Level 2 Certificate/Diploma in Engineering Operations (Knowledge) (4510-11/12)

April 2025 Version 2.3

Test Specifications

Contents

1 Assessment

Summary of assessment methods

The mandatory unit 201 is assessed by an external short answer test, which is graded Pass/Fail only.

The optional units 202-247 are assessed by short answer tests, which are internally marked by centres and externally quality assured, with results being submitted to City & Guilds.

City & Guilds has produced guidance for centres to develop their own centre devised assessments for units 202-247, available from the City & Guilds website. (see separate Centre Devised Assessments guidance).

Centres may choose whether to create their own assessments, or use the assessments devised by City & Guilds.

- Examinations will be short answer questions
- There will be varying marks available per question
- The exams are typically between 1 and 1½ hours
- They will be graded Pass/Fail only

2 Test Specifications

Test specifications have been developed to ensure that there is a consistent and suitable range of difficulty of questions available and that sufficient coverage across the qualification content is maintained.

The test specifications outline how many marks will be available in each optional test for each learning outcome. The questions cover all the criteria within the outcome, so candidates must be prepared across the whole of the content as detailed in the qualification handbook.

The way the knowledge is covered by each test is laid out in the tables below.

Key:

AO1 - Knowledge (recall)
AO2 - Understanding

4510-202 Engineering techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand drawings used by engineering businesses	1.1 Explain types of drawings used in engineering	6		✓	26	65
	1.2 Describe information available on engineering drawings	6	✓			
	1.3 Describe the types of symbols used on engineering drawings	8	✓			
	1.4 Explain the benefits and limitations of Computer Aided Drawing (CAD) compared to manual drawing	6		✓		
2. Understand quality processes in engineering	2.1 Explain the principles of quality assurance and quality control	6		✓	14	35
	2.2 Explain the characteristics of quality assurance	2		✓		
	2.3 Explain the types and methods of quality control	6		✓		
	Total	40			40	100

4510-203 Engineering mathematics & science principles

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hours 30 minutes
Marks: 70
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand arithmetical and trigonometrical applications	1.1 Perform simple arithmetic operations on integers and decimal numbers	2		✓	15	21
	1.2 Determine fractions and percentages	4		✓		
	1.3 Use rules of arithmetical preference to solve simple equations	2		✓		
	1.4 Use a scientific calculator to determine numbers when raised to a given power	2		✓		
	1.5 Apply appropriate degree of accuracy to express numbers	2		✓		
	1.6 Solve simple trigonometrical problems	3		✓		
2. Know how to determine perimeters, areas and volumes of shapes	2.1 Identify 2D and 3D shapes	1	✓		15	21
	2.2 Describe properties of 2D shapes	2	✓			
	2.3 Apply Pythagoras' theorem	3		✓		
	2.4 Calculate perimeters of simple shapes	3		✓		
	2.5 Determine areas of 2D shapes	3		✓		
	2.6 Determine volumes of 3D shapes	3		✓		
3. Understand terminology used in engineering science	3.1 Describe common terms used in engineering science	4	✓		17	25
	3.2 Name the units used to quantify the terms used in engineering	4	✓			
	3.3 Perform calculations relating to the common terms used in engineering	9		✓		

4. Understand the effect of changes of temperature on engineering materials	4.1 Explain the difference between heat and temperature	2		✓	9	13
	4.2 Explain the effect of changes of temperature on the physical state of a material	2		✓		
	4.3 Explain the effect of changes of temperature on the dimensions of a material	2		✓		
	4.4 Perform simple calculations on the effect of temperature on materials	3		✓		
5.Understand the properties of engineering material	5.1 Describe the types of materials used in common engineering applications	4	✓		14	20
	5.2 Describe the physical properties of materials	4	✓			
	5.3 Explain the mechanical properties of materials	6		✓		
	Total	70			70	100

4510-204 Fitting and assembly techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Understand engineering health and safety requirements	1.1 Describe the legislation affecting health and safety in engineering	4	✓		20	40
	1.2 Describe safe working practices in engineering	8	✓			
	1.3 Explain the process for carrying out risk assessments	8		✓		
2. Understand fitting and assembly techniques	2.1 Explain considerations required when planning engineering workshop activities	6		✓	30	60
	2.2 Explain the purpose and limitations of equipment required for fitting and assembly	4		✓		
	2.3 Explain fitting and assembly operations	12		✓		
	2.4 Explain quality checks and the equipment used to carry them out	8		✓		
	Total	50			50	100

4510-205 Business improvement techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 30 minutes
Marks: 60
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Understand the concept of continuous improvement	1.1 Explain the meaning of continuous improvement	2		✓	20	33
	1.2 Describe continuous improvement strategies commonly used in engineering	4	✓			
	1.3 Explain benefits of applying continuous improvement techniques	6		✓		
	1.4 Define each stage of the plan–do–check–act (PDCA) improvement cycle	4	✓			
	1.5 Explain the categories of waste in relation to business improvement	4		✓		
2 Understand what is meant by workplace organisation	2.1 Explain the meaning of workplace organisation	2		✓	14	23
	2.2 Describe the benefits of having an organised working environment	2	✓			
	2.3 Explain the potential effects of a disorganised work environment	4		✓		
	2.4 Describe the 5S approach to workplace organisation	4	✓			
	2.5 Explain the importance of Standard Operating Procedures (SOPs) within workplace organisation	2		✓		
	3.1 Explain the meaning of visual management	2		✓		

3 Understand what is meant by visual management	3.2 Describe the benefits of applying good visual management	2	✓		10	17
	3.3 Describe different types of visual management	6	✓			
4 Understand problem solving techniques	4.1 Explain what is meant by a problem within a work environment	2		✓	16	27
	4.2 Describe the benefits of solving work related problems	2	✓			
	4.3 Describe different techniques used for identifying and analysing problems	10	✓			
	4.4 Explain the importance of applying the appropriate corrective action and eliminating the root cause of a problem	2		✓		
	Total	60			60	100

4510-206 Principles of turning and milling

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 2 hours
Marks: 80
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Know equipment required for turning and milling operations	1.1 Describe the characteristics and function of parts of a lathe	6	✓		34	43
	1.2 Describe the characteristics and function of parts of a milling machine	8	✓			
	1.3 Describe the characteristics and types of work holding devices	6	✓			
	1.4 Describe cutting tools and their purpose	8	✓			
	1.5 Describe the characteristics and use of measuring equipment	6	✓			
2. Understand how to produce manually machined components	2.1 Describe safety issues and control measures associated with manual machining	8	✓		32	40
	2.2 Describe the characteristics of different types of machined features	10	✓			
	2.3 Describe alignment techniques for work holding devices and work pieces	4	✓			
	2.4 Describe the techniques for mounting cutting tools	4	✓			

	2.5 Explain how the process parameters vary for different materials and components	4		✓		
3. Understand how to meet quality requirements for machining operations	3.1 Describe methods of monitoring machine performance	6	✓		14	17
	3.2 Describe methods of evaluating machined components against specification requirements	10		✓		
	Total	80			80	100

