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GENERATOR MECHANIC



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LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - November, 2019



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Introduction

Welcome to your Learner's Guide for the *Generator Mechanic* Programme. It will help you to complete the programme and to go on to complete further study or go straight into employment.

The *Generator mechanic* programme is to engage young people with a programme of development that will provide them with the knowledge, skills and understanding to start this career in Pakistan. The programme has been developed to address specific issues, such as the national, regional and local cultures, the manpower availability within the country, and meeting and exceeding the needs and expectations of their customers.

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.

Overview of the program

Course: <i>Generator Mechanic Level 2</i>	Total Course Duration: 310 Hours
Course Overview:	
<p>In this training program trainee will learn and acquire specialized knowledge and particle skills required to function as a Generator mechanic both at domestic and commercial levels. Generator Mechanic will responsible to maintain safety, maintain tools & equipment, identification of faults, diagnose mechanical faults, repair/replace mechanical components, as per the procedures involved. The specific objectives of developing these qualifications are as under:</p> <ul style="list-style-type: none"> • Improve the overall quality of training delivery and setting national benchmarks for training of generator mechanic in the country • Provide flexible pathways and progressions to learners enabling them to receive relevant, up-to-date and recent skills • Provide basis for competency-based assessment which is recognized and accepted by employers • Establish a standardized and sustainable system of training for generator mechanic in the country 	

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of Modules
<p>Module 1: Comply Personal Health and Safety Guidelines</p> <p>Aim: This Competency Standard identifies the competencies required to protect/apply occupational Safety, Health and Environment at workplace according to the industry's approved guidelines, procedures and interpret environmental rules/regulations. Trainee will be expected to identify and use Personal Protective Equipment (PPE) according to the work place requirements. The underpinning knowledge regarding Observe Occupational Safety and Health (OSH) will be sufficient to provide the basis for the job at workplace.</p>	<p>LU1: Identify Personal Hazard at work place</p> <p>LU2: Apply personal protective and safety equipment (PPE)</p> <p>LU3: Comply with occupational safety and health (OSH)</p> <p>LU4: Dispose of hazardous waste/materials from the designated area</p>	06	24	30
<p>Module 2: Communicate the Workplace Policy and Procedure</p> <p>Aim: This unit describes the performance outcomes, skills and knowledge required to develop communication skills in the workplace. It covers gathering, conveying and receiving information, along with completing assigned written information under direct supervision.</p>	<p>LU1. Identify workplace communication procedures</p> <p>LU2. Communicate at workplace</p> <p>LU3. Draft Written Information</p> <p>LU4. Review Documents</p>	04	16	20
<p>Module 3: Perform Basic Communication (Specific)</p> <p>Aim: This unit describes the skills and knowledge required to assist in the development of communication</p>	<p>LU1. Communicate in a team to achieve intended outcomes</p> <p>LU2. Follow Supervisor's instructions as per organizational SOPs</p> <p>LU3. Develop Generic communication skills at workplace</p>	06	24	30

<p>competence by providing information regarding different forms of communication and their appropriate use.</p>				
<p>Module 4: Perform Basic Computer Application (Specific)</p> <p>Aim: This unit describes the skills and knowledge required to use spreadsheet to prepare a page of document, develops familiarity with Word, Excel, email, and computer graphics basics.</p>	<p>LU1. Create Word Documents LU2. Create Excel Documents LU3. Use internet for Browsing</p>	<p>08</p>	<p>32</p>	<p>40</p>
<p>Module 5: Identify General Fault</p> <p>Aim: After completing this learning module, the learner will be able to check physical conditions of Generator, take history of faulty generator, check battery, check self-starter, check self-starter, check alternator charger, check control panel, document fault for identifying generator fault.</p>	<p>LU1: Check physical condition of generator LU2. Take History of faulty generator LU3. Check battery LU4. Check self-starter LU5. Check Alternator charger LU6. Check control Panel LU7. Document fault</p>	<p>10</p>	<p>50</p>	<p>60</p>

<p>Module 6: Identify Mechanical fault</p> <p>Aim: After completing this learning module, the learner will be able to inspect/service lubrication system, inspect/service cooling system, inspect/service air intake system, inspect and service fuel system, inspect and service exhaust system, inspect safety equipment and service cam timing system for identifying mechanical fault in generator.</p>	<p>LU1. Inspect and service lubrication system</p> <p>LU2. Inspect and service cooling system</p> <p>LU3. Inspect and service air intake system</p> <p>LU4. Inspect and service fuel system</p> <p>LU5. Inspect and service exhaust system</p> <p>LU6. Inspect safety equipment</p>	13	47	60
<p>Module 7: Identify Electrical Fault</p> <p>Aim: After completing this learning module, the learner will be able to inspect and service ignition system, inspect and service alternator, inspect and service display panel, inspect and service governor /Actuator System, inspect and service charging system, inspect and service warning system, to diagnose electric fault (s) in generator.</p>	<p>LU1. Inspect and service Ignition system</p> <p>LU2. Inspect and service alternator</p> <p>LU3. Inspect and service display panel</p> <p>LU4. Inspect and service governor /Actuator System</p> <p>LU5. Inspect and service charging system</p> <p>LU6. Inspect and service warning system</p>	10	60	70
TOTAL		57	253	310

GENERATOR MECHANIC



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Module-5

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Module 5: Identify General fault

Objective of the module: After completing this learning module, the learner will be able to check physical conditions of Generator, take history of faulty generator, check battery, check self-starter, check alternator charger, check control panel, document fault for identifying generator fault.

Duration:	Total hours	60	Theory	10	Practical	50
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Learning Unit	Learning Outcomes	Learning Elements	Materials (Tools & Equipment) Required
LU1. Check physical condition of generator	<ul style="list-style-type: none"> . Check foundation and balance of generator . Check earthing of generator . Check canopy and exhaust of generator 	Knowledge and understanding of : <ul style="list-style-type: none"> • Foundation and balance of generator • Earthing of generator, importance of earthing, Advantages of earthing, 	<ul style="list-style-type: none"> • Multimeter • Pliers • Screw drivers

