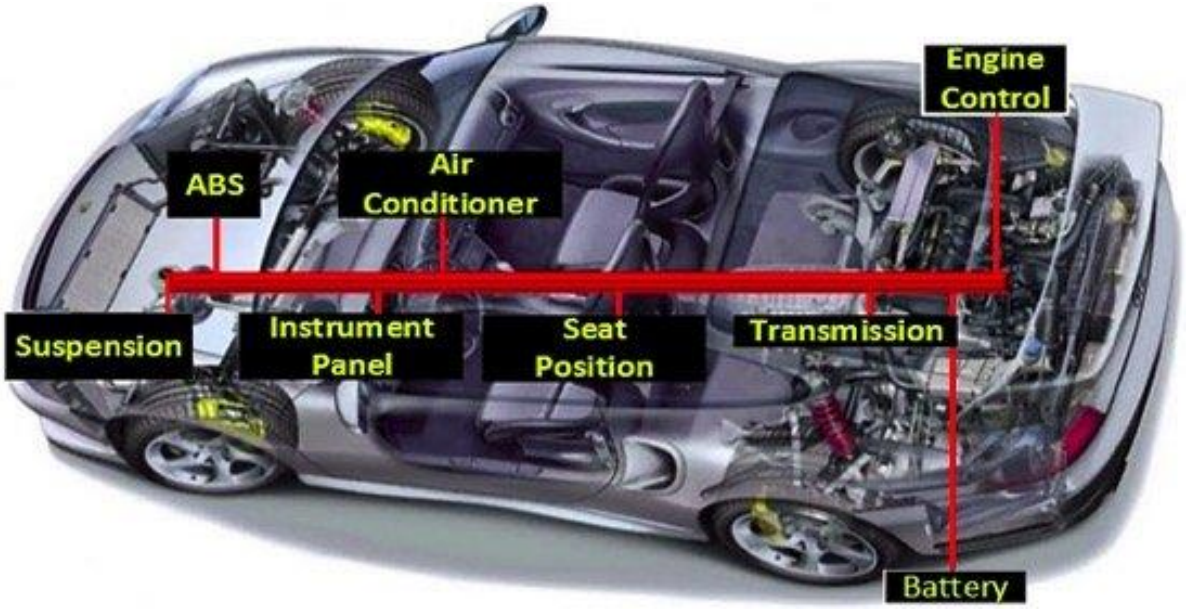
The calculations used to determine your GPS receiver's position is based on very small time differences, from when the satellite transmitted the signal, to, when the GPS receiver received the signal. These small differences are then used to calculate the distance from the receiver to the satellite. However, when receiving only one signal, we can only calculate how far away from the satellite we are. When receiving two signals, we can determine two likely positions where we are. We need three satellite signals to determine our exact position on the earth's surface. (2D/2 Dimensional positioning). When more than three satellites are 'visible' to the GPS receiver, it will also calculate the altitude of the receiver (3D/3 dimensional positioning).

For more detailed information, please visit https://www.techwalla.com/articles/purpose-of-the-gps-system-why-it-was-started and https://www.streetdirectory.com/travel_guide/12293/gps_vehicle_tracking/how_global_positioning_system_gps_works.html also visit https://www.seat.com/owners/my-seat/navigation/resolve-doubts.html

Controller Area Network (CAN)

A Controller Area Network (CAN) bus is a communication system made for vehicle intercommunication. This bus allows many microcontrollers and different types of devices to communicate with each other in real time and also without a host computer. A CAN bus, unlike Ethernet, does not require any addressing schemes, as the nodes of the network use unique identifiers.

The CAN bus was developed by Bosch Electronics for the automotive and aerospace industries. The automotive application consists of a central controller that monitors all of the car's systems and sensors. This configuration simplifies the monitoring and diagnosis of detected faults.



There is a single pair of wires connecting all of the communications between modules. This reduces the points of failure that were common in the older wiring looms. Additionally, the CAN bus also enables the system to continue operating even if a module fails.

CAN bus vs OBD 2
The On-Board Diagnostics protocols (OBD 2) would never have been possible without the CAN bus. The problem codes supported by the OBD 2 protocol are interpreted by technicians to diagnose and fix problems.
Moreover, the data port where the OBD 2 codes are accessed also serves as the port for software updates to modules connected to the CAN bus. This process alone has greatly simplified the ability of car manufacturers to keep your car operating at peak efficiency.

How does a CAN bus work?

CAN bus protocol
The CAN bus is a message-based protocol that is based on a set of rules. These rules define how messages are sent and received on the network. In general, all of the devices connected to the CAN Bus are designed to follow the rules. This ensures that data is transferred correctly from one device to the other.

CAN bus connector
The CAN bus is accessed via the OBD port. This is the same port that is used for troubleshooting error codes and for software updates.

How to get CAN bus data
Acquiring CAN bus data is really no different than troubleshooting OBD error codes. When a CAN bus communication problem occurs, it will set the “U” trouble code and will illuminate the check engine light.

How to decode CAN bus data
To diagnose a CAN bus problem, the same OBD port is used but the scanning tool is a bit different.

The first difference is that the tool must be compliant with the latest high-speed CAN network. The second difference is that the tool must be capable of sending commands to individual modules to run specific system self-tests.

How a CAN bus scanner works
A CAN-compliant code reader or scan tool is plugged into the OBD port to identify the specific error code.

Like the OBD scanning tool, it will not tell you exactly what module has failed. It will only tell you that a fault has been detected in the system.

For more detailed information, please visit https://www.techopedia.com/definition/32255/controller-area-network-can and https://obdstation.com/can-bus/

Diagnosing and troubleshooting of ABS

The ABS ECU has a self-diagnostic system which monitors the input and output circuits. The ABS ECU operates the solenoid valves and the pump motor in sequence in order to check each respective electrical system. This function operates only once each time the ignition switch is turned ON. During this check the operation of the actuator can be heard, however this is normal and does not indicate a malfunction.

Diagnostic Function

When a problem is detected in any of the signal system, the ECU turns on the ABS warning light in the combination meter to alert the driver that a malfunction has occurred. The code is stored in memory for access at a later time. Diagnostic trouble codes can be read from the warning light. The ABS ECU will also store the diagnostic trouble codes for any ABS malfunction.

Trouble Code Check

To access the diagnostic trouble codes stored in the ECU, locate the Data Link Connector (DLC1) or (DLC2). Consult the Repair Manual or the ABS Reference Card to determine whether the ABS Check Connector is physically disconnected or the short pin for Wa and Wb is removed.

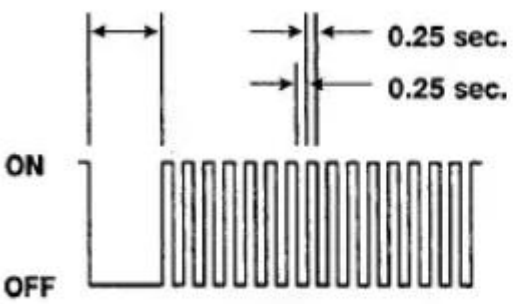
To access diagnostic codes:

- Disconnect the check connector or remove the short pin in DLC1.
- Jumper terminals Tc and E1 of the Data Link Connector (DLC1 or DLC2).
- Turn the ignition switch ON and read the trouble code from the ABS warning light on the Combination Meter.

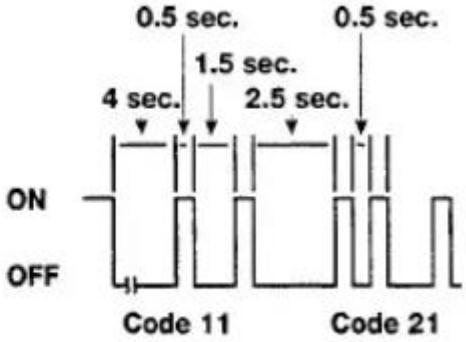
Diagnostic Codes

If the computer has not detected a malfunction, the lamp will blink two times per second after a 2 second pause. When a malfunction has been detected there will be a 4 second, then the first digit will begin. The number of times the lamp blinks before a one and a half second pause is the first digit of the code. Next, the number of blinks before the second pause is the second digit of the code. In the example below, the first code is Code 11 and the second code is Code 12.