4510-207 Manual turning techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Know the equipment required for turning operations	1.1 Describe the characteristics and function of parts of a lathe	6	✓		18	36
	1.2 Describe the characteristics and types of work holding devices	4	✓			
	1.3 Describe cutting tools and their purpose	4	✓			
	1.1 Describe the characteristics and use of measuring equipment	4	✓			
2 Understand how to produce turned components on a lathe	2.1 Describe safety issues associated with the use of a lathe and control measures	6	✓		22	44
	2.2 Describe the characteristics of different types of turned features	4	✓			
	2.3 Describe alignment techniques for work holding devices alignment techniques for work holding devices and work pieces	4	✓			
	2.1 Describe the techniques for mounting cutting tools	4	✓			
	2.5 Explain how the process parameters vary for different materials and component dimensions	4		✓		

3 Understand how to meet quality requirements for turning operations	3.1 Describe methods of monitoring machine performance	4	✓		10	20
	3.2 Describe methods of evaluating turned components against specification requirements	6		✓		
	Total	50			50	100

4510-208 Manual milling techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Know the equipment required for milling operations	1.1 Describe the characteristics and function of parts of a milling machine	6	✓		18	36
	1.2 Describe the characteristics and types of work holding devices	4	✓			
	1.3 Describe cutting tools and their purpose	4	✓			
	1.4 Describe the characteristics and use of measuring equipment	4	✓			
2 Understand how to produce components on a milling machine	2.1 Describe safety issues associated with the use of a mill and control measures	6	✓		22	44
	2.2 Describe characteristics of different types of milled features	4	✓			
	2.3 Explain alignment techniques for work holding devices and work pieces	4		✓		
	2.4 Describe the techniques for mounting cutting tools	4	✓			
	2.2 Explain how the process parameters vary for different materials and components	4		✓		

3 Understand how to meet quality requirements for milling operations	3.1 Describe methods of monitoring machine performance	4	✓		10	20
	3.2 Describe methods of evaluating milled components against specification requirements	6		✓		
	Total	50			50	100

4510-209 Grinding techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Know the equipment required for grinding operations	1.1 Identify types of grinding machines and their differences	4	✓		20	40
	1.2 Identify characteristics and function of parts of grinding machines	4	✓			
	1.3 Describe characteristics, function and limitations of work holding devices	4	✓			
	1.4 Identify characteristics, function and limitations of abrasive wheels	4	✓			
	1.5 Describe characteristics, function and limitations of measuring equipment	4	✓			
2 Understand how to produce components on grinding machines	2.1 Describe safety issues and training requirements associated with the use of grinding machines	6	✓		20	40
	2.2 Identify components to be produced and wheel selection	4	✓			
	2.3 Identify techniques for securing work holding devices	2	✓			
	2.4 Identify methods of balancing and mounting abrasive wheels	4	✓			
	2.5 Identify methods of maintaining abrasive wheels	2	✓			

	2.6 Explain the principles of planning grinding operations	2		✓		
3 Understand how to meet quality requirements for grinding operations	3.1 Describe monitoring of machine performance	4	✓		10	20
	3.2 Identify defects and methods of rectifying them	4	✓			
	3.3 Describe how to evaluate ground components against specification requirements	2		✓		
	Total	50			50	100

4510-210 Principles of CNC machining/fabrication

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the equipment available for CNC fabrication operations	1.1 Describe the types of equipment available for CNC fabrication	4	✓		24	48
	1.2 Explain the function and characteristics of CNC fabrication equipment	14		✓		
	1.3 Explain the health and safety requirements specific to CNC equipment	6		✓		
2. Understand the programming of CNC fabrication machinery	2.1 Describe manual data programming of CNC fabrication machinery	10	✓		16	32
	2.2 Describe remote programming of CNC fabrication machinery	6		✓		
3. Understand the benefits and limitations of using CNC fabrication machinery	3.1 Explain the benefits and limitations related to component quality	6		✓	10	20
	3.2 Explain the benefits related to efficiency	4		✓		
	Total	50			50	100

4510-211 CNC turning techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Know the equipment required for CNC turning operations	1.1 Identify the characteristics and function of parts of a CNC lathe	8	✓		24	48
	1.2 Identify characteristics and function of work holding devices	2	✓			
	1.3 Describe characteristics of cutting tools	8	✓			
	1.4 Explain characteristics and limitations of measuring equipment	6		✓		
2. Understand how to produce turned components on a CNC lathe	2.1 Identify safety issues and control measures associated with the use of a CNC lathe	6	✓		20	40
	2.2 Describe characteristics of turned features	6	✓			
	2.3 Identify techniques for mounting cutting tools	2	✓			
	2.4 Describe different methods of inputting CNC programs	4	✓			
	2.5 Explain principles of planning CNC turning operations	2		✓		
3. Understand quality requirements for CNC turning operations	3.1 Describe ways to monitor machine performance	4	✓		6	12
	3.2 Describe ways to evaluate turned components against specification requirements	2		✓		
	Total	50			50	100

4510-212 CNC milling techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Know the equipment required for CNC milling operations	1.1 Identify characteristics and function of parts of CNC mills	6	✓		22	44
	1.2 Identify characteristics, function and limitations of work holding devices	4	✓			
	1.3 Describe characteristics and limitations of cutting tools	6	✓			
	1.4 Explain characteristics and limitations of measuring equipment	6		✓		
2. Understand how to produce components on a CNC mill	2.1 Identify safety issues and control measures associated with the use of a CNC mill	6	✓		22	44
	2.2 Describe characteristics of different types of milled features	6	✓			
	2.3 Identify techniques for securing work holding devices	2	✓			
	2.4 Identify techniques for mounting cutting tools	2	✓			
	2.5 Describe different methods of inputting CNC programs	4	✓			
	2.6 Explain the principles of planning CNC milling operations	2		✓		
3. Understand quality requirements for CNC milling operations	3.1 Describe ways to monitor machine performance	4	✓		6	12
	3.2 Describe ways to evaluate milled components against specification requirements	2		✓		
	Total	50			50	100

4510-213 Computer aided design (CAD)

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principles of using a CAD system	1.1 Explain the health & safety requirements for a safe CAD working environment	6		✓	24	48
	1.2 Describe applications of CAD software	4		✓		
	1.3 Identify current standards used for CAD drawing	2	✓			
	1.4 Explain the purpose of storage and data management	4		✓		
	1.5 Describe the benefits and limitations of using CAD software compared to manual drawing	8	✓			
2. Know the main capabilities of CAD software	2.1 Describe the key operating features of CAD software	10	✓		26	52
	2.2 Describe the key operating features used in part modelling	8	✓			
	2.3 Describe the key operating features used in assembly modelling	8	✓			
	Total	50			50	100

4510-214 Electrical and electronic principles

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand electrical and electronic circuit principles	1.1 Explain electrical and electronic terms, laws and theorems	6		✓	8	20
	1.2 Explain types of electrical current and their advantages/disadvantages	2		✓		
2. Understand the units of measurement used to quantify electrical parameters	2.1 State the SI units used to measure electrical parameters	3	✓		7	18
	2.2 Convert units to different multiples and submultiples	4		✓		
3. Understand methods of calculating values in electrical and electronic circuits	3.1 Calculate values using Ohm's law	6		✓	25	62
	3.2 Calculate values using Watt's law	3		✓		
	3.3 Calculate resistance in series and parallel circuits	6		✓		
	3.4 Determine values using the resistor colour code	4		✓		
	3.5 Calculate electrical energy transferred in a circuit	3		✓		
	3.6 Calculate the efficiency of an electrical appliance	3		✓		
	Total	40			40	100