	<ul style="list-style-type: none"> . Check power cable connections and circuit breaker . Check leakage of lubricants, coolant and fuel 	<ul style="list-style-type: none"> • canopy , function of canopy, exhaust of generator, importance of exhaust in a generator • Power cable and circuit breaker, working principal of circuit breaker, Different types of circuit breakers • Leakage of lubricants, coolant and fuel. • physical checking • MCB circuit breaker , and its rating (rating of circuit breaker) • draw backs of power cable loose connection. 	
LU2.Take History of faulty generator	<ul style="list-style-type: none"> . Examine log book . Seek information from operator . Prepare report of the faults 	<p>Knowledge and understanding of :</p> <ul style="list-style-type: none"> • log book focusing on all types entries procedure • preparation of report regarding faults , Main components of a report, 	<ul style="list-style-type: none"> . Log book . Report format
LU3.Check battery	<ul style="list-style-type: none"> . Check charge of battery . Check battery electrolyte and terminals . Check battery leads 	<p>Knowledge and understanding of :</p> <ul style="list-style-type: none"> • methods of battery charging like <ol style="list-style-type: none"> 1.Constant voltage 2.Constant current 3.Taper current 4.Pulsed charged 5.Burp charging 6.Trickle charge 	<ul style="list-style-type: none"> . Hydrometer .Multi-meter

		<ul style="list-style-type: none"> • specific gravity of electrolyte, importance of specific gravity, • battery leads and terminals • battery, rating of battery, 	
LU4.Check self-starter	<ul style="list-style-type: none"> . Check physical condition and connections of self-starter . Check battery voltage on self – starter terminals. 	Knowledge and understanding of : <ul style="list-style-type: none"> • self –starter, main parts of self-starter like <ol style="list-style-type: none"> 1. Electromagnetic Field Coils and Housing. 2. Armature 3. Solenoid. ... 4. Shift Fork. ... 5. Starter Drive Gear. <ul style="list-style-type: none"> • Function of a self-starter <ul style="list-style-type: none"> • Measurement of voltage with multi-meter 	. Multi-meter
LU5.Check Alternator charger	<ul style="list-style-type: none"> . Check charging generator belt . Check generator wires 	Knowledge and understanding of : <ul style="list-style-type: none"> • battery charging alternator • types of charging alternator • functions of charging alternator • generator belt, importance of generator belt, knowledge about generator wires 	. Multi-meter
LU6.Check control Panel	<ul style="list-style-type: none"> . Check AC/DC supply . Check fuses/breakers . Check parameters and wiring 	Knowledge and understanding of : <ul style="list-style-type: none"> • control panel and its functions • Fuses and different types of fuses such as 	. Multi-meter

		<p>LV Fuses. The low voltage fuses are divided into five types such as re-wire able, cartridge, drop out, striker and switch fuses. HV Fuses.</p> <ul style="list-style-type: none"> • Circuit breakers, types of circuit breakers ,rating of circuit breakers, working principal of circuit breaker • measuring instruments/gauges of control panel • measuring techniques of various gauges in control panel • Ac and DC system , measuring various parameters with the help of measuring instruments 	
LU7.Document fault	<ul style="list-style-type: none"> . Note fault in log book . Report to supervisor 	<p>Knowledge and understanding of :</p> <ul style="list-style-type: none"> • techniques/procedure to update log book • Reporting to supervisor 	.Log book

Examples and illustrations:

FUSE:

In the field of electronics or electrical, a fuse is an essential device used in various electrical circuits which gives the protection from the overcurrent. It comprises a strip or a metal wire that dissolves when the heavy flow of current supplies through it. Once this device has functioned in an open circuit, it ought to rewire or changed based on the type of fuse. A fuse is an automatic disconnection of supply which is frequently shortened to ADS. The alternative of the fuse is a stabilizer or circuit breaker, but they have many different characteristics.

Why do we require Fuse?

These are used to prevent the home appliances from the high current or overload damage. If we use a fuse in the homes, the electrical faults cannot happen in the wiring and it doesn't damage the appliances from the fire of wire burning. When the fuse gets break or damage, then an abrupt sparkle happens which may direct to damage your home appliances. That is the reason we require different types of fuses to guard our home-appliances against damage.

Working Principle of Fuse

The working principle of the fuse is "heating consequence of the current". It is fabricated with a lean strip or thread of metallic wire. The connection of the Fuse in an electrical circuit is always in series.

When the too much current is produced due to the heavy flow of current in the electrical circuit, the fuse gets soften and it opens the circuit. The extreme flow of current may direct to the collapse of the wire and prevents the supply.

