



NATIONAL VOCATIONAL TRAINING INSTITUTE

TESTING DIVISION

TRADE TESTING REGULATIONS AND SYLLABUS

TRADE: CONSTRUCTION MACHINERY MECHANICS

LEVEL: CERTIFICATE TWO

CONSTRUCTION MACHINERY MECHANICS CERTIFICATE TWO

A. INTRODUCTION

- i. The review of this syllabus has been generally influenced by the demands of industries due to its continuous change as a result of technological advancement and the changing needs of society. It was also influenced by the TVET reforms under the directions of the new educational reforms with the view to opening up further education and training opportunities to TVET graduates. The certificate TWO syllabus is designed to respond to the following level descriptors:

QUALIFICATION	KNOWLEDGE LEVEL	SKILLS AND ATTITUDE:
Certificate II	<ol style="list-style-type: none">1. To demonstrate broad knowledge base with substantial depth in area(s) of study.2. To demonstrate a command of analytical interpretation of range of data.3. To present results of study accurately and reliably.	<ol style="list-style-type: none">1. Needs varied skills and competencies in different tasks under various contexts.2. Require a wide range of technical and supervisory skills.3. Would be employed in different contexts.

- ii. The rationale of this syllabus is to establish the level of knowledge and skills required by mechanics over a wide range of applications, including the development of an ability to diagnose faults, recommend means of rectifying these faults and to test and analyse the performance of the vehicle after repairs or modification has been completed.

B. THE GENERAL OBJECTIVES

On completion of this course, the trainee should be able to:

- i) understand the Basic Mechanical operations essential for the repairs and maintenance of Construction Equipment
- ii) demonstrate thorough knowledge of the Construction Machinery Equipment, their auxiliary systems with emphasis on basic similarities and differences.

C. THE COURSE COMPONENTS

Trade Theory
Trade Science and Calculation
Trade Drawing
General Paper
Trade Practical

EXAMINATION: The candidates would be examined in the FIVE components listed above.

Practical work must be carefully planned to illustrate application of the theory and to provide maximum opportunity for shop practice, laboratory work and demonstration.

D KNOWLEDGE AND SKILLS REQUIREMENT

The prime objective of the programme is to provide the skills of the trade in a manner that will best meet the needs of the trade in Construction Machinery Equipment.

E. ENTRY TO THE COURSE

Minimum education : Must have passed Certificate One and SHS examination. Age – 18 years and above. However, the selection of the students for the course is within the discretion of the head of the institution.

F. ELIGIBILITY FOR ENTRY TO EXAMINATION

Candidates may enter for examination only as internal candidate that is those who at the time of entry to the examination are undertaking (or have already completed the course at an approved establishment).

G. EXTERNAL EXAMINERS

The practical work of candidates will be assessed by an external examiner appointed by the Trade Testing Commissioner.

H EXAMINATION RESULTS AND CERTIFICATES

Each candidate will receive record of performance given the grade of performance for the components Taken. These are:

- i) Distinction
- ii) Credit
- iii) Pass
- iv) Referred/Fail

Certificates would be issued to candidates who pass in all the components

NOTE

All Technical and Vocational trainees who aspire to take advantage of the opportunities opened to them in the educational reforms should NOTE that for a trainee to progress to certificate Two (2) a pass in Certificate One (1).

I. J. APPROVAL OF COURSE

Institutions or other establishments intending to prepare trainees for the Examination must apply to:

THE COMMISSIONER
TESTING DIVISION
NVTI HEAD OFFICE
P. O. BOX MB 21, ACCRA

ACKNOWLEDGEMENT

NVTI wishes to acknowledge the preparatory material done by the team of experts, which have been incorporated into this syllabus.

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Government's desire to improve the lot of Technical/Vocational Training, which led to the preparation of this syllabus, is hereby acknowledge.