4510-215 Electrical and electronic testing methods

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Understand the units of measurement used to quantify electrical parameters	1.1 Explain electrical and electronic laws and theorems	6		✓	14	28
	1.2 State the SI units used to measure electrical parameters	4	✓			
	1.3 Convert units to different multiples and submultiples	4		✓		
2 Understand the applications of electrical and electronic test equipment	2.1 Describe the characteristics of waveform signal types	8	✓		24	48
	2.2 Explain the purpose and benefits/limitations of test equipment	8		✓		
	2.3 Describe how test equipment is used to measure electrical parameters	8	✓			
3 Understand electrical and electronic test equipment calibration techniques	3.1 Explain the principles of test equipment calibration	6		✓	12	24
	3.2 Describe procedures used to validate test equipment functionality	6	✓			
	Total	50			50	100

4510-216 Electrical and electronic systems and devices

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1 Understand the functions of electrical and electronic components and devices	1.1 Describe the functions and applications of input, process, output and interface devices	12		✓	24	60
	1.2 Describe the functions and applications of passive components	6		✓		
	1.3 Explain advantages/disadvantages of programmable microcontrollers	6		✓		
2 Understand methods of representing electrical and electronic systems	2.1 Explain the purpose of types of diagrams used to represent electrical and electronic systems	6		✓	16	40
	2.2 Interpret symbols and abbreviations (to current industry standards) of components used in circuit schematics	10	✓			
	Total	40			40	100

4510-217 Fabrication and welding principles

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the equipment available to produce fabricated components	1.1 Describe the types of equipment available for marking out	4	✓		14	28
	1.2 Describe the types and purpose of datums	2	✓			
	1.3 Explain marking out methods for a range of features	4		✓		
	1.4 Describe fabrication hand tools, equipment and their application	4		✓		
2. Understand cutting and forming methods used for fabrication	2.1 Describe the principles that underpin cutting by shear methods	4	✓		18	36
	2.2 Describe equipment used for cutting by shear and their applications	4		✓		
	2.3 Describe the principles that underpin chip forming cutting methods	4	✓			
	2.4 Describe equipment used for chip forming cutting and their applications	2		✓		
	2.5 Describe types of forming equipment available for fabrication and their application	4		✓		

3. Understand the joining and assembly methods for fabrication	3.1 Describe non-thermal permanent joining methods and their applications	2		✓	18	36
	3.2 Describe non-thermal temporary joining methods and their applications	2		✓		
	3.3 Describe thermal fusion joining methods and their applications	6		✓		
	3.4 Describe thermal non-fusion joining methods and their applications	4		✓		
	3.5 Describe assembly methods for fabrication and their applications	4		✓		
	Total	50			50	100

4510-218 Manual welding techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 2 hours
Marks: 70
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand safe working practices associated with welding processes	1.1 Describe Personal Protective Equipment (PPE) used in welding processes	8	✓		12	17
	1.2 Describe hazards associated with welding processes and ways of minimising them		✓			
	1.3 Explain the importance of restoring the work area and following correct procedures for waste disposal	2		✓		
	1.4 Describe post welding activities	2	✓			
2. Understand principles of manual welding	2.1 Describe the function of equipment used for preparing and finishing welded joints	4	✓		20	29
	2.2 Explain different joint types and welding position	4		✓		
	2.3 Explain different welding techniques	4		✓		
	2.4 Describe assembly and distortion control method	4	✓			
	2.5 Describe a weld procedure specification	2	✓			
	2.6 Describe the weldability of common materials	2	✓			
3. Understand the Manual Metal Arc	3.1 Describe the major components of welding equipment	2	✓		6	9

(MMA) welding process	3.2 Describe different types of electrodes and storage requirements	2	✓			
	3.3 Describe the parameters for welding	2		✓		
4. Understand the Metal Inert Gas/Metal Active Gas (MIG/MAG) welding processes	4.1 Describe the major components of welding equipment	2	✓		10	14
	4.2 Describe different types of filler wire and storage requirements	2	✓			
	4.3 Identify shielding gases for MIG/MAG welding	2	✓			
	4.4 Explain the parameters for welding	4		✓		
5. Understand the Tungsten Inert Gas (TIG) welding process	5.1 Describe the major components of welding equipment	2	✓		10	14
	5.2 Describe types of tungsten electrodes and their sizes	2	✓			
	5.3 Describe different filler wires and storage requirements	2	✓			
	5.4 Identify shielding gases for TIG welding process	2	✓			
	5.5 Describe the parameters for welding	2		✓		
6. Understand inspection methods for weld defects	6.1 Explain the cause of weld defects and how their occurrence can be reduced	4		✓	12	17
	6.2 Explain quality assessment techniques	4		✓		
	6.3 Describe workshop destructive testing techniques	4	✓			
	Total	70			70	100

4510-219 Producing components from metal plate

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand tools and equipment used to produce metal plate components	1.1 Describe tools and equipment available for marking out and their applications	6		✓	18	36
	1.2 Explain marking out methods for a range of features	6		✓		
	1.3 Explain the importance of datums when marking out	2		✓		
	1.4 Describe metal plate hand tools, equipment and their applications	4		✓		
2. Understand cutting methods for metal plate	2.1 Describe equipment used for cutting by shear and their application	6		✓	12	24
	2.2 Describe equipment used for chip forming and their application	6		✓		
3. Understand forming methods for metal plate	3.1 Describe the process of forming of metals	2	✓		6	12
	3.2 Describe forming equipment and their applications	4		✓		
4. Understand joining and assembly methods for metal plate	4.1 Describe non-thermal temporary joining methods and their applications	2		✓	14	28
	4.2 Describe thermal fusion joining methods and their applications	6		✓		

	4.3 Explain assembly methods for fabrication and their applications	6		✓		
	Total	50			50	100

4510-220 Producing components from sheet metal

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions#
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand tools and equipment used to produce sheet metal components	1.1 Describe tools and equipment available for marking out and their applications	6		✓	16	32
	1.2 Explain marking out methods for a range of features	6		✓		
	1.3 Explain the importance of datums when marking out	2		✓		
	1.4 Describe sheet metal hand tools, equipment and their applications	2		✓		
2. Understand cutting methods for sheet metal	2.1 Describe equipment used for cutting by shear and their application	4		✓	8	16
	2.2 Describe equipment used for chip forming and their application	4		✓		
3. Understand forming methods for sheet metal	3.1 Describe the processes of forming metals	2	✓		10	20
	3.2 Describe forming equipment and their applications	4		✓		
	3.3 Describe methods of stiffening sheet metal	4	✓			
4. Understand joining and assembly methods for sheet metal	4.1 Describe non-thermal permanent joining methods and their applications	2		✓	16	32
	4.2 Describe non-thermal temporary joining methods and their applications	2		✓		