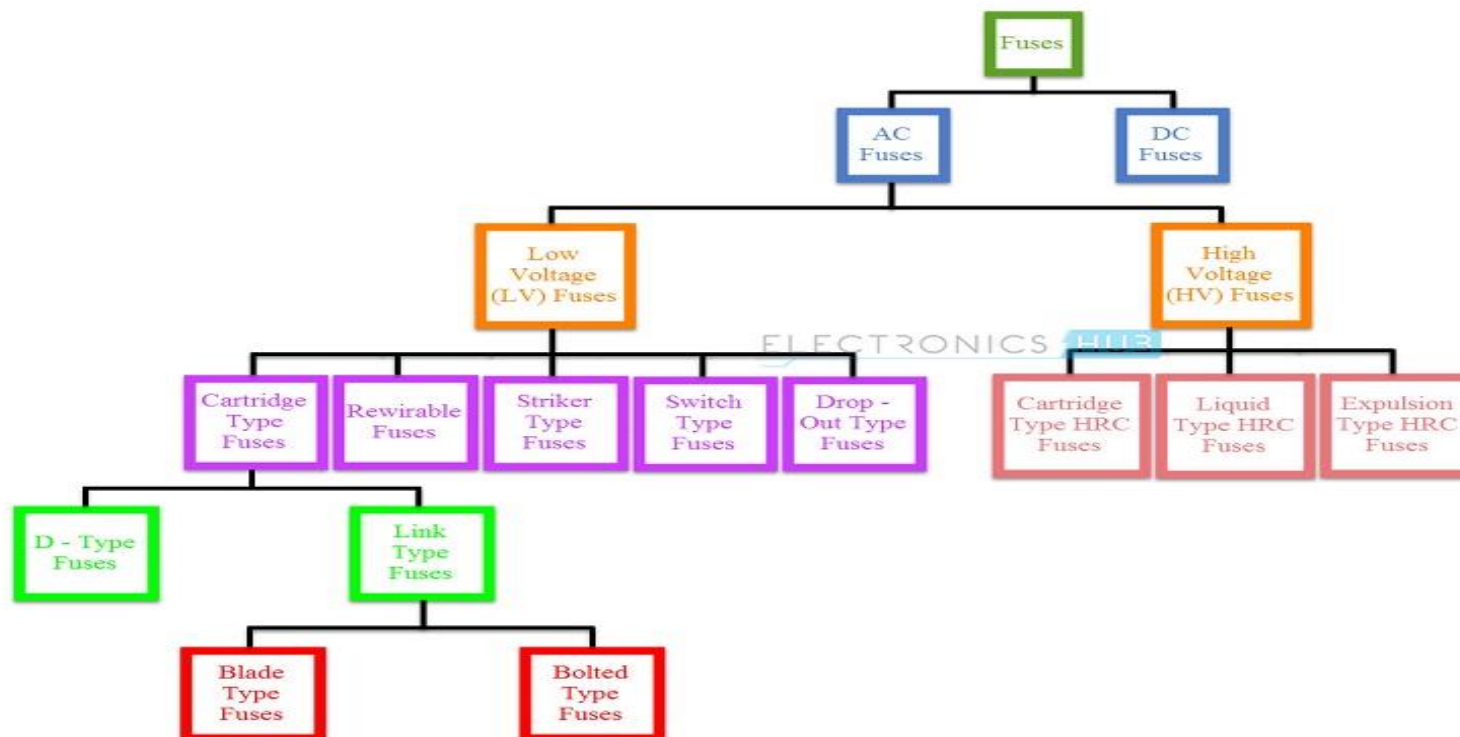
Types of Fuses

There are many types of fuses available for a variety of applications. The main category of Fuses are based on the type of circuit they are used in i.e. AC Fuses and DC Fuses. Again, AC Fuses are divided in to High Voltage (HV) Fuses and Low Voltage (LV) Fuses.

High Voltage (HV) AC Fuses are used for voltages above 1000V and Low Voltage (LV) AC Fuses are used for voltages less than 1000V. Low Voltage (LV) Fuses are again classified in to Cartridge Fuses (Totally Enclosed Type), Rewirable Fuses (Semi – Enclosed Type), Switch Fuses, Drop out Fuses and Striker Fuses.

High Voltage (HV) Fuses are further divided in to Cartridge Type HRC (High Rupturing Capacity) Fuses, Liquid Type HRC Fuses and Expulsion type Fuses.

The following image shows the chart of fuses divided based on the AC and DC currents.



<https://www.electronicshub.org/fuses-types-fuses/>

We will now see the different types of Fuses in general, irrespective of the above classification.

DC Fuses

The main difference between the DC Fuses and AC Fuses is the size of the fuse. In a DC circuit, when the current exceeds the limit, the metallic wire in the fuse melts and disconnects the rest of the circuit from power supply.

Since DC is constant value and is always above 0V, there is a chance of an electric arc between the melted wires, which will be difficult to avoid and turn off. Hence, usually, the electrodes of the DC Fuses are placed at larger distance when compared to the AC Fuses.

This will minimize the chance of arc and since the distance between the electrodes is increased, the size of the DC Fuses is comparatively large.

AC Fuses

We know that AC current (and voltage) oscillates as 50 or 60 times per second and in this the amplitude of the signal varies from minimum to maximum. At one point of this oscillations, the AC Voltage touches the 0V and hence the arc between the melted electrodes can be easily terminated.

As a result, the size of the AC Fuses can be much smaller when compared to the size of DC Fuses.

Rewire-able Fuses

Rewireable or Kit – Kat Type Fuses are a type of Low Voltage (LV) Fuses. They are most commonly used in house wiring, small industries and other small current applications.

Rewireable Fuses consists of two main parts: a Fuse Base, which contains the in and out terminal, and a Fuse Carrier, which holds the Fuse Element. The Fuse Base is generally made up of Porcelain and the Fuse Element is made up of Tinned Copper, Aluminium, Lead, etc.

The Fuse Carrier can be easily plugged in or removed from the Fuse Base without the risk of any electric shock. When the fuse is blown due to over current, we can easily remove the Fuse Carrier and replace the fuse wire. This is the main advantage of Rewireable Fuses.

Cartridge Type Fuses or Totally Enclosed Type Fuses

As the name indicates, Cartridge or Totally Enclosed Fuses have a completely closed structure with the Fuse Links enclosed in the container. This type of design and construction will help in keeping the arc with in the container at the event of blown fuse.

Cartridge Type Fuses are a very important category of fuses that are used in almost all types of applications like Low Voltage (LV), High Voltage (HV) and miniature fuses.

Cartridge Type Fuses are again further divided in to D Type Cartridge Fuses and Link Type Cartridge Fuses.

D – Type Cartridge Fuse

This type of fuses consists of a Cartridge, fuse base, cap and adapter ring. The cartridge with the fuse element in it is fitted with the fuse cap and is inserted in to the fuse base through the adapter ring and the connection is complete only when the tip of the cartridge touch the conductor.

D – Type Fuses are non – interchangeable and have an advantage of being highly reliable.

Link Type Cartridge Fuse or High Rupturing Capacity (HRC) Fuse

High Rupturing Time or HRC Fuses are a type of Cartridge Fuses. In HRC Fuses, the current flows through the fuse element under normal conditions.

In case of a fault, the high current due to short circuit (or any other fault) will be allowed to flow through the fuse for a short but known period of time. If the fault is cleared in this time, the fuse will not blow or the fuse element doesn't melt.

If the fault continues even after some time i.e. short circuit current for longer duration than allowed, the fuse blows by melting the fuse element.

Since HRC Fuses are designed for high current rupturing, a special method must be used to control the arc produced in the event of blown fuse. Usually, the body of the fuse is made up of Porcelain or Ceramic and the fuse element chamber is filled with Silica Sand.

There are two types of HRC Fuses: Blade Type and Bolted Type. Blade Type Fuses are also known as Plug – in Type Fuses.

The body of the Blade Type Fuse is generally made up of plastic and the two conducting Blade Type Plates are fixed to the fuse element. Blade Type Fuses are generally used in Automobiles.

High Voltage Fuses

High Voltage Fuses are generally used in power systems and are typically rated for voltages above 1500V and up to 138000 V. High Voltage (HV) Fuses are used to protect transformers, either small power transformers or instrument transformers, where circuit breakers might not guarantee the protection.

Circuit Breakers.

Electrical circuit breaker is a switching device which can be operated automatically or manually for protecting and controlling of electrical_power_system. In the modern power system the design of the circuit breaker has changed depending upon the huge currents and to prevent from arc while operating.

Electricity which is coming to the houses or offices or schools or industries or to any other places from the power distribution grids forms a large circuit. Those lines which are connected to the power plant forming at one end is called the hot wire and the other lines connecting to ground forming other end. Whenever the electrical charge flows between these two lines it develops potential between them. For the complete circuit the connection of loads (appliances) offers resistance to the flow of charge and the whole electrical system inside the house or industries will work smoothly.