CERTIFICATE TWO - TRADE THEORY

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
1.0	ARC WELDING	1.1 Process and Precaution in Arc Welding	1.2 The uses of types of electrodes in Arc Welding	1.3 Demonstrate to students the process and uses of types of electrodes in Arc Welding.
2.0	BRAZE WELDING	2.1 Process and Precaution of Braze welding.	2.2 Application of Braze welding.	2.3 Demonstrate to students the process of Braze welding
3.0	CLASSIFICATION OF ENGINES	3.1 <u>Engines</u> a) Valve arrangements b) Cylinder arrangements c) Method of cooling d) Method of Ignition e) Number of Strokes Firing order, etc	3.2 Details of which an engine can be classified.	3.3 Discuss with students the details with Engine classification.
4.0	CRANKSHAFT ARRANGEMENTS	4.1 Crankshaft arrangement and firing order.	4.2 The importance of Crankshaft arrangement and firing orders.	4.3 Demonstrate/Guide students to examine the crank arrangement and the firing order of Four and Six cylinder Engine.
5.0	CAMSHAFT ARRANGEMENT	5.1 Types of Camshaft arrangements	5.2 Camshaft arrangements	5.3 Discuss with students Camshaft arrangements with Constructional features.
6.0	VALVE OPERATING MECHANISM	6.1 Types of Valve operating mechanism	6.2 Operational details of Valve operating mechanism.	6.3 Discuss with students construction and operating principles.
7.0	VALVE TIMING DIAGRAM	7.1 The importance of Valve Timing Diagram	7.2 The Valve Timing Diagram with the aid of sketch.	7.3 Demonstrate/Guide students to interpret the Valve Timing Diagram
8.0	SUPER CHARGERS	8.1 The purpose and operation of super charger.	8.2 Types of super chargers <ul style="list-style-type: none"> • Blower • Turbo charger 	8.3 Guide students to identify types of Blowers and Super Chargers

CERTIFICATE TWO - TRADE THEORY

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
9.0	LUBRICATION	9.1 Types and Functions of the Lubrication system.	9.2 The functions and purpose of the main components of the lubrication system. Cause and defect of oil consumption.	9.3 Discuss with students the main functions and purpose of the lubrication systems. Trouble shooting in the lubrication system.
10.0	LUBRICATION OIL ADDITIVES	10.1 The importance of Additives in the Lubricating system	10.2 Types of additives in lubricating oils.	10.2 Discuss with students the importance of additives in lubrication oils.
11.0	COOLING SYSTEM (COMPONENT)	11.1 The functions of the main components in the Cooling system	11.2 Diagnosing and rectifying faults in the cooling system.	11.3 Discuss with student diagnosing of faults in cooling system.
12.0	HEAT EXCHANGER	12.1 Functions and operation of the Heat Exchanger	12.2 Types of Heat exchangers and oil coolers.	12.3 Discuss with students constructional feature, operation and diagnosing of faults.
13.0	LIFT PUMPS (DIESEL)	13.1 Function and operation of the Diesel fuel Lift Pumps.	13.2 Types of Lift Pumps and their constructional features.	13.3 Discuss with student the importance of a lift pump in the diesel fuel system operation.
14.0	FUEL INJECTION PUMP	14.1 Functions, Types and Lay out of the Fuel injection pump.	14.2 Functions and the purpose of the main components of diesel fuel injection pump.	14.3 Describe the operation of diesel injection pump.
15.0	DIESEL FUEL INJECTION PUMP GOVERNORS	15.1 Purpose and functions of the diesel fuel injection pump governors.	15.2 Types of Governors eg a) Mechanical governor b) Pneumatic governor c) Hydraulic governor	15.3 Discuss with students types of governors and their constructional features
16.0	PHASING AND CALIBRATION OF (FUEL INJECTION PUMPS)	16.1 Definition of Phasing and Calibration of diesel fuel injection pump.	16.2 Methods of carrying out phasing and calibration of fuel injection pump.	16.3 Describe with students how phasing and calibration is carried out on diesel fuel injection pump.

CERTIFICATE TWO - TRADE THEORY

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
17.0	INJECTORS	17.1 Functions and operation of injectors	17.2 Types of injectors examples; <ul style="list-style-type: none"> • Pintle nozzle • Pintaux nozzle • Multihole • Unit injector 	17.3 Guide students to identify types of injectors and how it works
18.0	COLD STARTING DEVICES	18.1 Functions of cold starting devices	18.2 Types of Cold Starting devices; <ol style="list-style-type: none"> a) Heater plug b) De-compression devices c) Ether Spray d) Heavy duty Battery, etc 	18.3 Explain to students the operation of cold starting devices.
19.0	TORQUE CONVERTER FLUID COUPLING	19.1 Purpose and Function of the Torque converter and Fluid Coupling.	19.2 The Purpose of Fluid Coupling and Torque converter <ul style="list-style-type: none"> • Impeller • Stator • Turbine 	19.3 Discuss with students functions, purpose of the main components of Torque converter.
20.0	POWER SHIFT TRANSMISSION	20.1 Operation of the Power Shift Transmission.	20.2 Diagnosing and rectifying fault on the Power Shift Transmission.	20.3 Discuss with students how to diagnose and rectify faults on Power Shift transmission.
21.0	PROPELLER SHAFT AND UNIVERSAL JOINT	21.1 Purpose of the Propeller Shaft and Universal joint.	21.2 Types of Propeller Shaft and Universal joint. <ul style="list-style-type: none"> • Propeller shaft • Universal joint 	21.3 Discuss with students to identify as in 212 <ul style="list-style-type: none"> • Propeller Shaft • Universal joint