	4.3 Describe thermal fusion joining methods and their applications	4		✓		
	4.4 Describe thermal non-fusion joining methods and their applications	2		✓		
	4.5 Explain assembly methods for fabrication and their applications	6		✓		
	Total	50			50	100

4510-221 Principles of sheet and plate metal work technology

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand methods of work organisation	1.1 Describe preparations before commencing metal work tasks	10	✓		14	28
	1.2 Explain the use of nesting to minimise waste	4		✓		
2. Understand cutting and forming principles	2.1 Explain the principles of cutting by shear	6		✓	24	48
	2.2 Describe how cutting by shear principles are applied to metal working equipment	6	✓			
	2.3 Explain the principles of chip forming	6		✓		
	2.4 Describe how chip forming principles are applied to metal working equipment	6		✓		
3. Know pattern development techniques	3.1 Describe methods of parallel line pattern development	4	✓		12	24
	3.2 Describe methods of radial line pattern development	4	✓			
	3.3 Describe methods of triangulation pattern development	4	✓			
	Total	50			50	100

4510-222 Non-Fusion thermal joining methods

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the soft soldering method of joining metals	1.1 Describe the principles of soft soldering	6		✓	15	30
	1.2 Describe the consumables used for soft soldering	2	✓			
	1.3 Describe soft soldering heat sources	2	✓			
	1.4 Describe the stages required to complete a soft soldered joint	5	✓			
2. Understand the hard-soldering method of joining metals	2.1 Describe the principles of hard soldering	6		✓	15	30
	2.2 Describe the consumables used for hard soldering	2	✓			
	2.3 Describe hard soldering heat sources	2	✓			
	2.4 Describe the stages required to complete a hard-soldered joint	5	✓			
3. Understand the use of adhesives to join materials	3.1 Describe the principles of joining using adhesives	6	✓		20	40
	3.2 Explain types of adhesives used to join materials and their applications	4		✓		
	3.3 Describe the stages to complete an adhesive joint	4	✓			
	3.4 Describe the applications of sealants in engineering	6	✓			
	Total	50			50	100

4510-223 Thermal cutting techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principle of oxy-fuel thermal cutting	1.1 Explain the principle of oxy-fuel thermal cutting	4		✓	26	65
	1.2 Identify the types of gases available for oxy-fuel thermal cutting	2	✓			
	1.3 Describe the flame used for oxy-fuel thermal cutting	6	✓			
	1.4 Describe the equipment used for oxy-fuel thermal cutting	6	✓			
	1.5 Describe the safe use and applications of oxy-fuel cutting	8		✓		
2. Understand the principle of plasma cutting	2.1 Explain the principle of plasma cutting	4		✓	8	20
	2.2 Describe the equipment used for plasma cutting	4	✓			
3. Understand the principle of laser cutting	3.1 Explain the principle of laser cutting	2		✓	6	15
	3.2 Describe the equipment used for laser cutting	4	✓			
	Total	40			40	100

4510-224 Engineering maintenance safety

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand safe working practices, tools and equipment for maintenance activities	1.1 Describe health and safety in engineering maintenance	10	✓		30	75
	1.2 Describe the hazards associated with maintenance activities	4	✓			
	1.3 Describe equipment used for working at height	4	✓			
	1.4 Describe different types of lifting equipment	4	✓			
	1.5 Describe safe lifting methods/techniques	4		✓		
	1.6 Describe methods for moving heavy equipment across flat surfaces	4	✓			
2. Know how to clean and restore work areas following maintenance activities	2.1 Identify procedures for cleaning work areas following a spillage or leakage	6	✓		10	25
	2.2 Describe how to restore the work area following maintenance activities	4	✓			
	Total	40			40	100

4510-225 Engineering maintenance techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand fault diagnostic methods	1.1 Describe diagnostic methods used for fault finding	10		✓	14	28
	1.2 Describe diagnostic aids used in fault finding	4	✓			
2. Understand measuring systems and instrumentation	2.1 Describe how measuring equipment is used for maintenance operations	8		✓	10	20
	2.2 Identify instrumentation used in maintenance	2	✓			
3. Understand how plant and equipment is maintained	3.1 Explain preparation required for maintenance operations	10		✓	26	52
	3.2 Describe safe use of tools	4	✓			
	3.3 Describe joining and bonding processes used in maintenance operations	8	✓			
	3.4 Describe dismantling and reassembly methods	4	✓			
	Total	50			50	100

4510-226 Engineering maintenance planning

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand different types of planned maintenance	1.1 Describe different types of planned maintenance	8	✓		18	36
	1.2 Explain the importance of planned preventative maintenance	6		✓		
	1.3 Describe sources of data used in condition based monitoring	4	✓			
2. Understand health and safety requirements for planning maintenance activities	2.1 Describe the purpose of a risk assessment for a maintenance activity	8		✓	12	24
	2.2 Identify legislation relevant to planning maintenance activities	4	✓			
3. Understand the planning of maintenance activities	3.1 Explain the considerations when planning for maintenance activities	8		✓	20	40
	3.2 Explain the planning process for maintenance activities	6		✓		
	3.3 Describe types of resources required for planned maintenance	6	✓			
	Total	50			50	100

4510-227 Engineering materials

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 30 minutes
Marks: 60
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the properties of materials	1.1 Explain the difference between mechanical and physical properties	2		✓	24	40
	1.2 Describe the relative mechanical properties, physical properties, sustainability and applications of a range of materials	12		✓		
	1.3 Describe how the mechanical properties of materials are measured	4	✓			
	1.4 Explain the typical characteristics shown on a load-extension graph during the tensile testing of different types of materials	6		✓		
2. Understand methods by which the properties of materials can be changed	2.1 Explain the effect of cold working on the mechanical properties of materials	4		✓	12	20
	2.2 Explain how heat treatment affects the microstructure and properties of metals	8		✓		
3. Understand failure mechanisms in materials	3.1 State the type of process that causes corrosion	1	✓		24	40
	3.2 Explain how corrosion can cause the failure of a metal part	4		✓		
	3.3 Explain methods that can be used to manage corrosion in ferrous metals	7		✓		
	3.4 Explain the causes of fatigue in metals and how the risk of this can be reduced	6		✓		

	3.5 Explain the causes of material failure due to creep and how the risk of this can be reduced	6		✓		
	Total	60			60	100

4510-228 Electrical installation methods, wiring and circuit protection

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principles of electrical circuit wiring	1.1 State the regulations that apply to electrical installation	2	✓		16	32
	1.2 Describe the characteristics and applications of cable types	6		✓		
	1.3 Explain the purpose of documentation required for electrical installations	8		✓		
2. Know electrical installation and wiring methods	2.1 Describe the methods used to install electrical circuits, cables and wiring systems	14	✓		26	52
	2.2 Describe the tools and equipment used in electrical installations and their purpose	6	✓			
	2.3 Describe cable termination methods	6	✓			
3. Understand the applications of electrical circuit protection devices	3.1 Explain the purpose and applications of circuit protection devices	4		✓	8	16
	3.2 Explain the factors that affect the selection of circuit protection devices	4		✓		
	Total	50			50	100