If there is more than one trouble code, the code with the smallest number will appear first, followed by a pause for 2.5 second, then the next code.



Normal Code



Code 11 and 21

For more detailed information, please visit https://www.scribd.com/document/329490084/ABS-DTC

Hill Start Assist Explained

Hill Start Assist (HSA)**–**also known as **Hill Holder** or **Hill Hold Control**–is a driver-assistance system that detects when the car is on an incline and holds the brakes for a few seconds until the clutch finds its biting point and the car begins to move forward. It works even when the handbrake is released. This helps the driver to accelerate smoothly without the danger of the vehicle descending and hitting anything behind it.

Hill-start Control Components

The hill-start control system consists of a number of different sensors (though the specific sensors may vary according to the implementation), an electronic control unit (ECU) and a brake actuator under the control of the ECU that can apply the brakes as needed to prevent the car from rolling backward. We'll look at these safety and regulatory devices individually; bear in mind those specific hill-start control systems may not necessarily require every one of the following components:

Angle sensors: These detect the angle of the car on an incline, which corresponds to the slope of the hill the car is on.

Pressure sensors: These are part of the suspension system of the car and can detect the vehicle's weight, including the weight of passengers and cargo. This can also be done by piezoelectric sensors or strain gauges. These sensors produce an electrical signal proportional to the weight of the vehicle.

Torque sensor: Torque is the rotational force from the engine that eventually accelerates the vehicle from a complete stop. The torque sensor can detect how much torque is being transmitted to the wheels via the drivetrain.

Wheel-speed sensors: These detectors, usually placed on the axles, can determine the speed and direction the wheels are turning.

Electronic Control Unit (ECU): This is the vehicle's embedded computer system that receives signals from the various sensors. The ECU decides when the brakes need to be applied based on that input. The ECU can also calculate the traveling resistance, which is a function of the car's weight (determined by the pressure sensors) and the slope of the hill that the car is on (determined by the angle sensors). Traveling resistance is used to calculate how much engine torque will be necessary to move the vehicle uphill.

Brake actuator: An actuator is a device that converts an electrical signal into a physical movement. The brake actuator receives a signal from the ECU telling it to trigger the brakes. It then activates brake valves, sending brake fluid to the brakes to hold the vehicle in place, which keeps it from rolling back down the hill. In the case of a hybrid vehicle, the electric motor may be used in place of the brake to apply sufficient forward motion to the vehicle to keep it from rolling backward.

Working of hill start

Earlier, such a facility was available only on the vehicles with an automatic or semi-automatic transmission. But, nowadays vehicles having a manual transmission could also have it. This is because Hill start assist now works with the help of the Electronic Stability Program (ESP). ESP & acceleration sensor work in unison. They can detect the situation of vehicle stoppage on the slope.

In such a situation, when the driver releases the brake pedal; the system still maintains the brake pressure on the wheels for almost two seconds. Thus, it enables the driver to start off again smoothly. The techniques most commonly used to implement hill-start control are: incline detection, backward motion detection, clutch detection, accelerator detection, brake detection and engine torque detection.

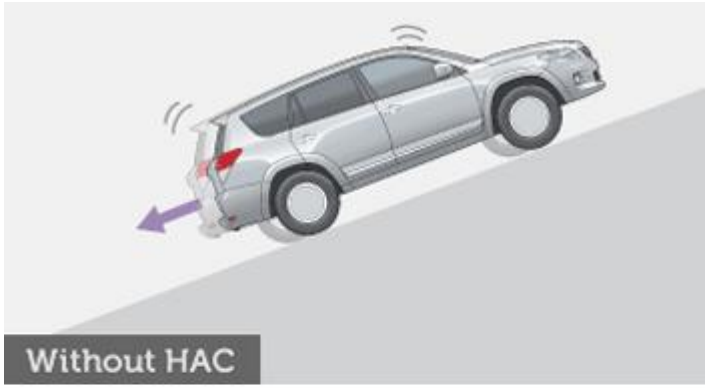
Clutch detection: One of the most obvious applications of hill-start control is in cars with a manual transmission or stick shift. To start a car with a manual transmission, it's necessary to step on a clutch, which disengages the engine from the transmission. While the engine is disengaged, the car is no longer held in place by the engine's braking power, and if the brakes are also disengaged, which is usually the case while accelerating, the car can roll freely, especially if it's on an incline.

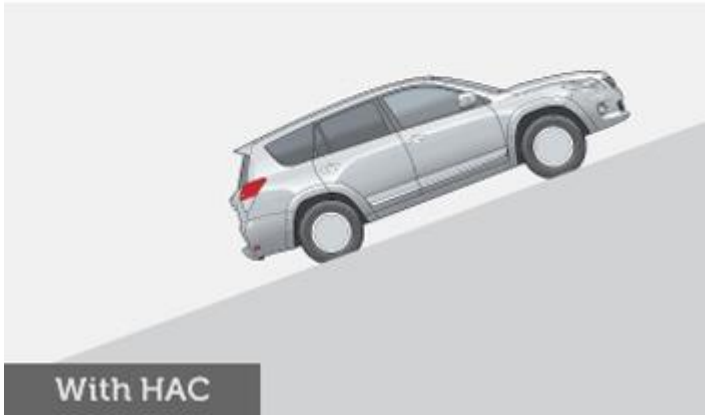
Incline detection: If a car is stopped on an incline while the motor is still running, there's a good chance that some kind of hill-start control will be needed. A sensor that detects an incline of more than a certain amount -- say, three degrees or more -- can send a signal to the hill-start control indicating that the vehicle has the potential to start rolling. The disadvantage of incline detection is that sometimes a car maybe on an incline without needing the hill-start control -- for instance, when a tire slips into a pothole.

Engine torque detection: This simply detects whether the engine is producing sufficient torque to accelerate the car forward. If it is, then the car is no longer in danger of rolling backward and the hill-start control is turned off.

Brake detection: This detects whether the brakes are in use and whether there is sufficient braking force to hold the car in place.

Backward motion detection: Although it isn't strictly necessary, some systems may include a means of detecting the fact that the car is rolling backward.





Systems that use incline detection work roughly like this: The incline sensor detects when the car is on a hill. A brake sensor determines whether a brake is being applied. If it's not, then the car is in danger of rolling backward, so the system automatically activates the vehicle's brakes to keep the car stationary. In a vehicle with a manual transmission, clutch detection and brake detection can be used together to sense when the vehicle is in danger of rolling backward and the brake can be activated.

For more detailed information, please visit https://www.carmudi.com.ph/journal/hill-start-assist/ and https://carbiketech.com/hill-start-assist/ also visit https://auto.howstuffworks.com/car-driving-safety/safety-regulatory-devices/hill-start-control1.htm

ABS Control Module Symptoms, Function & Replacement

The anti-lock braking system or ABS is an advanced safety feature found in almost all vehicles nowadays.

The ABS system consists of the ABS module and the ABS sensors found on each tire. The whole system works in tandem to ensure your car does not skid or go out of control in heavy braking situations.

ABS control unit is the main processing module of the entire Anti-lock braking system or ABS system of your vehicle. All the modern vehicle designs have a preinstalled anti-lock braking system.

The main components of the ABS system are the controlling module, the valves and the sensors. The control unit essentially receives all the information, records and makes it usable for the vehicle's engine system as well as to ensure the safety of brakes application without causing the vehicle to skid.

Signs of a Bad ABS Control Module

The ABS Control Module is a lifesaving component in a car. But just like every other component it has a life after which it can show signs of deterioration.

If the module fails you will become prone to accidents while hydroplaning and skidding will become more common when you brake hard. Fortunately, a failure in the ABS Module can be spotted easily.