CERTIFICATE TWO - TRADE THEORY

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
22.0	REAR AXLE	22.1 Purpose and operations of the Rear Axle	22.2 Types and the purpose of the main components of the rear axle final drive.	22.3 Guide students to identify types of Rear axle.
23.0	SUSPENSION SYSTEM	23.1 Functions and operations of suspension system.	23.2 Types of Suspension on Heavy Duty Trucks a) Spring Suspension b) Air Suspension c) Telescopic Suspension	23.3 Guide students to identify the following suspension system a) Spring Suspension b) Air Suspension c) Telescopic Suspension
24.0	TRACK ALIGNMENT (UNDER CARRIAGE)	24.1 Purpose of Track alignment.	24.2 Procedure of carrying out Track alignments and Adjustments	24.3 Guide students how to carry out Track alignment.
25.0	UNDER CARRIAGE COMPONENTS	25.1 Purpose of the main components of the under carriage (Crawler Tractor)	25.2 Types a) Track Shoe b) Track Link c) Track Adjusters d) Track Frame e) Track Sprocket	25.3 Guide students to identify the following a) Track Shoe b) Track Link c) Track Adjusters d) Track Frame e) Track Sprocket
26.0	POWER STEERING	26.1 Principles and operation of Power Steering	26.2 Types and layout of main components in the Power Steering.	26.3 Describe the constructional features of the Power Steering system.
27.0	POWER BRAKES (AIR BRAKES)	27.1 Differentiate between Air Brakes and the conventional Braking system.	27.2 Functions and Layout of the air braking system.	27.3 Discuss with students the functions lay out and operations of the air braking system.

CERTIFICATE TWO - TRADE THEORY

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
28.0	ATUATORS	28.1 Purpose of Atuaters	28.2 <u>Types of Atuaters</u> a) Liner atuater b) Rotary atuater c) Hydraulic Cylinders d) Hydraulic Motors	28.3 Discuss with students the different between <ul style="list-style-type: none"> • Liner and • Rotary atuater
29.0	HYDRAULIC PUMPS	29.1 Functions and operations of hydraulic pumps	29.2 Types of Hydraulic Pumps.	29.3 Discuss with students the constructional features of Hydraulic pumps.
30.0	CONTROL VALVES	30.1 Functions and Purpose of control valves	30.2 <u>Types of control valves</u> a) Pressure control valves b) Directional control valves c) Volume control valves	30.3 Discuss with students the construction of hydraulic control valves
31.0	ACCUMULATORS	31.1 Functions and operation of Accumulators	31.2 <u>Types of hydraulic accumulators</u> <ul style="list-style-type: none"> • Fluid accumulators • Gas accumulators 	31.3 Discuss types and operation of Accumulators.
32.0	OIL COOLERS	32.1 Functions and operation of oil coolers.	32.2 <u>Types of oil coolers</u> <ul style="list-style-type: none"> • Air-to oil cooler • Water-to oil cooler 	32.3 Discuss with students types and constructional features of oil coolers.
33.0	HYDRO STATICS	33.1 Principles of Operation	33.2 Types of Hydrostatic drives: a) Piston types b) Vane types c) Gear types	33.3 Discuss with student types and constructional features on hydrostatic drives.