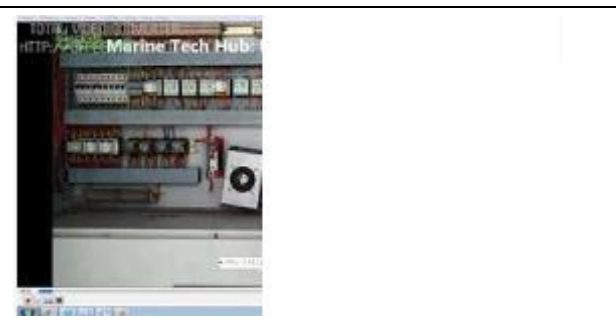
They work smoothly as long as the appliances have sufficiently resistant and do not cause any over current or voltage. The reasons for heating up the wires are too much charge flowing through the circuit or short circuiting or sudden connection of the hot end wire to the ground wire would heat up the wires, causing fire. The circuit breaker will prevent such situations which simply cut off the remaining circuit.

- Air Circuit Breaker
- SF6 Circuit Breaker
- Vacuum Circuit Breaker
- Oil Circuit Breaker
- Air Circuit Breaker

References:

1. <https://www.elprocus.com/what-is-fuse-different-types-of-fuses-and-applications/>
2. <https://www.linkedin.com/pulse/types-circuit-breaker-its-importance-shabith-ahamed>

Videos:

	<p>How to check battery condition of generator https://www.youtube.com/watch?v=wabU_bI5bJ8</p>
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How to check self starter, Battery charging and battery lead of generator

<https://www.youtube.com/watch?v=qxKCRDbWErE>



Generator Control Panel

<https://www.youtube.com/watch?v=NX7UoWDHxm0>



How to test an alternator?

<https://www.youtube.com/watch?v=LGB6ZEjGm7Q>

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Module-6

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Module 6: Identify Mechanical Fault:

Objective of the module: After completing this learning module, the learner will be able to inspect/service lubrication system inspect/service cooling system, inspect/service air intake system, inspect and service fuel system, inspect and service exhaust system, inspect safety equipment and service cam timing system for identifying mechanical fault in generator.

Duration	Total hours	60 hours	Theory	13 hours	Practical	47 hours
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Learning Unit	Learning Outcomes	Learning Elements	Materials (Tools & Equipment) Required
LU1. Inspect and service lubrication system	<ul style="list-style-type: none"> . Locate lubricant filling cap and drainage plug . Check oil level of engine . Adjust oil level . Identify leakage and report to supervisor 	<p>Knowledge and understanding of</p> <ul style="list-style-type: none"> • Lubricant and its importance, lubrication, purpose of lubrication, Types of lubricants, properties of lubricants. • lubricant grading • filling cap and draining plug and its location in engine • Checking oil level of engine • Adjusting oil level • Knowledge about measuring of oil level with dip stick. • Identifying leakage and reporting to supervisor 	<ul style="list-style-type: none"> . Lubricant Generator
LU2. Inspect and service cooling system	<ul style="list-style-type: none"> . Adopt appropriate safety measures . Ensure unobstructed air flow of radiator . Maintain coolant level . Replace fan belts and hose pipe 	<p>Knowledge and understanding of</p> <ul style="list-style-type: none"> • coolant • functions of radiator • antifreeze solution • importance of fan belts and hose pipe • safety measures while inspecting and servicing cooling system • air flow in radiator • fan belt, why we change fan belt, hose pipe, 	<ul style="list-style-type: none"> ○ .Coolant ○ .Radiator fan ○ .Fan belt ○ . Water body ○ Generator

<p>LU3. Inspect and service air intake system</p>	<ul style="list-style-type: none"> . Locate components to be inspected . Check air service indicator . Select appropriate tools/equipment . Clean primary air filter . Replace intake hoses and clamps 	<p>Knowledge and understanding of</p> <ul style="list-style-type: none"> • functions of intake components of air intake system • checking techniques for air intake system • components of air intake system, air service indicator, air filter , importance of air filter, hoses and clamps • Cleaning primary air filter • Replacing intake hoses and clamps 	<ul style="list-style-type: none"> .Air filter . Air intake indicator . Hoses and clamps <p>Generator</p>
<p>LU4. Inspect and service fuel system</p>	<ul style="list-style-type: none"> . Locate components to be inspected . Identify fuel gauges and level indicators . Select appropriate tools . Perform basic maintenance such as cleaning of fuel stain/fuel tank/carbonator . Identify service need defect and hazardous condition through visuals/physical inception . Report fuel leakage and faults 	<p>Knowledge and understanding of</p> <ul style="list-style-type: none"> • Differentiating engines using petrol, diesel and gas • types of fuel gauges • carburetor • different circuit of carburetor • components of fuel system, • fuel gauge and level indicator, • selecting appropriate tools for servicing fuel system , • cleaning of fuel stain/fuel tank /carburetor 	<ul style="list-style-type: none"> . Fuel gauge . Carburetor .Fuel stain .Fuel tank .Carburetor . Fuel pump . Fuel filter <p>Generator</p>
<p>LU5.</p>	<ul style="list-style-type: none"> . Locate components to be 	<p>Knowledge and understanding of :</p>	<ul style="list-style-type: none"> .Silencer and silencer shield

Inspect service system and exhaust	inspected <ul style="list-style-type: none"> . Check silencer shield . Check blockage & leakage of silencer . Dismantle silencer 	<ul style="list-style-type: none"> • silencer • Carbon Monoxide Ratio (COR) • dismantling procedure of silencer • components of exhaust system , • importance of silencer shield, • blockage and leakage of silencer, • dismantling silencer 	<ul style="list-style-type: none"> . Silencer seal . Exhaust gas analyzer . Socket box Generator
LU6. Inspect safety equipment	<ul style="list-style-type: none"> . Check and clean heat sensor . Check oil pressure sensor . Check and clean air sensor . Check and clean RPM sensor 	Knowledge and understanding of : <ul style="list-style-type: none"> • Various safety sensors and functions of sensors such as heat sensor, oil pressure sensor, air sensor, RPM sensor • locating sensors in a engine, heat sensor, oil pressure sensor, rpm sensor • types and functions of sensors 	<ul style="list-style-type: none"> .Heat sensor .Pressure sensor . Air sensor . RPM sensor . Tachometer . Engine analyzer Generator

Examples and illustrations:

LUBRICATION.

To supply lubricating oil between the moving parts is simply termed as “lubrication”.