4510-229 Electrical circuit inspection, testing and fault diagnosis

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand safe electrical isolation procedures	1.1 Explain the dangers of electricity and mains voltage	4		✓	10	20
	1.2 Explain the need to safely isolate circuits	2		✓		
	1.3 Describe the methods used to safely isolate circuits	4	✓			
2. Understand methods of inspecting, testing and fault-finding electrical circuits	2.1 Describe preparatory activities required prior to testing electrical circuits	6	✓		34	68
	2.2 Describe methods of testing electrical circuits	12	✓			
	2.3 Explain the symptoms and causes of typical faults in electrical circuits	8		✓		
	2.4 Describe fault diagnosis techniques	8	✓			
3. Know standards and guidance relating to electrical testing and fault diagnosis	3.1 State the regulations and requirements that apply to electrical testing and fault diagnosis	2	✓		6	12
	3.2 Describe the markers/labels used to identify wiring and cables	4	✓			
	Total	50			50	100

4510-230 Building services engineering pipework fixing, bending and jointing methods

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the materials used in domestic pipework applications	1.1 State the materials used for domestic pipework applications	4	✓		4	8
	1.2 Explain the typical applications of pipes made from different materials			✓		
2. Understand methods of bending pipework	2.1 Calculate dimensions and measurements from scaled drawings and diagrams	2		✓	6	12
	2.2 Describe methods of producing different types of bends in copper pipes	4	✓			
	2.3 Explain techniques used to determine and achieve bend dimensions when using different methods			✓		
	2.4 Describe methods of bending plastic pipework		✓			
3. Understand methods of joining pipes	3.1 Describe methods used to join copper pipes	4	✓		10	20
	3.2 Explain the advantages and disadvantages of the different joining methods used with copper pipes			✓		
	3.3 Describe fittings used with plastic pipework and their applications	2	✓			
	3.4 Describe methods of installing fittings used with plastic pipework		✓			
	3.5 Describe methods of checking that fittings are sufficiently tight prior to testing	4	✓			

	3.6 Identify faults in fittings		✓			
4. Understand methods of fixing pipework to the fabric of a building	4.1 Describe fixing devices and their applications	2	✓		16	32
	4.2 Identify the tools and equipment required to install basic pipework systems	2	✓			
	4.3 Describe methods of preparing building construction features for the installation of pipework systems	2	✓			
	4.4 Describe methods of allowing for thermal movement of pipework	2	✓			
	4.5 Describe methods of marking out for horizontal and vertical clips for copper pipework	6	✓			
	4.6 Describe methods of fixing clips and brackets		✓			
	4.7 Explain safety considerations when drilling and fixing clips and brackets			✓		
	4.8 Describe methods of restoring the fabric of the building after installation, where required	2	✓			
5. Understand methods of testing domestic pipework	5.1 Explain the importance of a visual inspection being carried out prior to filling a pipework system with water	8		✓	14	28
	5.2 Describe the British standard soundness test		✓			
	5.3 Describe the method used to test a pipework for tightness		✓			
	5.4 Describe the equipment used for pressure testing		✓			
	5.5 Describe the method used to carry out a pressure test on pipework		✓			
	5.6 Explain the actions to be taken if pipework fails a test			✓		

	5.7 Explain how water pressure and flow rate is measured and recorded	4		✓		
	5.8 Describe the typical water pressures required for domestic premises and problems arising from low water pressure		✓			
	5.9 Explain safety considerations when testing pipework	2		✓		
	Total	50			50	100

4510-231 Building services engineering pipework fabrication processes and techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand pipework fabrication and installation methods	1.1 Describe the purpose and applications of tools used in pipework fabrication and installation	4	✓		24	48
	1.2 Describe materials used for pipework applications and their typical sizes	4		✓		
	1.3 Describe functions and applications of pipework fittings	4		✓		
	1.4 Describe methods of jointing copper pipework	6	✓			
	1.5 Describe methods of jointing low carbon steel pipework		✓			
	1.6 Describe methods of jointing plastic pipework for different applications		✓			
	1.7 Describe methods of bending pipework made from different materials	4	✓			
	1.8 Describe methods of preparing construction features for pipework installation	2	✓			
2. Understand methods of supporting domestic pipework	2.1 Describe marking out methods for pipework fixings and brackets	10	✓		10	20
	2.2 Describe the applications of fixing devices			✓		
	2.3 Describe the purpose and applications of clips and brackets			✓		

	2.4 Describe methods of installing fixings and brackets for pipework		✓			
3. Understand methods of testing domestic pipework	3.1 Explain the importance of a visual inspection being carried out prior to filling a pipework system with water	12		✓	16	32
	3.2 Describe the British standard soundness test		✓			
	3.3 Describe the method used to test a pipework for tightness		✓			
	3.4 Describe the equipment used for pressure testing		✓			
	3.5 Describe the method used to carry out a pressure test on pipework		✓			
	3.6 Explain the actions to be taken if pipework fails a test			✓		
	3.7 Explain safety considerations when testing pipework	4		✓		
	Total	50			50	100

4510-232 Building services pipework systems

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand hot and cold water supply systems used for domestic plumbing	1.1 Outline the main requirements of regulations and standards for domestic water supply	4	✓		16	32
	1.2 Explain the importance of complying with the regulations and standards			✓		
	1.3 Describe the types of water supply systems used for domestic plumbing	8	✓			
	1.4 Identify the main components in water supply systems		✓			
	1.5 Describe the layouts of different water supply systems		✓			
	1.6 Identify the symbols used to represent components on system layout drawings		✓			
	1.7 Explain the basic operation of water supply systems, including their advantages and disadvantages	4		✓		
2. Understand the principles of central heating systems	2.1 Identify the layouts of central heating systems	4	✓		12	24
	2.2 Describe the operating principles of central heating systems		✓			
	2.3 Explain the difference between traditional and condensing boilers	2		✓		
	2.4 Explain the operating principles of controls used on central heating systems	2		✓		

	2.5 Describe methods of attaching radiators and pipework to walls and boards	4	✓			
	2.6 Describe methods of bending copper pipe to required angles		✓			
	2.7 Describe methods of joining copper pipes together		✓			
3. Understand above ground discharge systems	3.1 Identify the layouts of above ground discharge systems	6	✓		10	20
	3.2 Explain the advantages and disadvantages of different system types			✓		
	3.3 Explain system design considerations			✓		
	3.4 Explain the causes of issues that can occur in discharge systems and how these can be avoided	2		✓		
	3.5 Describe the air test used for sanitary pipework including consideration of parameters	2	✓			
4. Understand energy and environmental issues arising from heating and water usage	4.1 Explain the importance of energy conservation in the home	2		✓	12	24
	4.2 Describe sources of heat losses from domestic buildings	2	✓			
	4.3 Identify methods of conserving energy in the home	4	✓			
	4.4 Describe common insulation methods for buildings		✓			
	4.5 Explain the importance of conserving water	4		✓		
	4.6 Describe ways to minimise water usage		✓			
	Total	50			50	100