1. Unresponsive Brake Pedal

In some cars, braking is directly linked with the ABS Control Module. This means the entire braking function is activated after going through the ABS module. If this is so and the module fails, your entire braking system can become unresponsive.

Either you won't be able to activate the brakes at all or the brakes will not react fast enough for you to brake at a safe distance. This is a life-threatening issue, so it is better you get it looked after by a mechanic as soon as possible.

2. More Force Required to Brake

When the ABS module malfunctions, it sends over incorrect information to the braking system. This causes the brake calipers to act out of their character and you require more force to apply the brake.

Not only that but your vehicle will take much longer to stop, while there is always a possibility it does not stop at all. If you feel this effect over time, you should schedule an appointment with a certified mechanic.

3. ABS Light Illuminates

The ABS has its own warning light that is triggered once there is an issue with the brakes. The ABS Control Module is monitored by the car's onboard computer so if and when a malfunction occurs the ABS Light comes on in your dash.

This ABS light can depict an issue with the ABS sensors or the ABS Control Module, so it is better to go to a mechanic to know of the exact issue. A high-end error code scanner can usually tell you where the problem lies.

4. Locked Brakes

An ABS Control Module malfunction can sometimes cause the exact same thing to happen that the system is trying its best to avoid, which is the locking up of brakes. When you can feel your car's brakes are locking up randomly or if they are completely locked up and not allowing your car to move at all, you might have a Control Module problem.

Cleaning the ABS Control Module

The ABS Control Module can also deteriorate due to the buildup of dust and debris. It is an electrical and mechanical component so it is necessary that you clean it regularly to ensure its proper function.

Things you will need

Blower
Clean microfiber cloth
Alcohol or cleaner

Process for Cleaning

The process to clean requires patience. First, you need to locate the sensor, which we have already told you where to find. Once you find the control module, inspect it for signs of wear and tear. It is possible the control module is covered with dust and damaged by debris.

Process by using the blower at a low setting. You don't want the dust to contaminate any other component. Try to cover all the area equally. Once you are done, you will have cleaned all the fresh dust which had deposited on top of the control module. Now it is time to use the cloth to clean all the dirt that has stuck to the module.

The dirt that is left can be cleaned with alcohol. Rub the cloth with some alcohol and clean the surface of the module, while making sure no liquid touches an electrical component. Lastly, let the module dry.

https://mechanicbase.com/brakes/abs-control-module-symptoms/

VIDEOS:

	**How to Update Your In-Car Navigation System** **https://youtu.be/rhAN2H5p_rg**
	**How to use a GPS** **https://whatis.techtarget.com/definition/GPS-navigation-system**

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<td>How to Remove Radio / Navigation / Touch Screen

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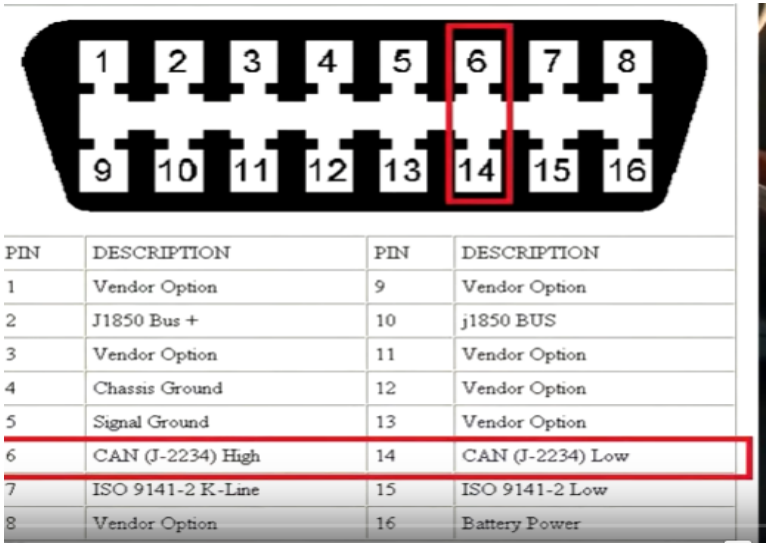
<td> 

PIN	DESCRIPTION	PIN	DESCRIPTION
1	Vendor Option	9	Vendor Option
2	J1850 Bus +	10	j1850 BUS
3	Vendor Option	11	Vendor Option
4	Chassis Ground	12	Vendor Option
5	Signal Ground	13	Vendor Option
6	CAN (J-2234) High	14	CAN (J-2234) Low
7	ISO 9141-2 K-Line	15	ISO 9141-2 Low
8	Vendor Option	16	Battery Power

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<td>TECH TIP CAN BUS DIAGNOSTICS

https://youtu.be/5YWHrTTmWE8</td>
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	**CAN bus explained-a simple intro** **https://www.csselectronics.com/screen/page/simple-intro-to-can-bus/language/en**
	**BMW Traction Control ABS DSC DTC issue or loss of engine power** **https://youtu.be/-2rgUi8MC50**

	**How to Fix ABS Problems in Your Car - Light Stays On** **https://youtu.be/T21th6nJe6Y**
	**Hill Start Assist Control** **https://youtu.be/nbKIQ4TvBFg**

AUTOMOTIVE MECHATRONICS

Module-13

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

Module 13: 071400965 Maintain Hybrid System

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

Duration: 50 Hrs **Theory:** 06 Hrs **Practical:** 44 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Maintain Series Hybrid	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Check function of engine Check function of generator/alternator in series hybrid system Check function of inverter in series hybrid system Check function of battery in series hybrid system Check function of drive motor in series hybrid system	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and use proper PPEs for the activity Explaining Hybrid System and its types (series, parallel and combined) Describing series hybrid system (electric hybrid) and its functioning procedure. Describing the procedure of series hybrid system maintenance. Describing the functions of high tension cables in hybrid system Describing the function of Inverters in hybrid system Describing the function of Power Split Unit Describing various sensors used in Hybrid vehicles Performing inspection of various sensors used in Hybrid vehicles Describing types of batteries in Hybrid vehicle (Lead acid	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Fender cover WD-40 Cotton Rag OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley Appropriate PPEs

	Check function of Powertrain Control Module (PCM) in series hybrid system Check function of sensors in series hybrid system Check function of hybrid breaker in series hybrid system Ensure housekeeping after completion of task	battery, Nickel-metal-Hydride battery, Lithium-ion battery) Describing the function AC-DC Convertor in hybrid system Describing the function of PCM in hybrid system Performing work area cleans during and after the activity Importance of housekeeping	
LU 2: Maintain Parallel Hybrid	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Maintain engine in Parallel Hybrid system Maintain transmission in Parallel Hybrid system Maintain hybrid motor in Parallel Hybrid system Maintain battery in Parallel Hybrid system	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and use proper PPEs for the activity Explaining parallel hybrid system (mild extended hybrid) components and their functions Describing the maintenance in parallel hybrid system using OBD-II Scanner. Performing work area cleaning during and after the activity Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Fender cover WD-40 Cotton Rag OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set

	Maintain Powertrain Control Module (PCM) in Parallel Hybrid system Perform sensors maintenance in Parallel Hybrid system Perform hybrid breaker maintenance in Parallel Hybrid system Ensure housekeeping after completion of task		Screw driver set Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley Appropriate PPEs
LU 3: Maintain Combined Hybrid 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 engine performance Check Generator/Alternator performance Check inverter performance Check battery	Understanding of appropriate tools and equipment Explaining the safety precautions regarding personal health and workplace Recognizing and use proper PPEs for the activity Describing the components of Series- Parallel or Combined Hybrid (Active Hybrid) system. Explaining the fault diagnosing procedure using OBD-II Scanner. Performing work area cleans during and after the activity Importance of housekeeping	Teaching materials White board, Markers, required piping layout Drawings. Multimedia projector Fender cover WD-40 Cotton Rag OBD-II Scanner Multi meter Repair Manual Wire cutter Combination Plier Combination spanner set Small socket set Screw driver set

	performance Check hybrid motor performance Check power split device performance Check PCM performance Check sensor performance Perform hybrid breaker performance Ensure housekeeping after completion of task		Needle nose pliers Car lifting equipment Car Jack Wheel Spanner Service creeper Tool Trolley Appropriate PPEs