Purpose of Lubrication:

- To reduce friction between the moving parts to a minimum value, thereby to reduce power loss due to friction.
- To minimize wear of moving parts as far as possible.
- To provide cooling effect by acting as a cooling medium & remove heat from various parts.
- To form an effective seal between the piston rings & cylinder walls and thus prevent the escape of gases from the cylinder and avoid power loss.
- To keep the engine parts clean by washing off and carrying away the impurities from the engine parts.

Properties of Lubricant:

1. Viscosity: Viscosity is a measure of the resistance to flow or the internal friction of the lubricant. It is used to grade lubricants. Viscosity is inversely proportional to temp. If temp. increases, the viscosity of the lubricant decreases and if temperature decreases, the viscosity of the lubricant increases. That is why low viscos oil is recommended for automobile engines in winter than summer. It also explains why engines are so hard to start in very cold weather. The viscosity of a lubricant should be just sufficient to ensure lubrication. If it is more than this value, power loss will be higher due to increased oil resistance.

2. Oiliness: It is the property of a lubricating oil to spread & attach itself firmly to the bearing surfaces. Generally, the oiliness of the lubricating oil should be high particularly when it is to be used for mating surfaces subjected to a high intensity of press. So that the metal is protected by a layer of the oil and the wear is considerably reduced.

3. Flash Point: Flash point of an oil is the min. temp. at which the lubricating oil will flash when a small flame is passed across its surface. The flash point of the lubricating oil must be higher than the temp. likely to be developed in the bearings in order to avoid the possibility of fire hazards.

4. Fire Point: If the lubricating oil is further heated after the flash point has been reached, the lowest temp. at which the oil will burn continuously is called fire point.

5. Cloud Point: It is the temp. at which the lubricating oil changes its state from liquid to solid.

6. Pour Point: It is the lowest temp. at which the lubricating oil will pour. This property must be considered because of its effect on starting an engine in cold weather.

Types of Lubricants:

1. Solid: graphic, mica etc

2. Semi solid: grease
3. Liquid: mineral oil, vegetable oil, animal oil etc.

Grade of lubricants:

Generally lubricating oils are graded by their SAE (society of automotive engineers) viscosity no. 5w, 10w, 20w SAE no. lubricating oil are for winter use.

20, 30, 40 SAE no. lubricating oil are for summer use.

Engine Lubrication System:

Engine lubrication system is mainly of following types.

1. Splash system
2. Pressure system
3. Petrol system

The Necessity of Cooling System in Engine:

All the I.C engine require a cooling system because combustion of fuel takes place inside the engine itself. All the heat produced by the combustion of fuel in the engine cylinders is not converted into useful power at the crankshaft. Only about 30% of the heat is converted into mechanical work. About 40% goes off through the exhaust. The remaining 30% is useless to waste heat.

It is seen that the quantity of heat given to the cylinder walls is considerable and if this heat is not removed from the cylinders, it would result in the seizing of the piston, high fuel consumption, pre-ignition and burning of lubricant etc.

Keeping the above facts in view, it is observed that suitable means must be provided to dissipate that excess heat from the cylinder walls so as to maintain the temperature below certain limits. Therefore the method of removing away the excess heat from the engine cylinder is called a cooling system

Types of Cooling System in Engine:

Following are the two type of cooling system for engine:

1. Air cooling system

2. Water cooling system

Air cooling system:

Air cooled system is generally used in small engines say up to 15-20 kW. The air system is used in the engines of motorcycles, scooters, aeroplanes and other stationary installations. In countries with cold climate, this system is also used in car engines.

In this system, the heat is dissipated directly to the atmospheric air by conduction through the cylinder walls. In order to increase, the rate of cooling, the outer surface area of the cylinder and cylinder head is increased by providing radiating fins and flanges. In bigger units, fans are provided to circulate the air around the cylinder walls and cylinder head.

Water Cooling System:

The water cooling system is used in the engines of cars, buses, trucks, etc. In this system, the water is circulated through water jackets around each of the combustion chambers, cylinder, valve seats and valve stems.

The water is kept continuously in motion by a centrifugal water pump which is driven by a V-belt from the pulley on the engine crankshaft. After passing through the engine jackets in the block and cylinder heads.

The water is passing through the radiator. In the radiator, the water is cooled by air drawn through the radiator by a fan. Usually, the fan and water pump are mounted and driven on a common shaft. After passing through the radiator, the water is drained and delivered to the water pump through a cylinder inlet passage. The water again circulates through the engine jackets.

Parts of Water Cooling System:

1. Radiator.
2. Thermostat valve.
3. Water pump
4. Fan.
5. Water Jackets.
6. Antifreeze mixtures.

Sensors:

It is a device that converts signals from one energy domain to electrical domain.

Classification of Sensors:

There are several classifications of sensors made by different authors and experts. Some are very simple and some are very complex. The following classification of sensors may already be used by an expert in the subject but this is a very simple classification of sensors.

In the first classification of the sensors, they are divided into Active and Passive. Active Sensors are those which require an external excitation signal or a power signal.

Passive Sensors, on the other hand, do not require any external power signal and directly generate output response.

The other type of classification is based on the means of detection used in the sensor. Some of the means of detection are Electric, Biological, and Chemical, Radioactive etc.

The next classification is based on conversion phenomenon i.e. the input and the output. Some of the common conversion phenomena are Photoelectric, Thermoelectric, Electrochemical, Electromagnetic, Thermooptic, etc.

The final classification of the sensors are Analog and Digital Sensors. Analog Sensors produce an analogue output i.e. a continuous output signal with respect to the quantity being measured.

Digital Sensors, in contrast to Analog Sensors, work with discrete or digital data. The data in digital sensors, which is used for conversion and transmission, is digital in nature.

Different Types of Sensors:

The following is a list of different types of sensors that are commonly used in various applications. All these sensors are used for measuring one of the physical properties like Temperature, Resistance, Capacitance, Conduction, Heat Transfer etc.