4510-233 Building services engineering systems and their layout requirements

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1.Understand types of cold water systems used in domestic buildings	1.1 Outline the main requirements of current regulations and standards for domestic water supply	2	✓		16	32
	1.2 Explain the importance of complying with the regulations and standards			✓		
	1.3 Describe the requirements of the pipework system between the water main and the main internal stop valve in a domestic building	4	✓			
	1.4 Explain the importance of correct water pressure	2		✓		
	1.5 Describe the types of cold water systems used in domestic plumbing and their benefits/limitations	6	✓			
	1.6 Interpret layout diagrams of cold water systems		✓			
	1.7 Explain the causes of backflow in cold water systems	2		✓		
2. Understand types of hot water systems used in domestic buildings	2.1 Explain the factors that affect the selection of hot water systems	6		✓	10	20
	2.2 Describe the types of hot water systems used in domestic plumbing and their benefits/limitations		✓			
	2.3 Interpret layout diagrams of hot water systems		✓			
	2.4 Describe the purpose of pipes used in open vented hot water systems	2	✓			

	2.5 Explain the causes of backflow in hot water systems	2		✓		
3. Understand the principles of central heating systems	3.1 Identify the layouts of central heating systems	6	✓		10	20
	3.2 Describe the operation of central heating systems		✓			
	3.3 Describe the operation and requirements of gas-fired boilers			✓		
	3.4 Describe the operation of flues	4	✓			
4. Understand types of sanitary pipework systems	4.1 Describe the operation and applications of sanitary pipework systems	2	✓		10	20
	4.2 Explain the implications of trap seal loss	2		✓		
	4.3 Describe the system layout features for the wet portion of the discharge stacks	6	✓			
	4.4 Describe the system layout features for branch discharge pipework		✓			
5. Understand energy sources used in the building services industry	5.1 Describe types of energy sources	4	✓		4	8
	5.2 Explain the benefits and limitations of low and zero carbon energy sources			✓		
	Total	50			50	100

4510-234 Installation and servicing of refrigeration equipment

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 30 minutes
Marks: 60
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principles of thermodynamics	1.1 Convert values between temperature scales	2		✓	17	28
	1.2 Define the laws of thermodynamics	4	✓			
	1.3 Describe the concept of heat as energy in transition		✓			
	1.4 Describe how heat is transferred		✓			
	1.5 Describe latent heat processes	2	✓			
	1.6 Describe sensible heat processes		✓			
	1.7 Calculate the rate of heat transfer	3		✓		
	1.8 Explain the implications of the ideal gas laws	4		✓		
	1.9 Describe the impact of changing pressures on saturation temperatures for different substances			✓		
	1.10 Explain the vapour compression cycle in single stage refrigeration			✓		
	1.11 Determine variables using a pressure-enthalpy diagram	2		✓		
2. Understand the operating principles and controls for refrigeration systems	2.1 Describe the operating principles of refrigeration systems and their application	2		✓	11	18
	2.2 Describe the range of refrigeration systems in common use	2	✓			
	2.3 Describe the operating principles of the system controls	7	✓			

	2.4 Describe the operating principles for defrost systems		✓			
	2.5 Describe control circuits used for refrigeration systems		✓			
3. Understand the principles of installing refrigeration systems	3.1 Describe the information required to plan the activities	8	✓		22	37
	3.2 Describe the roles and responsibilities of persons involved in installation		✓			
	3.3 Explain the safety considerations required for the installation			✓		
	3.4 Identify the services required for the installation		✓			
	3.5 Describe the methods used to form and join pipework	4	✓			
	3.6 Describe methods of applying insulation to pipework systems	2	✓			
	3.7 Describe methods of fixing and terminating different types of cabling	2	✓			
	3.8 Identify test instruments and state their purpose	4	✓			
	3.9 Describe how installation activities are documented	2	✓			
4. Understand the principles of maintaining and servicing refrigeration systems	4.1 Describe maintenance requirements for refrigeration systems	4	✓		10	17
	4.2 Identify sources of information which aid service and maintenance of refrigeration systems	2	✓			
	4.3 Identify faults resulting from the failure of components and their symptoms	2	✓			
	4.4 Describe how maintenance and servicing activities are reported	2	✓			
	Total	60			60	100

4510-235 Installation and servicing of air-conditioning equipment

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 30 minutes
Marks: 60
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principles of thermodynamics	1.1 Convert values between temperature scales	2		✓	17	28
	1.2 Define the laws of thermodynamics	4	✓			
	1.3 Describe the concept of heat as energy in transition		✓			
	1.4 Describe how heat is transferred		✓			
	1.5 Describe latent heat processes	2	✓			
	1.6 Describe sensible heat processes		✓			
	1.7 Calculate the rate of heat transfer	3		✓		
	1.8 Explain the implications of the ideal gas laws	4		✓		
	1.9 Describe the impact of changing pressures on saturation temperatures for different substances			✓		
	1.10 Explain the vapour compression cycle in single stage refrigeration			✓		
	1.11 Determine variables using a pressure-enthalpy diagram	2		✓		
2. Understand the operating principles and controls for air-conditioning systems	2.1 Describe the operating principles of air-conditioning systems and their application	2		✓	11	18
	2.2 Describe the range of air conditioning systems in common use	2	✓			
	2.3 Describe the effect of air conditioning on its moisture content	2	✓			

	2.4 Describe the operating principles of the system controls	5	✓			
	2.5 Describe control circuits used for air-conditioning systems		✓			
3. Understand the principles of installing air-conditioning systems	3.1 Describe the information required to plan the activities	8	✓		22	37
	3.2 Describe the roles and responsibilities of persons involved in installation		✓			
	3.3 Explain the safety considerations required for the installation			✓		
	3.4 Identify the services required for the installation		✓			
	3.5 Describe the methods used to form and join pipework	4	✓			
	3.6 Describe methods of applying insulation to pipework systems	2	✓			
	3.7 Describe methods of fixing and terminating different types of cabling	2	✓			
	3.8 Identify test instruments and state their purpose	4	✓			
	3.9 Describe how installation activities are documented	2	✓			
4. Understand the principles of maintaining and servicing air-conditioning systems	4.1 Describe maintenance requirements for air-conditioning systems	4	✓		10	17
	4.2 Identify sources of information which aid service and maintenance of air-conditioning systems	2	✓			
	4.3 Identify faults resulting from failure of components and their symptoms	2	✓			
	4.4 Describe how maintenance and servicing activities are reported	2	✓			
	Total	60			60	100

4510-236 Installation of security systems

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 30 minutes
Marks: 60
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand types of security systems	1.1 Describe security systems and their application	10		✓	10	16
	1.2 Describe the operating principles of access control systems relating to the functional system elements		✓			
	1.3 Describe the methods used for access control		✓			
	1.4 Describe formats used for detection in alarm systems		✓			
	1.5 Explain the applications of CCTV			✓		
2. Understand circuit wiring and transmission paths	2.1 Explain the information needed about the site to support system design	2		✓	22	37
	2.2 Explain the requirement for primary and secondary power supplies	2		✓		
	2.3 Describe the operation of power supplies	4	✓			
	2.4 Describe the transmission of power in a security system		✓			
	2.5 Explain the difference between bonding and earthing	2		✓		
	2.6 State the practical applications of different cable types including limitations on their use	4	✓			
	2.7 Describe methods for overcoming the problems of induced noise (rfi/emi) in system cables	2	✓			
	2.8 Explain the advantages and disadvantages of linking system components to the system using different transmission methods	4		✓		
	2.9 Describe methods for cable fixing and containment	2	✓			