Examples and illustrations

Hybrid System

It is a way of working, organizing, or doing something that is composed of elements of two separate systems

Hybrid Vehicle

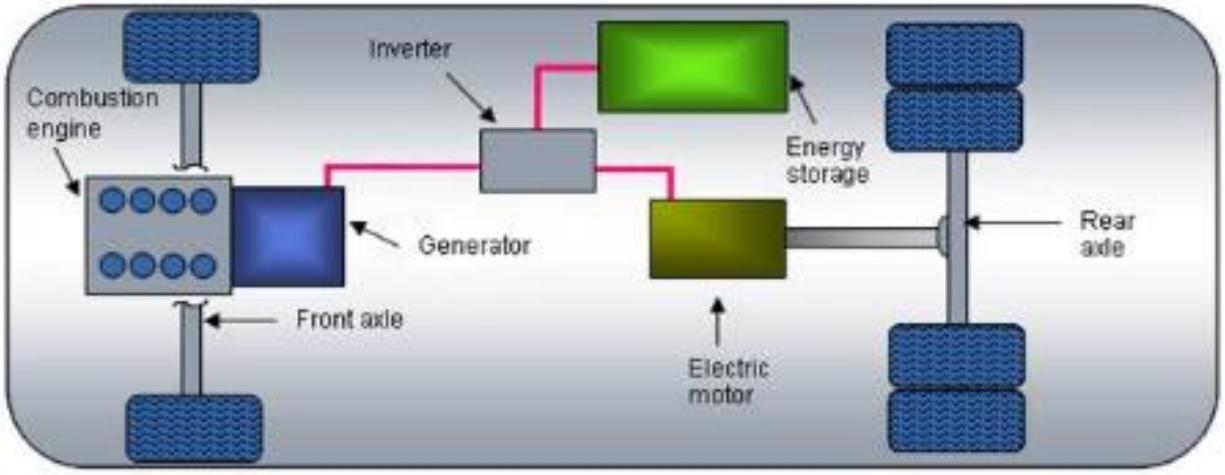
A hybrid vehicle is a vehicle using two different forms of power, such as an electric motor and an internal combustion engine, or an electric motor with a battery and fuel cells for energy storage.

The main advantages of a hybrid are that it should consume less fuel and emit less CO2 than a comparable conventional petrol or diesel-engine vehicle.

Different Types of Hybrids

Hybrid systems can be further defined by architecture: parallel, series and series-parallel, which indicates how the motors supply power to the vehicle's wheels.

Series hybrid systems - use two power sources linked together, with only one source directly connected to the vehicle's transmission. A small ICE is used to power a generator that converts the energy to provide electric power to the vehicle's wheels and auxiliary devices as well as to a battery system and/or capacitor(s).

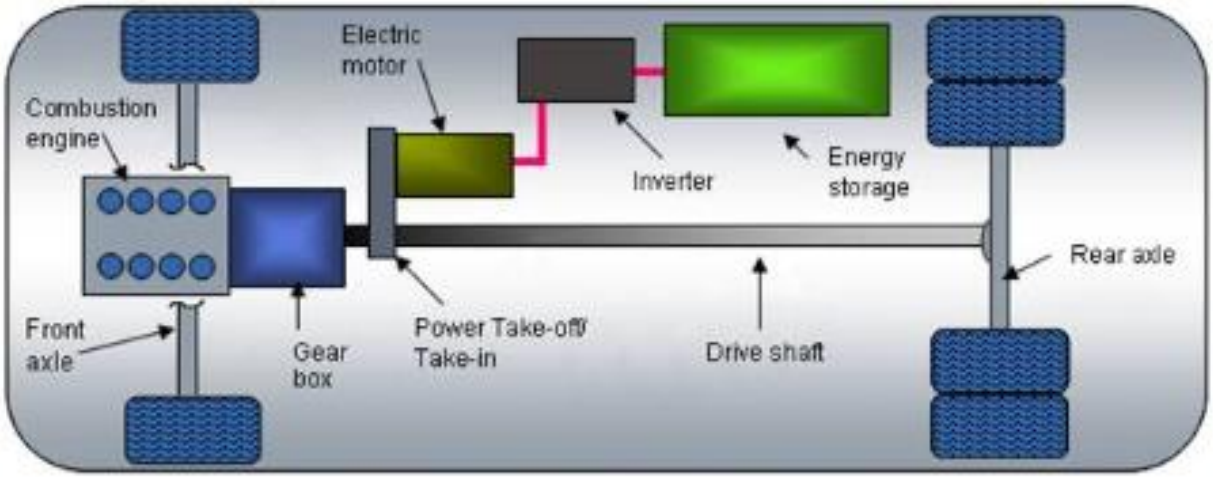


- Combustion engine operates as an auxiliary power unit and is mechanically disconnected from the wheels
- On-board energy storage supplements traction power
- The electric motor is directly connected to the drive shaft
- No transmission required
- Centralized system control to maximize energy flow from the battery and the engine
- Stop-start capability allows all electric operation for demanding inner-city travel

In a series hybrid system, the electric motor handles all the driving and the gasoline engine only recharges the battery pack. On longer trips (beyond 50 miles or so), the gas engine provides power. The combustion engine drives an electric generator instead of directly driving the wheels. The combustion engine with its attached generator works "as a power plant" to provide energy.

This energy is being supplemented by an energy storage unit.
The electric traction motor is responsible for driving the vehicle, either integrated into electric axles or connected to the drive shaft.
A transmission to switch gears is not needed as electric motors are efficient over a wide speed range.
An intelligent hybrid control system decides during the driving phase of the vehicle from where to feed the electric drive motor – either from the energy storage and / or from the generator.
During coasting, braking and stand-still where no traction power is required, it is possible to operate the auxiliaries completely from the energy storage, and shut down the combustion engine.
As soon as the hybrid control determines that more power is needed than is available from the energy storage – the combustion engine will be started via the generator in a very short time providing the required traction power.
Series hybrids are more expensive than parallel hybrids because they carry larger batteries to provide power for higher speeds

Parallel hybrid systems - provide a dual power supply that is physically connected to the vehicle's driving wheels. Either the ICE or the electric motor – or both – can power the vehicle's wheels.



- Wheels are mechanically connected to both the electric motor and the combustion engine
- Motor is also a generator to charge the batteries from regenerative braking or from engine power

- Efficient design for highway applications
- Compact system design
- Fewer components than a series hybrid results in a more cost effective solution

In a parallel hybrid electric vehicle the single electric motor and the internal combustion engine are installed to deliver power in parallel to drive the wheels. As both the engine and electric motor are connected to the drive shaft through a mechanical coupling, they can propel the vehicle by the engine alone, by the motor alone, or by both together. The electric motor can be used as a generator to charge the energy storage devices (battery or ultra-capacitors) by regeneration braking or by extra power from the engine.

As the engine is connected to the wheels via mechanical coupling, it makes this type hybrid quite efficient on the highway. In addition, a parallel hybrid vehicle only needs two propulsion devices – engine and electric motor, which makes the system very compact.

The result is that a parallel hybrid has less components than a series hybrid, which makes the system more cost effective. This type of hybrid is more suitable for traveling long distances. More drivers prefer parallel hybrids to series hybrids because they are more efficient.