- Temperature Sensor
- Proximity Sensor
- Accelerometer

- IR Sensor (Infrared Sensor)
- Pressure Sensor
- Light Sensor
- Ultrasonic Sensor
- Smoke, Gas and Alcohol Sensor
- Touch Sensor
- Color Sensor
- Humidity Sensor
- Tilt Sensor
- Flow and Level Sensor

References:

1. <https://www.machinerylubrication.com/Read/29185/oil-viscosity-importance>
2. <http://hillagric.ac.in/edu/coa/agengg/lecture/243/Lecture%207%20Cooling%20and%20lubrication.pdf>
3. <http://www.ignou.ac.in/upload/unit%205.pdf>
4. <https://www.electronicshub.org/different-types-sensors/>

Videos:

	<p>Lubrication service procedure for generator https://www.youtube.com/watch?v=APYN4XcAYkQ</p>
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Generator system Coolant maintenance
<https://www.youtube.com/watch?v=lqUbiFkW7cU>



Generator Fuel pump service
<https://www.youtube.com/watch?v=a1ZrAAYGt40>



Heating and cooling for Gensets
<https://www.youtube.com/watch?v=nCib2U2FrPo>

GENERATOR MECHANIC



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Module-7

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - November, 2019

Module 7: Identify Electrical Fault

Objective of the module: After completing this learning module, the learner will be able to inspect and service ignition system, inspect and service alternator, inspect and service display panel, inspect and service governor /Actuator System, inspect and service charging system, inspect and service warning system, to diagnose electric fault (s) in generator.

Duration:	Total hours	70	Theory	10	Practical	60
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Learning Unit	Learning Outcomes	Learning Elements	Materials (Tools & Equipment) Required
LU1. Inspect and service Ignition system	<ul style="list-style-type: none"> . Identify the tools and equipment . Check Direct Current (DC) power supply of ignition coil and distributor . Check High Tension (HT) leads . Check spark plug 	<p>Knowledge and Understanding of :</p> <ul style="list-style-type: none"> • Identifying tools and equipment for inspecting and servicing ignition system • Functions of ignition coil and distributor • High Tension (HT) Leads • Different types of spark plug • Cleaning /gauging procedure of spark plug 	<ul style="list-style-type: none"> .Ignition coil . Distributor . High Tension (HT) leads . Spark plug . Tool kit
LU2. Inspect and service alternator	<ul style="list-style-type: none"> . Identify the tools and equipment . Check DC output voltage . Check belt . connections of alternator 	<p>Knowledge and Understanding of :</p> <ul style="list-style-type: none"> • Identifying the tools and equipment for inspecting and servicing alternator • Functions of DC alternator • Belt adjustment techniques. 	<ul style="list-style-type: none"> . Alternator .Belt . Tool kit
LU3. Inspect and service display panel	<ul style="list-style-type: none"> . Identify tools and equipment . Check gauges, circuit breakers, relays 	<p>Knowledge and Understanding of :</p> <ul style="list-style-type: none"> • Identifying tools and equipment for inspecting and servicing display panel 	<ul style="list-style-type: none"> .Gauges .Circuit breakers

	and wiring as per standard parameters	<ul style="list-style-type: none"> • Function of various gauges on display panel. • Measuring techniques of various gauges on Control Panel. • Circuit breakers, working principal of circuit breaker, Different types of circuit breakers • Switches and relays. 	.Relays and harness wires .Toolkit
LU4. Inspect and service governor /Actuator System	<ul style="list-style-type: none"> . Identify the tools and equipment . Check Actuator card supply . Check magnetic pick up sensor . Check power supply on Actuator/Governor 	Knowledge and Understanding of : <ul style="list-style-type: none"> • Identifying tools and equipment for inspecting and servicing governor/actuator system • Functions of Governor / Actuator, Actuator card, magnetic pick up sensor and power supply. 	.Actuator card supply . Magnetic pick up sensor .Actuator/Governor . Tool kit
LU5. Inspect and service charging system	<ul style="list-style-type: none"> . Identify the tools and equipment . Check battery power leads . Check charging circuit of alternator 	Knowledge and Understanding of : <ul style="list-style-type: none"> • Identifying tools and equipment for inspecting and servicing charging system • Functions of charging system • Battery leads, charging alternator, charging IC 	.Battery leads . Charging alternator .Charging IC . Tool kit
LU6. Inspect and service warning system	<ul style="list-style-type: none"> . Identify tools and equipment . Check oil sensor . Check temperature sensor . Check fuel sensor . Check over/under load module 	Knowledge and Understanding of: <ul style="list-style-type: none"> • Identifying tools and equipment for inspecting and servicing warning system • Warning system • Oil sensor, temperature sensor and fuel sensors • Current, voltage, and frequency due to under and over load conditions 	oil sensor . Temperature sensor . Fuel sensor Over/under load module Tool kit

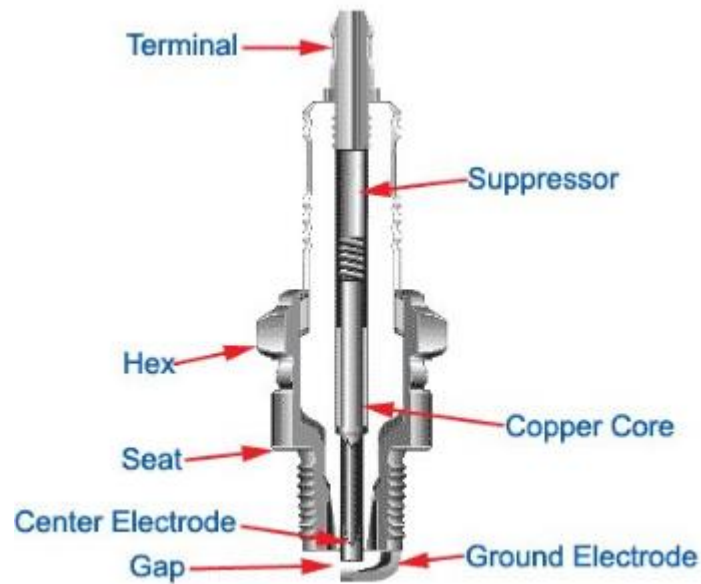
Examples and illustrations:

Spark Plugs:

Since the dawn of the automobile, spark plugs have been an integral part of gasoline engines because they conduct the electrical energy from a vehicle's ignition system needed to finalize the combustion process. After the gas/air mixture has been fully compressed inside the cylinder head, spark plugs serve a miniature bolt of lightning, igniting the mixture to create an explosion which pushes a piston downward.

Spark plugs aren't needed on diesel engines, which run at higher compression ratios sufficient to create combustion without the help of a spark. While 99% of engines feature one spark plug per cylinder, some high-performance engines such as modern Chrysler Hemi V8s have used two plugs per cylinder since their introduction.