3. Understand the design considerations of security systems	3.1 State the basic principles of shock protection, circuit overload and short-circuit protection	2	✓		22	37
	3.2 State the function of circuit protection devices		✓			
	3.3 Describe how a self-latching relay can be used as a means of switching higher currents	2	✓			
	3.4 Describe the operating principles of the lock types used in access control systems	2	✓			
	3.5 Describe the purpose of detection devices in an alarm system and their output characteristics	2	✓			
	3.6 Explain the purpose of detection methods in an alarm system			✓		
	3.7 Identify the purpose of control and indicating equipment (CIE) in an alarm system	2	✓			
	3.8 Explain the requirements of standards and building regulations for the location of the CIE			✓		
	3.9 State the influence of legislation, standards and regulatory bodies on CCTV	2	✓			
	3.10 Explain the function of the main system elements of a CCTV system	4		✓		
	3.11 Describe the operating principles, location and siting for the sensors used in fire detection systems	4	✓			
	3.12 Describe the operating principles of common alarm output devices	2	✓			
4. Understand the testing requirements of a security system	4.1 State the purpose of test equipment and its applications	6	✓		6	10
	4.2 Describe the techniques for testing movement detection			✓		
	Total	60			60	100

4510-237 Installation of security systems

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand site planning for a security system	1.1 Describe the information needed prior to starting installation	6	✓		8	20
	1.2 Calculate dimensions and measurements from scaled drawings and diagrams			✓		
	1.3 Interpret schematic diagrams of security systems		✓			
	1.4 Identify electro technical symbols from working drawings and specifications		✓			
	1.5 Identify services which may be required for the installation	2	✓			
2. Understand safety considerations for installation	2.1 Describe the main stages of the risk assessment process	4	✓		12	30
	2.2 Explain the purpose of a method statement and permit to work			✓		
	2.3 Identify types of electrical supply systems and their features		✓			
	2.4 State the risks of electric shock when using extension leads and electrical tools/equipment	4	✓			
	2.5 Describe the basic principles of shock protection, circuit overload and short-circuit protection		✓			
	2.6 Describe methods of verifying and securing (locking off) isolation		✓			
	2.7 Describe safety precautions for working at heights	4	✓			

	2.8 Describe safety considerations and precautions for lifting and handling		✓			
	2.9 Describe procedures for safe storage of tools and equipment		✓			
	2.10 Describe how to dispose of waste appropriately		✓			
3. Know methods of installing security systems	3.1 Identify cable types and their applications	2	✓		14	35
	3.2 Describe methods of terminating cables	2	✓			
	3.3 Describe methods for cable fixing and containment	8	✓			
	3.4 State the requirements for installing wiring complete with specified mechanical protection between the control and indicating equipment (CIE) position and the point of detection		✓			
	3.5 Identify the tools and fixings required to locate, install and connect enclosures and equipment to various types of surface		✓			
	3.6 Describe the methods of installing different sensor devices		✓			
	3.7 Describe the methods of installing and protecting closed circuit wiring		✓			
	3.8 Describe the methods of restoring building fabric on completion of installation	2	✓			
4. Understand procedures for commissioning and handover	4.1 List the typical documentation required to perform system commissioning and system handover	6	✓		6	15
	4.2 State the stages and tests involved in electrical installation testing		✓			
	4.3 Identify test instruments and their purpose		✓			

	4.4 Describe the procedures for demonstrating and handing over a system to a customer			✓		
	Total	40			40	100

4510-238 Project management in engineering

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: I hour 30 minutes
Marks: 60
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the importance of project management	1.1 Explain the principles of project management	8		✓	14	23
	1.2 Explain the benefits of project management	6		✓		
2. Understand how to plan, monitor and review a project	2.1 Explain the potential constraints to a project	8		✓	46	77
	2.2 State the types of resources needed to carry out a project	4	✓			
	2.3 Describe the roles and responsibilities within projects	4	✓			
	2.4 Explain the methods used to plan projects and their advantages and disadvantages	10		✓		
	2.5 Explain risks associated with project management and risk mitigation actions	8		✓		
	2.6 Describe methods of monitoring projects	6	✓			
	2.7 Explain the reasons for reviewing projects on completion	6		✓		
	Total	60			60	100

4510-239 Applied mathematics in engineering

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 2 hours
Marks: 70
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Apply principles of algebra to solve engineering problems	1.1 Use equations to solve engineering problems requiring calculations	3		✓	11	16
	1.2 Manipulate equations and change the subject	4		✓		
	1.3 Simplify equations and functions	4		✓		
2. Apply principles of calculus and use graphs to solve engineering problems	2.1 Interpret graphs used in engineering systems	4		✓	26	37
	2.2 Plot and use graphs to represent variables in engineering systems	8		✓		
	2.3 Determine the equation of the relationship shown in a straight-line graph	4		✓		
	2.4 Differentiate simple functions	6		✓		
	2.5 Determine maximum and minimum values of functions using differentiation	4		✓		
3. Apply principles of trigonometry to solve engineering problems	3.1 Apply trigonometric relationships to determine the dimensions in a triangle	6		✓	15	21
	3.2 Select and use appropriate principles of trigonometry to solve engineering problem	4		✓		
	3.3 Convert between Cartesian and polar co-ordinates	5		✓		
4. Apply statistics to solve engineering problems	4.1 Determine averages and standard deviation for data sets	6		✓	18	26
	4.2 Explain how statistical data is used in quality control	8		✓		
	4.3 Explain the benefits and limitations of using statistical process control, relative to quantity of parts being manufactured	4		✓		
	Total	70			70	100

4510-240 Leading an engineering team

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand approaches to leading a team	1.1 Describe the roles and responsibilities of a team leader	4	✓		18	45
	1.2 Explain different leadership styles and their advantages and disadvantages	4		✓		
	1.3 Explain the different roles that exist within a team	6		✓		
	1.4 Explain how to work effectively within a team	4		✓		
2. Understand types of communication used in engineering businesses	2.1 Explain the principles of communication	2		✓	8	20
	2.2 Describe types of business documentation and their typical uses	4	✓			
	2.3 Describe types of ICT applications	2	✓			
3. Understand how to resolve problems and conflict in the workplace	3.1 Explain the difference between the root cause and symptoms of a problem	2		✓	14	35
	3.2 Describe methods used to resolve problems and conflict	6	✓			
	3.3 Explain the reasons for conflict in work situations and ways to avoid them	6		✓		
	Total	40			40	100

4510-241 Engineering manufacturing techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand how to prepare for manufacturing operations	1.1 Explain considerations for preparing and maintaining work areas	4		✓	16	32
	1.2 Describe checks required on receipt of materials	4	✓			
	1.3 Describe methods of material handling	4	✓			
	1.4 Describe safety factors when handling materials	4	✓			
2. Understand the principles of manufacturing operations	2.1 Describe the types of manufacturing process	6	✓		20	40
	2.2 Describe the different scales of production	4	✓			
	2.3 Describe the types of instructions used to undertake manufacturing operations	4	✓			
	2.4 Describe ways of monitoring and controlling the manufacturing processes	6	✓			
3. Understand factors that affect the efficiency of manufacturing	3.1 Describe the “Eight Wastes” that affect manufacturing	6	✓		14	28
	3.2 Describe methods of minimising the “Eight Wastes”	4	✓			
	3.3 Explain manufacturing issues and ways in which they may be minimised	4		✓		
	Total	50			50	100