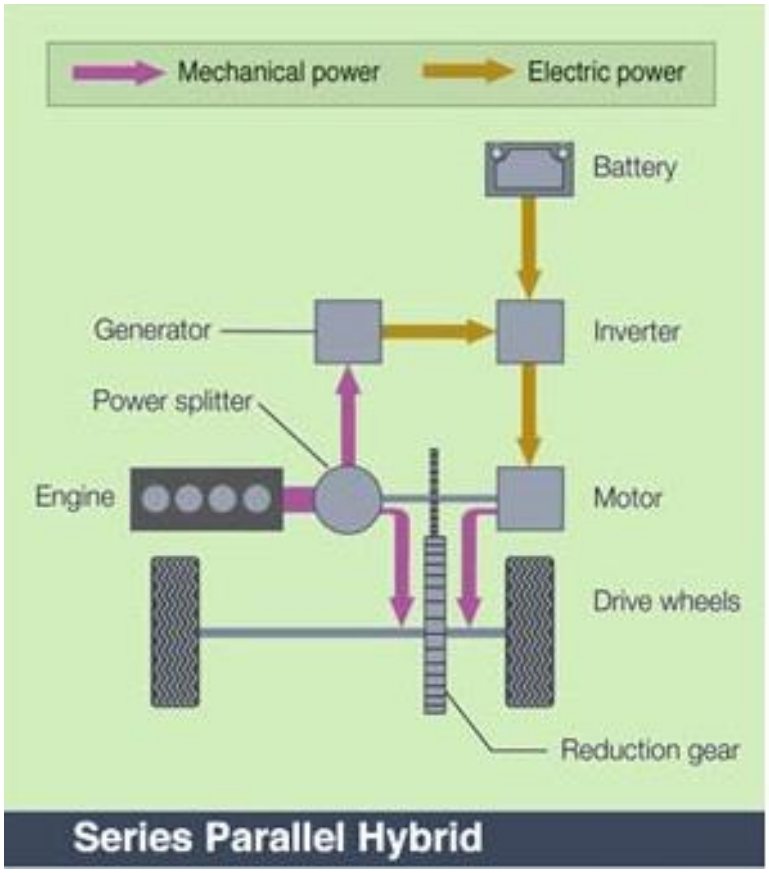
http://blog.parker.com/series-hybrid-vehicle-system-design and https://www.industry.usa.siemens.com/drives/us/en/electric-drives/hybrid-drives/automotive/Pages/hybrid-systems.aspx also visit https://auto.howstuffworks.com/different-types-of-hybrid-cars1.htm

Series-parallel hybrid systems

The series-parallel hybrid system uses an electric motor to drive the vehicle at low loads and speeds and a gasoline engine when loads and speeds increase. A control unit determines the best balance of power to achieve the most efficient vehicle operation.

The series-parallel hybrid system uses an electric motor to drive the vehicle at low loads and low speeds and the gasoline engine when loads and speeds increase. The electric motor and the gasoline engine can work individually, or together, depending on the power required to drive the vehicle. In addition, as the system drives the wheels, the combustion engine drives a generator to simultaneously generate electricity to recharge the battery when necessary.

A control unit determines the best balance of engine and electric power to achieve the most efficient vehicle operation. The combustion engine operates within its most efficient range resulting in a vehicle that reduces exhaust emissions by 80% to 90% compared to conventional vehicles. It also produces about half the amount of carbon dioxide.



The electric motor uses power from a high voltage battery, which is charged by the internal combustion engine, and by reclaiming the waste energy of decelerating or braking.

https://www.freeautomechanic.com/hybrid-series-parallel.htm and http://autocaat.org/Technologies/Hybrid_and_Battery_Electric_Vehicles/HEV_Types/ also visit https://www.team-bhp.com/forum/technical-stuff/137459-toyota-hybrid-technology-drive-experience-japan.html

Components of a hybrid electric vehicle

A. Series-Parallel HEV Architecture

Conceptually, the hybrid electric vehicle has characteristics of both the electric vehicle and the ICE (Internal Combustion Engine) vehicle. At low speeds, it operates as an electric vehicle with the battery supplying the drive power. At higher speeds, the engine and the battery work together to meet the drive power demand. The sharing and the distribution of power between these two sources are key determinants of fuel efficiency. Note that there are many other possible designs given the many ways that power sources can work together to meet total demand.

B. Design Steps

The key issues in HEV design are typical of classical engineering problems that involve multilayer, multi-domain complexity with tradeoffs. Here, we discuss briefly the key aspects of the component design:

Engine design

The key elements of engine design are very similar to those of a traditional ICE. Engines used in an HEV are typically smaller than that of a conventional vehicle of the same size and the size selected will depend on the total power needs of the vehicle.

Battery Design

The main considerations in battery design are capacity, discharge characteristics and safety. Traditionally, a higher capacity is associated with increased in size and weight. Discharge characteristics determine the dynamic response of electrical components to extract or supply energy to the battery.

Motor

Motors generally used in HEV systems are DC motors, AC induction motors, or Permanent Magnet Synchronous Motors (PMSM). Each motor has advantages and disadvantages that determine its suitability for a particular application. In this list, the PMSM has the highest power density and the DC motor has the lowest].

Power Splitter

A planetary gear is an effective power splitter that allows power flows from the two power sources to the driveshaft. The engine is typically connected to the sun gear while the motor is connected to the ring gear.

Vehicle Dynamics

The focus is on friction and aerodynamic drag interactions with weight and grade ability factors accounted in the equations.

Inverters and Converters in Hybrids and EV (Electric Vehicles)

In a hybrid and other electric vehicles (EVs), two key elements work together to manage power and recharge the circuits. Here is how these critical components—the *inverter* and *converter*—work in tandem.

The Function of an Inverter

Broadly speaking, an inverter is an electrical device that converts electricity derived from a DC (Direct Current) source to AC (Alternating Current) of the type that can be used to drive a device or appliance. In a solar power system, for example, the power stored by batteries charged by solar panels is converted to standard AC power by the inverter, which provides the power to plug-in outlets and other standard 120-volt devices.

An inverter serves the same kind of function in a hybrid or EV car, and the theory of operation is relatively simple. DC power, from a hybrid battery, for example, is fed to the primary winding in a transformer within the inverter housing. Through an electronic switch (generally a set of semiconductor transistors), the direction of the flow of current is continuously and regularly flip-flopped (the electrical charge travels into the primary winding, then abruptly reverses and flows back out). The in/outflow of electricity produces AC current in the transformer's secondary winding circuit. Ultimately, this induced alternating current electricity provides power for an AC load—for example, an electric vehicle's (EV) electric traction motor.

A r*ectifier* is a similar device to an inverter except that it does the opposite, converting AC power to DC power.

The Function of a Converter

More properly called a *voltage converter*, this electrical device actually changes the voltage (either AC or DC) of an electrical power source. There are two types of voltage converters: *step up converters* (which increases voltage) and *step down* converters (which decreases voltage). The most common use of a converter is to a take relatively low voltage source and step-it-up to high voltage for heavy-duty work in a high power consumption load, but they can also be used in reverse to reduce voltage for a light load source.

For more detailed information, please visit https://www.thoughtco.com/how-inverters-and-converters-work-85612

The Power Split Device

The power split device is the heart of the Toyota Prius. This is a clever gearbox that hooks the gasoline engine, generator and electric motor together. It allows the car to operate like a parallel hybrid -- the electric motor can power the car by itself, the gas engine can power the car by itself or they can power the car together. The power split device also allows the car to operate like a series hybrid -- the gasoline engine can operate independently of the vehicle speed, charging the batteries or providing power to the wheels as needed. It also acts as a continuously variable transmission (CVT), eliminating the need for a manual or automatic transmission. Finally, because the power split device allows the generator to start the engine, the car does not need a starter.