CERTIFICATE TWO - TRADE SCIENCE AND CALCULATION

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
1.0	HEAT AND TEMPERATURE	1.1 Heat Transfer and mixtures	Definitions and calculations on Heat transfer and mixtures.	1.3 Assist the trainees to solve problem on Heat transfer and mixtures.
2.0	HEAT TRANSFER	2.1 Specific Heat Capacity	2.2 Definition and calculation on specific heat capacity.	2.3 Guide trainees to solve problems on specific heat capacity.
3.0	STRAIN AND STRESS	3.1 Tensile test	3.2 Definition and calculation on Tensile test of materials. <ul style="list-style-type: none"> • Limit of proportionality • Elastic limit, etc 	3.3 Guide trainees to solve problems on specific tensile stress of materials. Laboratory work
4.0	ENERGY	4.1 Power	4.2 Definition and calculations on power.	4.3 Assist trainees to solve problems on power
5.0	FUELS AND COMBUSTION	5.1 Definition of combustion	5.2 Problem on combustion-equations. E.g <ul style="list-style-type: none"> • Complete combustion • Carbon monoxide • Hydrogen 	5.3 Assist trainees to solve problems on combustion equations
6.0	MOMENTS	6.1 Simple Beams and Centre of Gravity calculation.	6.2 Problems on simple beams and centre of gravity.	6.3 Assist trainees to solve problems on simple beams and centre gravity.
7.0	GAS LAW (GENERRAL GAS EQUATION)	7.1.1 Charles Law 7.1.2 Boyles Law 7.1.3 Pressure Law	7.2.1 <u>Definition</u> <ul style="list-style-type: none"> • Charles Law • Boyles Law • Pressure Law 7.2.2 Simple calculations of general Gas Law.	7.3 Guide trainees define and solve simple calculation on gas equations.

CERTIFICATE TWO - TRADE SCIENCE AND CALCULATION

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
8.0	MACHINES	8.1.1 Definition of Machines. 8.1.2 Determination of overall Gear Ratio of a simple machine.	8.2.1 Velocity ratio (Movement ratio) 8.2.2 Mechanical advantages (Force Ratio) 8.2.3 Efficiency of a machine.	8.3.1 Assist trainees to solve simple problems on the following listed in the sub-skills. 8.3.2 Guide trainees to define the various terms in the sub-skills.
9.0	HYDRAULICS	9.1.1 Pressure. 9.1.2 Definition of Hydraulics.	9.2.1 Force calculations on Ram and Plunger. 9.2.2 Calculation of pumping strokes on plunger.	9.3 Guide trainees to define hydraulics and solve simple problem on hydraulics
10.0	FRICITION	10.1.1 The law of Friction 10.1.2 Types of Friction 10.1.3 Friction Calculation	10.2 Define Friction a) Areas where friction i) Useful ii) Not useful b) Co-efficient of friction c) Friction in Bearing d) Friction in clutches e) Friction in Brakes	10.3 Guide trainees to define simple calculation on Friction mention in sub-skills.
11.0	LINEAR MOTION	11.1 Acceleration, Velocity, Distance	11.2.1 Definition <ul style="list-style-type: none"> • Acceleration • Velocity • Distance 	11.3.1 Guide trainees to define the following <ul style="list-style-type: none"> • Acceleration • Velocity • Distance

CERTIFICATE TWO - TRADE SCIENCE AND CALCULATION

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
11.0			11.2.2 Calculation on <ul style="list-style-type: none"> • Acceleration • Velocity • Distance 	11.3.2 Calculation <ul style="list-style-type: none"> • Acceleration • Velocity • Distance
12.0	ENGINE POWER	12.1. <ul style="list-style-type: none"> a Brake Power b Indicated Power c Thermal Efficiency d Engine Torque 12.1.2 Definitions and calculations	12.2.1 Definition <ul style="list-style-type: none"> • Indicated Power • Brake Power • Thermal Efficiency • Engine Torque • 12.2.2 Simple calculations on the above mention sub-skills. 12.2.3 The cycles; <ul style="list-style-type: none"> • Constant Volumes • Constant Pressure • Dual cycle 	12.3 Assist trainees to define and solve calculation on sub-points. Using simple sketches, explain the difference between the cycles listed in the sub-skills.
13.0	RESOLUTION OF FORCES	13.1 Triangular of Forces	13.2 Construction of triangular of forces	13.3 Guide trainees to construct triangular of forces.