4510-242 Engineering design techniques

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1.Understand the factors that affect the development of a product design specification (PDS)	1.1 Describe the information included in a design brief	4	✓		20	40
	1.2 Describe factors that influence new designs	4		✓		
	1.3 Describe the stages of the linear design process	3	✓			
	1.4 Describe the stages of the iterative design process	3	✓			
	1.5 Describe the information included in a PDS	6	✓			
2. Understand strategies and techniques used to develop design solutions	2.1 Describe the characteristics and applications of different design strategies	6	✓		18	36
	2.2 Explain how ergonomics influence the design of products	4		✓		
	2.3 Explain modelling techniques and their benefits/limitations	8		✓		
3.Understand the factors that affect the evaluation of a product design	3.1 Describe techniques used to evaluate designs	6	✓		12	24
	3.2 Explain considerations when evaluating a final design from proposals	6		✓		
	Total	50			50	100

4510-243 Marketing engineered products

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principles of marketing	1.1 Explain the difference between marketing and sales	2		✓	20	40
	1.2 Explain what is meant by a "market" and "market segments"	2		✓		
	1.3 Explain the basic concept of marketing	4		✓		
	1.4 State the advantages and disadvantages of establishing a brand identity	4	✓			
	1.5 Explain how the 5Cs of marketing influence the marketing of products	8		✓		
2. Understand the marketing process for an engineered product	2.1 Explain the reasons for developing a new product	4		✓	22	44
	2.2 Describe what is meant by a unique selling proposition (USP)	2	✓			
	2.3 Explain the stages of a product lifecycle and their effect on marketing	8		✓		
	2.4 Describe the key considerations in a marketing plan	8	✓			
3. Understand marketing as a communication method	3.1 Describe communication methods used for marketing	4		✓	8	16
	3.2 Describe types of marketing materials	4	✓			
	Total	50			50	100

4510-244 Additive manufacturing (3D printing)

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the principles of additive manufacturing	1.1 Explain the difference between additive and subtractive approaches to manufacturing	2		✓	12	30
	1.2 Describe the method by which additive manufacturing processes make products	2	✓			
	1.3 Describe different types of additive manufacturing processes	4	✓			
	1.4 Explain the advantages and limitations of additive manufacturing	4		✓		
2. Understand the set-up and operation of 3D printing	2.1 Describe the main parts of a 3D printer and their functions	4	✓		28	70
	2.2 Describe the materials that can be used with a 3D printer	2	✓			
	2.3 Explain the design limitations on the CAD model to be used for 3D printing	4		✓		
	2.4 Explain the methods used to communicate a 3D CAD model to a 3D printer	2		✓		
	2.5 Explain the safety considerations needed when 3D printing	2		✓		
	2.6 Describe the manufacture of a product using a 3D printer	4	✓			
	2.7 Explain the effect of the process parameters on the features and properties of the manufactured items	4		✓		
	2.8 Explain defects that arise when 3D printing and how they may be resolved	4		✓		
	2.9 Explain maintenance requirements for a 3D printer	2		✓		
	Total	40			40	100

4510-245 Effective working practices in an engineering environment when working on military vehicles and equipment

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 50
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the procedures for carrying out an engineering activity on military vehicles and equipment	1.1 Describe task requirements for an engineering activity	4		✓	16	32
	1.2 Describe a works programme for specific tasks	4		✓		
	1.3 Describe the procedure for completion of an engineering activity	4		✓		
	1.4 Describe how to complete appropriate documentation to organisational requirements	4		✓		
2. Understand data used for engineering activities	2.1 Describe sources of documentation and / or data to complete engineering tasks	5	✓	✓	22	44
	2.2 Describe required documentation and /or data to meet task outputs	4	✓			
	2.3 Describe how to use correct data for an engineering activity	4	✓	✓		
	2.4 Describe how to interpret engineering drawings	5	✓			
	2.5 Identify technical support structure	4	✓			
3. Understand the importance of quality control	3.1 Describe the procedures for record keeping	4		✓	12	24
	3.2 Describe the potential consequence of not following quality procedures	4		✓		
	3.3 Identify the procedure for reporting faults	4	✓			
	Total	50			50	100

4510-246 Principles of military vehicle and equipment maintenance

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour
Marks: 40
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the different types of maintenance	1.1 Explain the purpose of maintenance	4		✓	22	55
	1.2 Describe different types of maintenance	4	✓			
	1.3 Describe types of routine maintenance	4	✓			
	1.4 Explain time and usage maintenance	2	✓			
	1.5 Explain special maintenance	3		✓		
	1.6 Explain the Health and Safety considerations when planning and undertaking maintenance tasks on Military vehicles and equipment	5	✓			
2. Understand the procedures for maintenance on military equipment in line with the technical literature available	2.1 Describe how to prepare for maintenance activities	4	✓		12	30
	2.2 Describe how maintenance activities are undertaken	2		✓		
	2.3 Describe how post maintenance functional tests are carried out	4		✓		
	2.4 Describe the handover procedure following completion of maintenance activities	2		✓		
3. Understand the procedures for removing and replacing components	3.1 Describe the procedure for removing and replacing component	4		✓	6	15
	3.2 Explain the extent of own authority and reporting	2	✓			

procedures for problems that cannot be resolved			
Total	40	40	100

4510-247 Procedures and processes for fault identification on military vehicles and mechanical systems

Assessment type: Short answer test
Assessment conditions: Supervised examination conditions
Duration: 1 hour 15 minutes
Marks: 45
Grading: P/X

Learning Outcome	Assessment Criteria	No of marks	AO1	AO2	Total marks	% paper
1. Understand the function of military vehicles and mechanical systems	1.1 Describe the purpose of the main components of vehicle systems	5		✓	10	22.5
	1.2 Describe the operation of vehicle systems	5		✓		
2. Understand how to identify the symptoms of a fault	2.1 Explain how sensory methods are used to identify faults	4		✓	16	35
	2.2 Describe the system instruments / gauges available to identify faults	4	✓			
	2.3 Describe symptoms that indicate the system is faulty	4		✓		
	2.4 Explain the process for identification and location of faults	4	✓			
3. Understand procedures for rectifying / remedying faults	3.1 Describe the procedures for rectifying/ remedying faults	5		✓	9	20
	3.2 Describe the different levels of repair tasks as stipulated in the equipment supporting documentation	2	✓			
	3.3 Explain who is authorised to carry out different levels of repair	2	✓			
4. Understand the process for testing / checking the function of equipment following repair	4.1 Describe the process for testing / checking equipment for serviceability	4	✓		10	22.5
	4.2 Explain the extent of own authority and reporting procedures for problems that cannot be resolve	2	✓			
	4.3 Identify functional test requirements to be carried out	4		✓		

before handover in accordance with organisational procedures				
	Total	45	45	100

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