For more detailed information, please visit https://auto.howstuffworks.com/hybrid-car7.htm

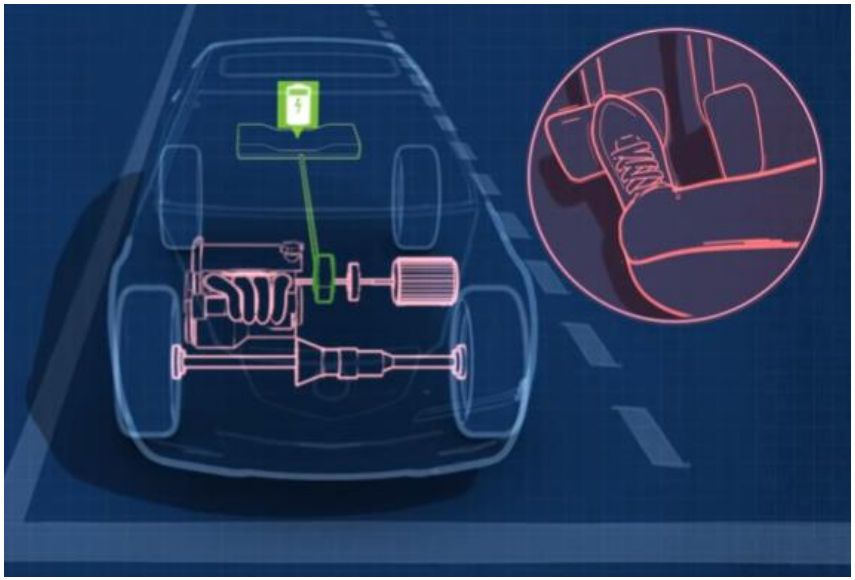
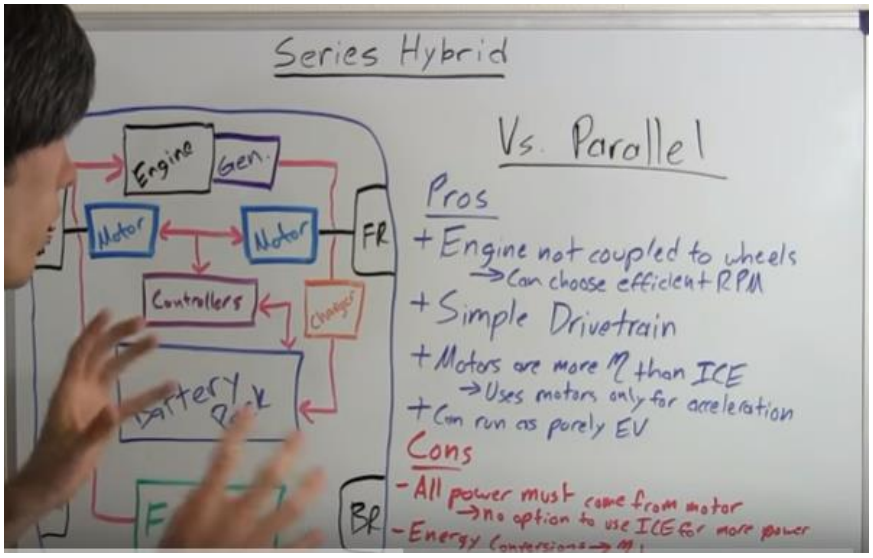
Types of batteries in Hybrid vehicle

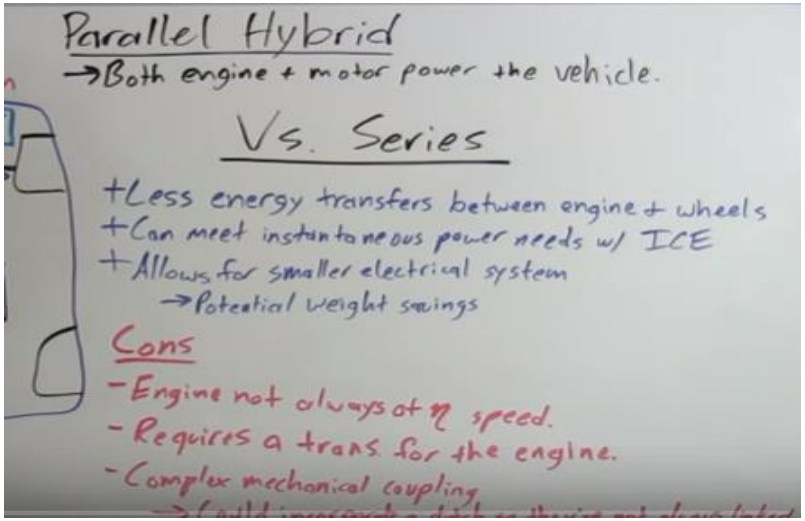
Batteries play a huge role in hybrid and electric vehicles. In hybrid vehicles, the battery-powered motor serves as a support to its gasoline engine, adding a boost to its performance.

Batteries in hybrid and electric vehicles vary according to model and manufacturer. There are 3 types of hybrid batteries Most commonly utilized in vehicles: Lithium-Ion, Nickel-Metal Hydride Battery (NiMH) and Lead-Acid.

https://www.upsbatterycenter.com/blog/vehicle-batteries/

VIDEOS:

	**Hybrid-Electric Vehicles** **https://youtu.be/uoBuOQn9XAQ**
	**Series Hybrid Cars - Explained** **https://youtu.be/axzTZZKm3mc**

	**Parallel Hybrid Cars – Explained** **https://youtu.be/wOZmG9cwUyU**
	**How Hybrid Electric Vehicles Work! (Animation)** **https://youtu.be/BMrA-5EDakg**

Module summary

Module	Learning Unit	Duration
Module 1 : Contribute to Work Related Health and Safety (WHS) Initiatives **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to contribute to work related health and safety (WHS) initiatives	**LU 1:** Contribute to initiate work-related health and safety measures **LU 2:** Contribute to establish work-related health and safety measures **LU 3:** Contribute to ensure legal requirements of WHS measures **LU 4:** Contribute to review WHS measures **LU 5:** Evaluate the organization's WHS system	30 Hrs
Module 2 : Analyze workplace policy and procedures **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to analyze workplace e policy and procedures	**LU 1:** Manage work timeframes **LU 2:** Manage to convene meeting **LU 3:** Decision making at workplace **LU 4:** Set and meet own work priorities at instant **LU 5:** Develop and maintain professional competence **LU 6:** Follow and implement work safety requirements	30 Hrs
Module 3 : Perform Advanced Communication **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perform advanced communication	**LU 1:** Demonstrate professional skills **LU 2:** Plan and Organize work **LU 3:** Provide trainings at workplace	30 Hrs

Module	Learning Unit	Duration
Module 4 : Develop Advance Computer Application Skills **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to develop advance computer application skills	**LU 1:** Manage Information System to complete a task **LU 2:** Prepare Presentation using computers **LU 3:** Use Microsoft Access to manage database **LU 4:** Develop graphics for Design	40 Hrs
Module 5 : Manage Human Resource Services **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to manage human resource services	**LU 1:** Determine strategies for delivery of human resource services **LU 2:** Manage the delivery of human resource services **LU 3:** Evaluate human resource service delivery **LU 4:** Manage integration of business ethics in human resource practices	20 Hrs
Module 6 : Develop Entrepreneurial Skills **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to Develop Entrepreneurial Skills	**LU 1:** Develop a business plan **LU 2:** Collect information regarding funding sources **LU 3:** Develop a marketing plan **LU 4:** Develop basic business communication skills	30 Hrs
Module 7: Maintain Fuel Control System-II **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain fuel control system	**LU 1:** Maintain Gasoline Direct Injection (GDI) **LU 2:** Maintain Common Rail Direct Injection (CRDI) **LU 3:** Maintain Eco-idle System	50 Hrs

Module	Learning Unit	Duration
Module 8: Maintain Emission Control System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain emission control system	**LU 1:** Analyze Exhaust Gas Operation **LU 2:** Adjust Exhaust Gas Recirculation (EGR) System **LU 3:** Perform Re-generation Process for Diesel System	40 Hrs
Module 9: Conserve Power Transmission-II **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to conserve power transmission	**LU 1:** Perform Diagnosis of CVT with OBD-II **LU 2:** Maintain Continuous Variable Transmission (CVT) system **LU 3:** Perform Road Test to check performance of CVT	60 Hrs
Module 10: Service Comfort & Safety System-II **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to service comfort & safety system	**LU 1:** Check Cruise Control System **LU 2:** Maintain Supplementary Restraint System (SRS)	40 Hrs