CERTIFICATE TWO - TRADE SCIENCE AND CALCULATION

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
14.0	ELECTRICITY CALCULATION	14.1 Calculation on the following; a) Series circuit b) Parallel circuit c) Combine series and Parallel circuit d) Power e) Voltage Drop f) Potential Difference g) Electromotive force h) Internal resistance	14.2 Simple problems involving the electrical circuit; a) Series circuit b) Parallel circuit c) Combine series and Parallel circuit d) Power e) Voltage Drop f) Potential Difference g) Electromotive force h) Internal resistance	14.3 Assist trainees to solve simple calculations on the following mention sub-skills. a) Series circuit b) Parallel circuit c) Combine series and Parallel circuit d) Power e) Voltage Drop f) Potential Difference g) Electromotive force h) Internal resistance

CERTIFICATE TWO - TRADE DRAWING

TASK		CRITICAL POINTS	SUB-POINTS	INSTRUCTIONAL TECHNIQUE
1.0	GEOMETRICAL DRAWING	1.1 Solid Geometric a) Prisms b) Cylinders c) Pyramids d) Cone	1.2 Construction of the solid Geometrics a) Prisms b) Cylinders c) Pyramids d) Cone	1.3 Guide trainees to construct the following solid Geometrics a) Prisms b) Cylinders c) Pyramids d) Cone
2.0	ORTHOGRAPHIC PROJECTIONS	2.1 <u>Orthographic projection</u> a) 1 st Angle Projection b) 3 rd Angle Projection	2.2 1 st and 3 rd Angle Projection Isometric View of a solid block.	2.3 Guide trainees to construct an Isometric View of a solid block in a) 1 st Angle Projection b) 3 rd Angle Projection
3.0	SECTIONAL VIEWS	3.1 Full and half section of an objects and true shape.	3.2 A Sectional view and the true shape of an objects.	3.3 Guide trainees to construct a sectional view and a true shape of an object.
4.0	DEVELOPMENT OF SOLIDS	4.1.1 Prisms a) Rectangular Prisms b) Hexagonal Prisms 4.1.2a Square Pyramid 4.1.2b Hexagonal Pyramid 4.1.3 Cylinders	4.2.1 Developing the objects; - Prism a) Rectangular Prism b) Hexagonal Prism 4.2.2a Square Pyramid 4.2.2b Hexagonal Pyramid 4.2.3 Cylinders	4.3 Assist trainees to develop the following objects; Prism a) Rectangular Prism b) Hexagonal Prism 4.3.2a Square Pyramid 4.3.2b Hexagonal Pyramid 4.3.3 Cylinders

CERTIFICATE TWO - TRADE DRAWING

TASK		CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
5.0	FREE HAND SKETCH (COMPONENTS)	5.1 Components of Engines; a) Crankshaft b) Piston c) Valve Timing diagram, etc	5.2 Engine components; a) Crankshaft b) Piston c) Valve Timing diagram, etc	5.3 Assist trainees in drawing the following engine components a) Crankshaft b) Piston c) Valve Timing diagram, etc
6.0	FREE HAND SKETCH HYDRAULIC (COMPONENTS)	6.1 Components of Hydraulic Graphic Symbols	6.2 A Hydraulic circuit using Hydraulic graphic symbols	6.3 Guide trainees to draw a Hydraulic circuit using Hydraulic graphic symbols
7.0.	GEOMETRICAL DRAWING	7.1 Solid Geometric e) Prisms f) Cylinders g) Pyramids h) Cone	7.2 Construction of the solid Geometrics e) Prisms f) Cylinders g) Pyramids h) Cone	7.3 Guide trainees to construct the following solid Geometrics e) Prisms f) Cylinders g) Pyramids h) Cone

CERTIFICATE TWO - PRACTICALS

TASK		CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
1.0	WORKSHOP SAFETY	1.1.1 Bench tools. 1.1.2 Marking out tools 1.1.3 Jacking and slinging devices 1.1.4 Safety Precaution	1.2 Marking out a piece of mild steel 1.2.1 Use of set square and radi gauge. 1.2.2 Use of set square and bevel protractor 1.2.3 Mark out round bar to ensure parallel faces. 1.2.4 Use of hammer and chisel to produce uniform surface.	1.3 Guide students to practice the following activities: 1.3.1 Guide students to mark out properly on a metal.
2.0	POWER TOOLS	2.1 Types of Power Tools Uses, care maintenance	2.2 Power Tools i) Power saw ii) Portable drilling machine iii) Impart wrendles iv) Hydraulic press, etc	2.3 Demonstrate/Guide students with the use of power tool to observe safety rules in carrying the task by demonstration.
3.0	HEAT TREATMENT OF METALS	3.1 The process of Heat treatment of metal	3.2 The process of Normalizing Annealing Hardening, Tempering	3.3 Discuss with the students the methods heat treatment of metals
4.0	DISMANTLING OF AN ENGINE	4.1 Measurement of Engine Components parts.	4.2 Precision instruments common to engine repair work. a. Dial Gauge b. Micrometer c. Venier Caliper d. Plastic gauge, etc	4.3 Guide students to correctly used in sub skills.