Spark plugs are designed with an inner central electrode that's covered by a visible white porcelain insulating shell. That central electrode is connected by a heavily insulated wire to the output terminal of the vehicle's ignition coil. more details on - <https://www.carid.com/articles/types-of-spark-plugs.html>



Spark Plug

<https://www.carid.com/articles/types-of-spark-plugs.html>

Copper/ Nickel Spark Plugs:

Sometimes referred to as "standard" or "normal", copper spark plugs actually use a nickel-alloy coating for the electrode. Only the inner core itself is copper. This is because copper is a soft metal that would melt almost instantly if subject to the extreme heat that outer spark plug areas endure. Because of the construction of these types of plugs, we'll refer to them as "copper/nickel" for the purposes of this article. It's interesting to note that most types of spark plugs use cores made of copper due to its ability to conduct electricity well.

Copper/nickel spark plugs are lower in cost and generally have a shorter lifespan – especially if fitted to modern vehicles with high-energy distributor-less ignition systems or coil-on-plug ignition systems.

However, there are cases when copper/nickel plugs are advantageous. Because copper delivers the best spark under the adverse conditions generated by turbochargers or higher compression ratios, some manufacturers of high-performing late-model vehicles design their engines to use copper/nickel plugs as original equipment. If your vehicle's maintenance recommendations specify copper/nickel spark plugs, we advise sticking with them. But generally, it's not recommended to install these types of plugs in most modern vehicles.

Additionally, copper/nickel plugs are best-suited to engines built before high-energy distributor ignition systems became common in the 1970s. Natural gas engines also tend to run better on copper/nickel plugs.

Single Platinum Spark Plugs:

Spark plugs known as platinum feature a platinum center electrode. These are also described as "single platinum" plugs. Platinum-tipped spark plugs are more expensive because platinum is a more rare element in nature. Where platinum spark plugs shine is their great longevity under normal driving conditions. Platinum is harder than nickel alloy, so it doesn't erode the way copper/nickel plugs do. This means the gap at the tip of the spark plug does not widen as the metal wears away – a factor that causes a drop in power, reduced mileage, and intermittent misfires on startup that can trigger check engine lights on modern vehicles.

Some platinum plugs may reference a "fine wire" center core featuring one or more platinum discs inside of it. What "fine wire" refers to is basically an inner central electrode that's thinner in design. The reason for this is there does not need to be as much of the premium metals used because they conduct electricity in a superior fashion.

Platinum plugs resist carbon buildup more effectively because they run at higher operating temperatures than copper/nickel ones do. These are well-suited to modern engines designed with distributor-based electronic ignition systems, and are standard OEM equipment on many new vehicles.

The lifespan of a set of platinum spark plugs is typically double that of copper ones, although some vehicle manufacturers using them specify long plug change intervals of up to 100,000 miles thanks to precise computer control of air fuel mixture at all running temperatures. If your vehicle manufacturer specifies using platinum plugs during maintenance, stick with them. Switching to copper/nickel plugs is not recommended.

Double platinum spark plugs:

While “single platinum” plugs feature a platinum center electrode, “Double platinum” one use platinum plating on both the center electrode AND ground electrode. Although this type of plug represents a step up in price, double platinum spark plugs typically yield slightly higher performance with the traditional long life platinum plugs are known for.

Iridium spark plugs

Iridium-tipped spark plugs offer better power, more complete combustion that leads to smooth-running engines, and a longer lifespan than copper/nickel plugs. Depending on application, iridium plugs can even approach the lifespan of some platinum ones. Iridium plugs are highest in cost, and typically feature "fine wire" centers designed to conduct electrical energy better.

Silver spark plugs

Silver-tipped spark plugs have the best thermal conductivity. However, they do not feature the longevity of platinum or iridium. Generally, they're specified in older European performance cars as well as some motorcycles

Gapping spark plugs

"Gapping" refers to adjusting the distance between the curved conducting electrode and the plug tip where the electricity emanates from. This is done by bending the electrode itself via a special "gap tool". Achieving proper gap distance is important for maximizing the power output, fuel consumption, smoothness, and overall lifespan of your spark plugs.

Alternator and how it Works.

An alternator works together with the battery to supply power for the electrical components of the vehicle. The output of an alternator is direct current (DC). When the alternator pulley is rotated, alternating current (AC) passes through a magnetic field and an electrical current is generated. This is then converted to DC via the rectifier.

Alternator components & their functions:

Regulator

The voltage regulator controls the amount of power distributed from the alternator to the battery in order to control the charging process. Regulators are designed with different functions and work depending on their specification.

Rectifier

The rectifier is used to convert current from alternating current (AC) to direct current (DC) during the charging process.

Rotor

The rotor is the spinning mass inside the alternator that rotates via the pulley and drive belt system. The rotor acts as a spinning electromagnet.

Slip Rings

The Slip rings are used as a means of providing direct current and power to the rotor.

Slip Ring End Bearing

The bearings are designed to support the rotation of the rotor shaft.

Stator

The stator consists of several coils of wire wound through an iron ring. The stator sits outside the rotor, when a magnetic field is created the electrical current is made.

Drive End Bearing

The bearings are designed to support the rotation of the rotor shaft.

Pulley

The pulley is connected to the rotor shaft and the drive belt system. Rotation created by the engine the drive belt system turns the pulley beginning the charging process.

References:

- <https://www.carid.com/articles/types-of-spark-plugs.html>
- <https://www.autoelectro.co.uk/alternators>

VIDEOS:



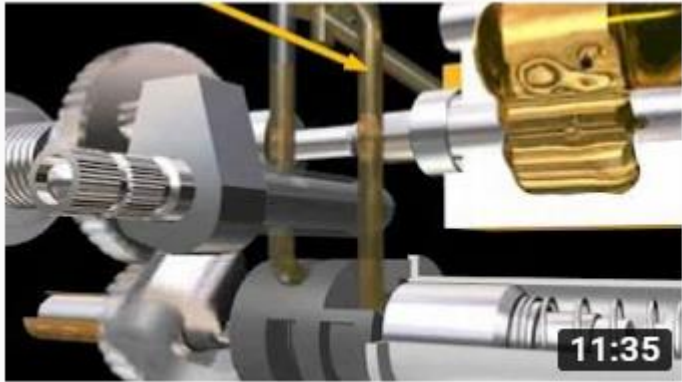
How does an alternator works

<https://www.youtube.com/watch?v=tiKH48EMgKE>



Adjusting alternator belt tension . bolt and pivot bracket design

https://www.youtube.com/watch?v=8JN0RtZk_2Y



Basics of governor system

<https://www.youtube.com/watch?v=GMMX88Zp0f0>



How spark plug works

<https://www.youtube.com/watch?v=dea07uYGkps>

Frequently Asked Questions:

<p>1. What is Competency Based Training (CBT) and how is it different from currently offered trainings in institutes?</p>	<p>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.</p>
<p>2. What is the passing criterion for CBT certificate?</p>	<p>You shall be required to be declared “Competent” in the summative assessment to attain the certificate.</p>
<p>3. What are the entry requirements for this course?</p>	<p>The entry requirement for this course is 8th Grade or equivalent.</p>
<p>4. How can I progress in my educational career after attaining this certificate?</p>	<p>You shall be eligible to take admission in the National Vocational Certificate Level-3 in Leather Products Development Technician (Pattern Maker). You shall be able to progress further to National Vocational Certificate Level-4 in Heavy Construction Machinery Operator Course; and take admission in a level-5, DAE or equivalent course (if applicable). In certain case, you may be required to attain an equivalence certificate from The Inter Board Committee of Chairmen (IBCC).</p>
<p>5. If I have the experience and skills mentioned in the competency standards, do I still need to attend the course to attain this certificate?</p>	<p>You can opt to take part in the Recognition of Prior Learning (RPL) program by contacting the relevant training institute and getting assessed by providing the required evidences.</p>
<p>6. What is the entry requirement for Recognition of Prior Learning program (RPL)?</p>	<p>There is no general entry requirement. The institute shall assess you, identify your competence gaps and offer you courses to cover the gaps; after which you can take up the final assessment.</p>
<p>7. Is there any age restriction for entry in this course or Recognition of Prior Learning program (RPL)?</p>	<p>There are no age restrictions to enter this course or take up the Recognition of Prior Learning program</p>
<p>8. What is the duration of this course?</p>	<p>The duration of the course work is 1,510 hrs. (11 months)</p>
<p>9. What are the class timings?</p>	<p>The classes are normally offered 25 days a month from 08:00am to 01:30pm. These may vary according to the practices of certain institutes.</p>
<p>10. What is equivalence of this certificate with other qualifications?</p>	<p>As per the national vocational qualifications framework, the level-4 certificate is equivalent to Matriculation. The equivalence certificate can be obtained from The</p>

	Inter Board Committee of Chairmen (IBCC).
11. 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 (NAVTTTC). These standards are also recognized worldwide as all the standards are coded using international methodology and are accessible to the employers worldwide through NAVTTTC website.
12. 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 in the local or overseas construction companies in heavy machinery operator job profile.
13. What are possible career progressions in industry after attaining this certificate?	You shall be able to progress up to the level of supervisor after attaining sufficient experience, knowledge and skills during the job. Attaining additional relevant qualifications may aid your career advancement to even higher levels.
14. 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 (NAVTTTC). The official certificates shall be awarded by the relevant certificate awarding body.
15. 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.
16. How much salary can I get on job after attaining this certificate?	The minimum wages announced by the Government of Pakistan in 2019 are PKR 17,500. This may vary in subsequent years and different regions of the country. Progressive employers may pay more than the mentioned amount. The heavy Machinery Operator normally earns 20,000 to 25,000 in the start.
17. Are there any alternative certificates which I can take up?	There are some short courses offered by some training institutes on this subject. Some institutes may still be offering conventional certificate courses in the field.
18. What is the teaching language of this course?	The teaching language of this course is Urdu and English.
19. Is it possible to switch to other certificate programs during the course?	There are some short courses offered by some training institutes on this subject. Some institutes may still be offering conventional certificate courses in the field.
20. 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.
21.Does this certificate enable me to work as freelancer?	You can start your small business by purchasing your own heavy construction machine and can start earning 50,000 per month. You may need additional skills on entrepreneurship to support your initiative.

Test Yourself (Multiple Choice Questions)

MODULE 5 Identify General Fault

- Question 1** A circuit breaker is
- A Power factor correcting device
 - B A device to neutralize the effects of transients
 - C A waveform correcting device
 - D A **current interrupting device**
- Question 2** The capacity of a battery is expressed in terms of
- A Current rating
 - B Voltage rating
 - C **Ampere hour rating**
 - D Ampere-ampere rating

Question 3 Fuses work only

A In a day light

B Twice

C **Once**

D In moonlight

Question 4 Circuit breaker work

A **Constantly**

B Only once

C When there is resistance

D When there is magnetic field

Question 5 During charging the specific gravity of the electrolyte of a lead acid battery

A Decreases

B **Increases**

C Remain same

D First increases then decreases

MODULE 6 Identify Mechanical fault

Question 1 Why is lubrication system important in the engine?

- A To improve fuel efficiency
- B To provide cooling
- C To **reduce the disturbance**
- D To help move the fuel easy

Question 2 Why is oil cleaning necessary in the engine?

- A For **continuous reliable operation**
- B To cool down the oil
- C To reduce the viscosity of oil
- D To increase thickness of oil

Question 3 The use of pressure cap on the radiator _____ within the cooling system.

- A **Increase air pressure**
- B Decrease air pressure
- C Keeps air pressure same
- D Do nothing with the pressure

Question 4 The cooling fan is

- A Fitted between the engine and radiator
- B Driven by belt and pulleys
- C Driven from the camshaft
- D **All of the above**

Question 5 What is used in engines to reduce the noise at the exhaust?

- A Noise dampers
- B Baffles
- C **Silencers**
- D Composite foam

MODULE 7 Identify Electrical Fault

- Question 1** The distributor serves the following purposes In the ignition system
- A It operates break and make mechanism
 - B It distributes high tension current to spark plug at correct time.
 - C Both A and B
 - D None of the above
- Question 2** The device in an ignition system that creates a spark to light the fuel in a cylinder :
- A P-lead
 - B Flash over
 - C Spark plug
 - D Magneto
- Question 3** The purpose of a _____ is to provide automatic control of the idling and maximum speeds to the engine
- A Governor
 - B Nozzle
 - C Throttle
 - D Spark plug

Question 4 In battery ignition system, the energy required for producing spark is obtained from a _____ battery

- A 6v to 12v.
- B 12v to 24v
- C 24v to 30v
- D 32v to 38v

Question 5 . In battery coil ignition system, the correct sequence of flow of current is :

- A Battery- Ammeter-ignition coil-Distributor- Spark plug
- B Battery – Ignition coil – Ammeter – Distributor – Spark plug
- C Battery – Ammeter – Distributor – Ignition coil – Spark plug
- D Battery – Distributor – Ammeter – Ignition coil – Spark plug

Answer Key

MODULE 5: Q1.d Q2.c Q3.c Q4.a Q5.b

MODULE 6: Q1.c Q2.a Q3.a Q4.d Q5.c

MODULE 7: Q1.c Q2.c Q3.a Q4.a Q5.a