Module	Learning Unit	Duration
Module 11: Perpetuate Controlled Electric & Electronic System-II **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perpetuate controlled electric & electronic system	**LU 1:** Service Controlled Wiper & Washer System **LU 2:** Repair Electric Power Steering (EPS) System **LU 3:** Test Function of Sensors	60 Hrs
Module 12: Maintain Network System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain network system	**LU 1:** Verify Navigation System **LU 2:** Maintain Control Area Network (CAN) System **LU 3:** Verify electric Parking System	50 Hrs
Module 13: Maintain Hybrid System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain hybrid system	**LU 1:** Maintain Series Hybrid **LU 2:** Maintain Parallel Hybrid **LU 3:** Maintain Combined Hybrid System	50 Hrs

Short Questions/Answers

What is gasoline direct injection (GDI) system?	The Gasoline is highly pressurized, and injected directly into the combustion chamber of each cylinder via common rail fuel line as oppose to conventional multipoint fuel injection that injects fuel into the intake cylinder port.
What is CRDI stands for?	CRDI stands for common rail direct injection.
How common rail direct injection (CRDI) works?	CRDI directly inject fuel into the cylinders of a diesel engine through a single common line known as the common rail.
What is the difference between CRDI and TDI engine?	TDI is the turbo diesel engine while the CRDI is common rail direct injection engine.
What is echo-idle system?	An echo-idle system is starts stop system in automobiles.
What is the working of pressure control valve?	Pressure control valve is a relieve valve or safety valve used to control or limit the pressure in the system.
What is a diesel particulate filter? https://www.rac.co.uk/drive/advice/emissions/diesel-particulate-filters/	A diesel particulate filter (DPF) is a filter that captures and stores exhaust soot (some refer to them as soot traps) in order to reduce emissions from diesel cars.
What is emission control system?	Emission control system is a system in automobile which employed to limit the discharged of anxious gasses from the internal combustion engine and other components.
What are the main components of emission control system?	The main components of emission control system are: 1. Catalytic converter 2. Exhaust gases recirculation valve (EGR) 3. Positive crankcase ventilation (PCV)
What is the function of catalytic converter?	Catalytic converter is an exhaust emission controlled device that reduce toxic gases and pollutants in an exhaust gases from an internal combustion engine.
What is the function of Exhaust gases recirculation (EGR) valve?	Exhaust gases recirculation (EGR) valve is an emission control technology allowing significant NOx emission reduction from most type of diesel and petrol engine.

What is AD Blue?	Ad blue is a liquid solution of urea when it meets hot exhaust system it release ammonia which is a catalyst to a chemical reaction that converts dangerous nitrogen oxide into two harmless products water vapor and nitrogen.
What is diesel particulate filter (DPF)?	Diesel particulate filter (DPF) is a device designed to remove diesel particulate matter from the exhaust gas of a diesel engine.
How do I maintain a diesel particulate filter? https://www.rac.co.uk/drive/advice/emissions/diesel-particulate-filters/	The best way to maintain a DPF is to make sure it's fully able to regenerate itself when it's full of soot (when the warning light appears).
What causes a diesel particulate filter blockage? https://www.rac.co.uk/drive/advice/emissions/diesel-particulate-filters/	Short journeys at low speeds are the prime cause of blocked diesel particulate filters. This is why car makers often go as far as recommending city-bound short-hop drivers choose a patrol car instead of diesel (and it's why diesels are something of a rarity in the city car sector). Other things that are bad for DPFs include poor servicing. A diesel particulate filter on a poorly serviced car may fail sooner than a well maintained one, generally, they should last for at least 100,000 miles. It's important you use the right type of oil as well – some oils contain additives that can actually block filters.
Which direction does the steel belt turn when driving in forward and reverse?	In reverse the steel belt turns in the opposite direction as in forward.
Explain continuous variable transmission (CVT)?	Continuous variable transmission is an automatic transmission that can change seamlessly through a continuous range of effective gear ratios.
Write down the components name of continuous variable transmission (CVT)?	The components of continuous variable transmission (CVT) are as follows: Steel belt, planetary gear assembly, forward clutch, reverse brake, start clutch, fly wheel, parking mechanism, ATF pump, hydraulic valve unit and Power control unit (PCU).
What is the purpose of the air bag installed in the motor	The purpose of the airbag is to provide the occupants a soft

vehicle/	cushioning and restraint during a crash event.
Write down the component of supplementary restraint system (SRS) system?	It consist of an air bag cushion, a flexible fabric bag, inflation module and impact sensor.
What is cruise control system?	Cruise control system is a system that automatically controls the speed of a motor vehicle.
Explain the mechanism of cruise control system?	Cruise control takes its speed signals from a rotating drive shaft, speedometer, cable, wheel speed sensor, from the engine RPM by the vehicle.
What is the mean of supplementary restraint system (SRS) system?	SRS system is the proper name for the Air bag system.
What is the function of wiper in a vehicle?	Wiper is used to remove rain water, snow and debris from wind screen of a vehicle.
What is windscreen washer system?	It is a system which provide water for wind screen cleaning.
Define rain sensor?	Rain sensor is a sensor which operate the wipers after sensing the rain drop on the screen.
Explain combination switch?	Combination switch is a switch which provide us different positions to operate wiper arms and washer system for screen.
Explain electric power steering (EPS)?	The steering system which is powered by the electric motor is called electric power steering (EPS) system.
What is the function of oxygen sensor?	Oxygen sensor is mounted in the exhaust manifold to monitor how much unburnt oxygen is in the exhaust as the exhaust exists in the engine.
What is the position of crank position sensors?	An electronic device used in an internal combustion engines to monitor the position or rotational speed of the crankshaft.
Explain the function of cam sensor?	Cam shaft sensor is a sensor which determine which cylinder is in power stroke while the car computer monitors the rotating position of the cam shaft which is related to the crank shaft.
What is function of throttle position sensors?	Throttle position sensor is a sensor which is used to monitor the air intake of an engine.

Define navigation system?	Navigation system is a system that aids in navigation.
Types of navigation system?	1. Automotive navigation system 2. Marine navigation system 3. Satellite navigation system 4. Surgical navigation system 5. Inertial guidance system 6. Robotic mapping
What is GPS and how does it work? http://www.trackingworld.com.pk/FAQsnavi.html	GPS is an acronym for Global Positioning System and it works in coordination with GPS satellites which send out coordinates of longitude and latitude to your GPS tracking device. The device communicates with devices that have the GPS chip installed in them. Through this way you can get the location of your vehicle and this information is transmitted to you over cellular networks of GSM/GPRS through wireless provider.
What is the best navigation system?	Global positioning system (GPS) is the best navigation system.
Explain control area network (CAN)?	Control area network (CAN) is a robust vehicle bus standard design to allow microcontroller and devices to communicate with each other in application without a host computer.
Explain the application of control area network (CAN)?	1. Passenger vehicles 2. Trucks 3. Buses 4. Gasoline vehicle 5. Electrical vehicles 6. Elevators 7. Escalators 8. Medical instruments & equipment
What is hill assist system?	Hill assist system control the car when you have stopped on an incline and want to start moving again.
What is ABS modulator?	ABS modulator is a device which electronically control ABS brakes from brake locking up status.
What is hybrid system?	Hybrid system uses more than one propulsion that means combining a petrol or diesel engine with electric motor.

Name types of hybrid system system?	1. Series hybrid system 2. Parallel hybrid system 3. Combined hybrid system
What are the types of hybrid car batteries?	1. Lead acid batteries 2. Lithium ion batteries 3. Nickel meta-hydride NiMH
What is the high tension cable?	High tension cable is a cable which is used for electric power transmission at high voltage for long distance.
Describe the function of inverters?	Inverter is an electric device which change direct current to alternate current.
Describe the function of DC – DC converter?	DC – DC converter is a device which converts high voltage direct current into low voltage.

Test Yourself (Multiple Choice Questions)

MODULE 7

Question	**1**	Where the piston reaches, when fuel injection system injects fuel into the combustion chamber of a diesel engine?	A Top dead Centre B Bottom dead Centre C In between top dead Centre and bottom dead Centre D Any of the above
Question	**2**	In which condition, the fuel consumption is least?	A Idling range B No load running C Cruising range D High power range
Question	**3**	Is the below statement True or false? Diesel engines are more fuel efficient than gasoline engines.	A True

B False

Question 4 Which of the following is (are) the part(s) of Electronic Control Unit (ECU)?