CERTIFICATE TWO - PRACTICALS

TASK		CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
5.0	DE-CARBONIZATION	5.1.1 De-carbonizing of valves, valve seats, combustion chambers. 5.1.2 Examine cylinder heads for cracks, valve seat wear.	5.2.1 Removal of carbon deposits from cylinder head piston head 5.2.2 Valve lapping.	5.3 Demonstrate/Guide students clean carbon deposits pistons and cylinder head. 5.3.1 Demonstrate/Guide the students to carry out valve lapping
6.0	ENGINE ASSEMBLING	6.1 Correct procedure for engine assembling.	6.2 Correct arrangement of Piston rings. 6.2.1 Passing of engine bearings. 6.2.2 Crank shaft with torque specification. 6.2.3 Fixing piston into bore with piston ring, compressor, etc	6.3 Demonstrate/Guide students to assemble the engine with the correct procedure.
7.0	VALVE TIMING	7.1 Valve adjustment	7.2 Correct size feeling gauge for inlet and exhaust valves	7.3 Demonstrate/Guide the students to carry out valve adjustment using the correct procedure.
8.0	DIESEL FUEL INJECTION PUMP	8.1 Injection Pump Timing	8.2 Timing the Injection Pump to the Engine provided, Noting <ul style="list-style-type: none"> • Advance Position • Retard Position 	8.3 Demonstrate/Guide students to carry out injection pump timing to the Engine with emphases on the <ul style="list-style-type: none"> • Advance Position • Retard Position
9.0	CLUTCH	9.1 Clutch Overhaul Procedure	9.2 Diagnose Clutch fault and effect repairs	9.3 Demonstrate/Guide the student to replace a faulty clutch.
10.0	STEERING CLUTCH	10.1 Overhauling steering clutch	10.2 Diagnosing steering Clutch faults and effect repairs.	10.3 Demonstrate/Guide students to replace the Clutch

CERTIFICATE TWO - PRACTICALS

TASK		CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
11.0	HEAVY DUTY MANUAL TRANSMISSING (GEAR BOX)	11.1 Overhauling of Heavy Duty, Manual Transmission.	11.2 Diagnosing faults and effect repairs of Manual Transmission	11.3 Demonstrate/Guide students to replace Manual Transmission
12.0	POWER SHIFT TRANSMISSION	12.1 Overhauling of Power shift Transmission.	12.2 Diagnosing faults and effect repairs of Power Shift Transmission	12.3 Demonstrate/Guide students to replace power shift transmission.
13.0	FINAL DRIVE	13.1 Overhauling of Final Drive.	13.2 Diagnosing faults and effect repairs of Final Drive of Transmission system.	13.3 Demonstrate/Guide students to replace Final Drive of Transmission system.
14.0	UNDER CARRIAGE	14.1 Under carriage Repairs.	14.2 Adjusting track tension, servicing roller idler alignment.	14.3 Demonstrate/Guide students to carry out adjustment of Track tension roller service, etc.
15.0	WHEELS AND TYRES	15.1 Removal of Tyres	15.2 Faulty tyres eg i) Under inflation ii) Over inflation iii) Wear	15.3 Demonstrate/Guide students to use Tyre Pressure gauge to test for under inflation and over inflation of Tyres.
16.0	HYDRAULIC CYLINDERS	16.1 Overhauling of Hydraulic Cylinders	16.2 Faults on hydraulic cylinders Repairing procedure	16.3 Guide students to carry out repairs.
17.0	CABLE CONTROL SYSTEM	17.1 Inspection of Cable Control System.	17.2 Faults on cable and replacement of the cable.	17.3 Guide students to carry out replacement of the Cable

**LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(PRACTICAL)**

NO	TOPIC	COGNITIVE KNOWLEDGE	AFFECTIVE UNDERSTANDING	PSYCHOMOTOR APPLICATION	TOTAL
1.	Workshop Safety			3	
2.	Power Tools			2	
3.	Heat Treatment of Metals		2		
4.	Engine Dismantling			2	
5.	Discarbonising		2	3	
6.	Engine Rebuilding		1	3	
7.	Value Timing		2	3	
8.	Diesel Injection Fuel Injection Pump			3	
9.	Value Adjustment			2	
10.	Clutch			3	
11.	Steering Clutch		1	3	
12.	Transmission Manual			2	
13.	Power Shift Transmission		1	3	
14.	Final Drive		1	3	
15.	Wheels and Tyres			3	
16.	Hydraulic Cylinders		1	2	
17.	Cable Control		2	3	

**LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(TRADE THEORY)**

NO	TOPIC	COGNITIVE KNOWLEDGE		AFFECTIVE UNDERSTANDING		PSYCHOMOTOR APPLICATION		TOTAL
		OBJ.	SUB.	OBJ.	SUB.	OBJ.	SUB.	
1.	Arc Welding	2	1	3	1	3	3	
2.	Bronze Welding	1	1	1	1	1	1	
3.	Engine Classification	3	2	3	2			
4.	Camshaft Arrangements	1	1	3	2			
5.	Crankshaft Arrangements	1	1	3	2			
6.	Valve Operating Mechanism	1	1	3	2			
7.	Valve Timing Diagram	2	1	2	1	3	2	
8.	Super chargers	2	1	2	1			
9.	Lubrication system	3	2	2	1	1	3	
10.	Lubrication oil additives	2	1	2	1			
11.	Cooling system components	2	1	1	1			
12.	Heat Exchanger	2	2	1	2			
13.	Off pump diesel	3	2					
14.	Fuel Injection Pump	2	1	1	2	1	3	
15.	Governors Diesel Fuel System	1	1	1	1	1	1	
16.	Phasing and Calibration			2	2	1	2	
17.	Injectors	2	1	2	1	2	1	
18.	Cold Starting Devices	2	1	2	1			
19.	Fluid Coupling and Torque Converters	2	2	1	1	2	1	
20.	Power shift transmission	2	2	1	1	2	2	
21.	Propeller Shaft and Universal joint	1	1	1	1			
22.	Rear Axle	2	1	2	1	3	1	
23.	Suspension System	2	1	2	1			
24.	Track Alignment	1	2	2	1	2	1	
25.	Undercarriage Components	2	1	2	1			

**LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(TRADE THEORY)**

NO	TOPIC	COGNITIVE KNOWLEDGE		AFFECTIVE UNDERSTANDING		PSYCHOMOTOR APPLICATION		TOTAL
		OBJ	SUB	OBJ	SUB	OBJ	SUB	
26.	Power Steering	2	1	2	1			
27.	Power Brakes (Air)	2	1	2	1			
28.	Actuators	2	1	2	1			
29.	Hydraulic pumps	2	1	2	3			
30.	Control valves	2	1	2	1			
31.	Hydraulic Accumulators	2	2	2	1			
32.	Oil Cooler	2	1	2	1			
33.	Hydrostatics	2	1	2	2			

**LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(TRADE SCIENCE AND CALCULATION)**

NO	TOPIC	COGNITIVE KNOWLEDGE	AFFECTIVE UNDERSTANDING	PSYCHOMOTOR APPLICATION	TOTAL
1.	Heat and temperature	1	1	2	
2.	Heat transfer	1	1	2	
3.	Stain and stress	1	1	2	
4.	Energy	1	1	2	
5.	Fuels and combustion	1	1	2	
6.	Moment	1	1	2	
7.	Gas law	1	1	2	
8.	Machines	1	1	2	
9.	Hydraulics	1	1	2	
10.	Friction	1	1	2	
11.	Linear motion	1	1	2	
12.	Engine power	1	1	2	
13.	Resolution of forces	1	1	2	
14.	Electricity calculation	1	1	2	

**LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(TRADE SCIENCE AND CALCULATION)**

NO	TOPIC	COGNITIVE KNOWLEDGE	AFFECTIVE UNDERSTANDING	PSYCHOMOTOR APPLICATION	TOTAL
1.	Geometrical drawing	1	1	2	
2.	Orthographic drawing	1	1	2	
3.	Sectional views	1	1	2	
4.	Development of solids	1	1	2	
5.	Freehand sketch		2	2	
6.	Freehand sketch on	2	2	2	
7.	Hydraulic components	1	1	1	