A Injector control

B Spark advance control

C Idling control

D All of the above

Question 5 Which of the following is not the function of the fuel injection system?

A Time the fuel injection

B Control the engine speed

C Atomize the fuel to fine particles

D Filter the fuel

Question 6 Which of the following are important parameters that can be controlled, in a gasoline engine?

A air-fuel ratio

B mixture distribution between cylinders

C ignition timing

D all of the mentioned

Question 7 Why Catalytic converters use lambda sensors? to keep

A to keep exhaust temperature constant

B to keep exhaust pressure constant

C to keep excess air ratio within a range

D to keep Flow rate of air constant

Question 8 A resistor that changes its resistance with changes of temperature is called a:

A Thermistor

B Transistor

C Potentiometer

D Rheostat

Question 9 Which of the following must be mixed in the right amount, with gasoline to burn properly?

A Carbon

B Air

C Hydrogen

D Lead

MODULE 8

Question 10 A technician suspects the EGR (Exhaust Gas Recirculation) valve is closed. Which of the following would indicate a closed EGR valve?

A Rough idle

B Stalling

C Spark knock

D Engine surge

Question 11 The plastic sensors on an electronically controlled EGR valve have melted. Technician A says excessive back pressure caused by a partially clogged exhaust system could be the cause. Technician B says to always check for a restricted exhaust whenever replacing a failed EGR valve sensor. Who is right?

A A only

B B only

C Both A & B

D Neither A nor B

Question 12 What is the main function of an exhaust muffler?

A Optimization of exhaust efficiency

B Reduction of exhaust noise

C Reduction of nitrogen oxide in the exhaust gases

D Reduction of the exhaust gas volume

Question 13 On which of the following, the level of gasoline depends during operation of an engine?

A Tank

B ignition chamber

C float chamber

D none of the mentioned

Question 14 Inside which of the following, gasoline vapours are removed from the charcoal particles, during purging process?

A Canister

B float chamber

C tank

D All of above

Question 15 What charcoal canister is also called?

A Vapour

B Fuel

C Water

D Carbon

Question 16 How exhaust valve of an engine is compared to inlet valve, In petrol engine?

A Same

B Smaller

C Bigger

D varies from design to design

Question 17 Which instrument is used to measure CO and CO_2 emission in the exhaust gases of an engine?

A FID analyzer

B NDIR analyzer

C Chemiluminescent analyzer

D lemda sensor

Question 18 Which is/are a by-product of combustion and is/are emitted from the exhaust system, in automotive applications?

A Fuel

B Air

C Emission

D Catalysts

Module 9

Question 19 What is the major purpose of an electronically controlled automatic transmission?

A Eliminates gear clutches

B Eliminates the gear shaft lever

C Reduces the number of automatic transmission components

D Reduces shift shock and achieves more efficient transmission of engine torque

Question 20 What is the other name of continuous variable transmission (CVT)?

A Shiftless transmission

B Shift gear transmission

Question 21 By which material the belt is made, in continuous variable transmission (CVT?

A Rubber

B Steel

C Leather

D None of these

Question 22 What component in continuous variable transmission (CVT) is used to switch the rotation direction?

A Dry pulley

B Driven pulley

C Planetary gear assembly

D Secondary driven gear

Question 23 Is the statement True or False?

Start clutch is located in a place which allow the pulleys and the steel belt to be isolated from the wheels when the start clutch is not engaged.

A False

B True

Question 24 By which the ATF pump in continuous variable transmission (CVT) is driven?

A Input shaft

B Output shaft

C None of these

D All of above

Question 25 With which the forward clutch engaged and disengaged?

A Ring gear

B Sun gear

C Pinion gear

D None of these

Question 26 How many parallel shafts, a continuous variable transmission (CVT) contains?

A 1

B 2

C 3

D 4

Question 27 What do conventional automatic transmissions have, that CVTs don't?

A A reverse gear

B A stick shaft

C A clutch

D A gear box

Question 28 Which of the following is not one of the key elements that enable CVT technology to work?

A the clutch

B A high power belt

C an output "driven" pulley

D A shaft

Question 29 Which pulley transfers energy to the driveshaft, in a CVT?

A Driving pulley

B Driven pulley

C Variable pulley

Question 30 Which of the following is not one of the benefits of CVTs?

A Improved fuel efficiency

B A smoother ride

			C	greater horsepower
			D	Reduce emission
Module	**10**			
Question	**31**	Which is the most commonly used supplementary restraint system (SRS) component?	A	Seat belt
			B	Brake
			C	Air bag
			D	Steering
Question	**32**	Due to which of the following, all cruise control system being turned off?	A	When the driver depress the accelerator pedal
			B	When the driver depress the brake pedal
			C	When the driver depress the accelerator and brake pedal at same time
			D	None of these

Question 33 Which was the first car made with cruise control system?

A Rolls Royce

B Chrysler Imperial

C Henry Ford Folks wagon

D None of the above

Question 34 Where the seat belt tensioners are built?

A In front seats

B In shoulder anchors

C In seat belt retractors

D In seat belt buckles

Module 11

Question 35 Which component is responsible for converting the rotation of the steering wheel into lateral motion is the

A Steering wheel

B Steering shaft

C Steering gearbox

D Tie rod

Question 36 Which of the following is not a part of the chassis?

A Wheels

B Front axle

C Steering system

D Seats

Question 37 What is the effect of having excess camber?

A Excessive steering alignment torque

B Hard steering

C Too much traction

D Uneven tyre wear

Question	**38**	How the power steering pump is driven? In a hydraulic power steering system?	A	By belt driven by crankshaft
			B	By belt driven by camshaft
			C	By chain driven by crankshaft
			D	By belt driven by driveshaft
Question	**39**	What incorrect steering axis inclination (S.A.I.) causes?	A	Tendency to assume toe-out orientation
			B	Generation of a braking effect at tight corners
			C	Poor recovery of the steering wheel after making a turn
			D	The vehicle to pull to the side of lesser inclination
Module	**12**			
Question	**40**	What is GPS stands for?	A	General process system
			B	Global Positioning System
			C	Global Project system

			D	General Post System
Question	**41**	What is the process called when the state vector is calculated on board the vehicle?	A	Navigation
			B	Guidance
			C	Surveillance
			D	Position location
Question	**42**	How can control area network protocol describe?	A	As input or output
			B	As high or low speed
			C	As reliable or limited
			D	As modern or old
Module	**13**			
Question	**43**	What purpose does a generator serve in a hybrid vehicle?	A	It converts nuclear energy into more nuclear energy.

B It converts mechanical energy into electrical energy.

C It converts chemical energy into electrical energy.

D It converts electrical energy into mechanical energy.

Question 44 Which vehicle use a high-voltage battery?

A Electric

B Hybrid

C Both electric & hybrid

D None of above

Question 45 What are the two main types of hybrid vehicle?

A The series hybrid vehicle and the mild hybrid vehicle.

B The parallel hybrid vehicle and the full hybrid vehicle.

C The series hybrid vehicle and the parallel hybrid vehicle.

D The full hybrid vehicle and the empty hybrid vehicle.

Question 46 Which sentence best describes a parallel hybrid vehicle?

A The engine is directly connected to the transmission.

B The electric motor is directly connected to the transmission.

C Both of the above

D None of the above.

Question 47 Which of these is a purpose of the power-split device?

A To split electrical energy into mechanical energy.

B To allow both the engine and electric motor to propel the vehicle.

C To recharge the battery while braking.

D To recharge the brakes while driving.

Question 48 What voltage is likely to be available from the battery of an electric vehicle or hybrid?

A 12 V

B 24 V

C 300 V

D 400 v

Question 49 Which of the following vehicle produce zero emission?

A Hybrid

B Electric

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