QUALIFICATION HANDBOOK

Level 5 Advanced Technician Diploma in Electrical and Electronic Engineering (9208-12)

April 2020 Version 1

City & Guilds

Qualification at a glance

Subject area	**Engineering**
City & Guilds number	9208
Age group approved	18+
Entry requirements	To take this qualification, learners must first achieve the 9208 Level 4 Diploma in Engineering or equivalent.
Assessment	• Assignments: externally set by City & Guilds, internally marked by centres, externally verified. • Dated entry written exam papers
Fast track	N/A
Support materials	• Qualification handbook
Registration and certification	Consult the Walled Garden/Online catalogue for last dates

Title and level	City & Guilds number	Accreditation number
Level 5 Advanced Technician Diploma in Electrical and Electronic Engineering	9208-12	N/A

Version and date	Change detail	Section
V1 April 2020	Document created	Throughout

Contents

1 Introduction

This document tells you what you need to do to deliver the qualification.

In the table below is an outline of this qualification at a glance.

Area	Description
Who is this the qualification for?	This Advanced Technician Diploma is aimed at learners who • wish to gain employment as an advanced Engineering Technician • wish to progress into higher level Engineering qualifications • intend to advance into third year of a selected university engineering degree programme. It also aims to contribute to recognition by professional institutions.
What does this qualification cover?	It allows learners to learn, develop and practise the advanced skills required for employment, career progression or university progression in the engineering sector. It will also allow learners to build their knowledge of the principles of mathematics, science and technologies that underpin engineering.
Who did we develop the qualification with?	Please refer to our recognition list on our website.
What opportunities for progression are there?	It allows learners to progress into employment, university or to the following City & Guilds qualifications: • 9210-01 Level 6 Graduate Diploma in Engineering or other equivalent City & Guilds qualifications.

2 Structure

To achieve the **Level 5 Advanced Technician Diploma in Electrical and Electronic Engineering** learners must achieve the **two** mandatory units and a minimum of **six** optional units.

City & Guilds unit number	Unit title	GLH	NLH
Mandatory units			
Unit 501	Advanced mathematics for electrical and electronic engineering	85	200
Unit 502	Electrical and electronic engineering principles	91	200
Optional units			
Unit 503	Engineering project	20	200
Unit 504	Project management	50	150
Unit 505	Instrumentation and control systems	89	150
Unit 506	Electronic communication systems	72	150
Unit 507	Digital design	58	150
Unit 509	Principles and operation of electrical machines	96	200
Unit 510	Analogue design	162	150
Unit 512	Business management	45	100

3 Centre requirements

Approval

If there is no fast track approval for this qualification, existing centres who wish to offer this qualification must use the **standard** Qualification Approval Process.

Resource requirements

Physical resources and site agreements

The equipment, systems and machinery must meet industrial standards and be capable of being used under normal working conditions.

Centre staffing

Staff delivering this qualification must be able to demonstrate that they meet the relevant occupational expertise requirements, ie they should be occupationally competent or technically knowledgeable in the areas for which they are delivering training with experience of providing training. This knowledge must be to the same level as the training being delivered

Trainers must also

- hold or be working towards a recognised training qualification.
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Centre staff may undertake more than one role, eg tutor and assessor or internal quality assurer, but cannot internally verify their own assessments.

Assessors and Internal Quality Assurer

Assessors

Although not specifically required for this qualification, City & Guilds recommends that Assessors hold, or are working towards, the relevant Level 3 TAQA qualification, covering the assessment types required for this qualification. Further information about the City & Guilds TAQA qualification can be found at **www.cityandguilds.com**. Assessors must be able to demonstrate clear experience in assessing learning and understand City & Guilds' quality assurance requirements. They must also have the required industry certification and experience as outlined above.

Internal Verifiers / Internal Quality Assurers

Although not specifically required for this qualification, City & Guilds recommends that Internal Verifiers / Internal Quality Assurers hold, or are working towards, the Level 4 TAQA qualification. Further information about the City & Guilds TAQA qualification can be found at **www.cityandguilds.com**. Internal Verifiers / Internal Quality Assurers must be able to demonstrate clear experience in quality assurance processes and understand City & Guilds' specific quality assurance requirements. They must also have the required industry certification and experience as outlined above.

Continuing professional development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Learner entry requirements

Learners should already hold the Level 4 Diploma in Electrical and Electronic Engineering or equivalent in order to complete the qualification satisfactorily.

Age restrictions

City & Guilds cannot accept any registrations for learners under 18 years of age.

4 Delivering the qualification

Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs,
- support and guidance they may need when working towards their qualification.
- any units they have already completed, or credit they have accumulated which is relevant to the qualification.
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualification, their responsibilities as a learner, and the responsibilities of the centre. This information can be recorded on a learning contract.

5 Assessment

Units 503, 504 and 512 are assessed by assignments set by City & Guilds, internally marked by centres and externally verified. These assignments are graded Pass, Merit and Distinction.
All the remaining units are assessed by dated entry written paper, which are also graded Pass, Merit and Distinction. Exam dates are available on the Catalogue and Walled Garden.

The assessments have all been developed with input from experts in the industry.

Please refer to the Assessor Guidance on **www.cityandguilds.com** for general assessment guidance for this qualification.

Summary of assessment requirements

To achieve this qualification, candidates will be required to complete the following assessments successfully:

- **one** dated entry written exam for **each** mandatory unit 501 and 502
- **one** assignment for **each** chosen optional unit assessed by assignment
- **one** dated entry written exam for **each** chosen optional unit assessed by dated entry written exam.

City & Guilds provides the following assessments:

Unit	Title	Assessment methodology	Where to obtain assessments
Mandatory units			
9208-501	Advanced mathematics for electrical and electronic engineering	Dated entry written exam paper 9208-501	Sample exam questions on www.cityandguilds.com
9208-502	Electrical and electronic engineering principles	Dated entry written exam paper 9208-502	Sample exam questions on www.cityandguilds.com

Optional units

9208-503	Engineering project	Assignment 9208-503 This assignment covers all the learning outcomes in this unit. Assignment set by City & Guilds, internally marked, externally verified	www.cityandguilds.com
9208-504	Project management	Assignment 9208-504 This assignment covers all the learning outcomes in this unit. Assignment set by City & Guilds, internally marked, externally verified	www.cityandguilds.com
9208-505	Instrumentation and control systems	Dated entry written exam paper 9208-505	Sample exam questions on www.cityandguilds.com
9208-506	Electronic communication systems	Dated entry written exam paper 9208-506	Sample exam questions on www.cityandguilds.com
9208-507	Digital design	Dated entry written exam paper 9208-507	Sample exam questions on www.cityandguilds.com
9208-509	Principles and operation of electrical machines	Dated entry written exam paper 9208-509	Sample exam questions on www.cityandguilds.com
9208-510	Analogue design	Dated entry written exam paper 9208-510	Sample exam questions on www.cityandguilds.com
9208-512	Business management	Assignment 9208-512 This assignment covers all the learning outcomes in this unit. Assignment set by City & Guilds, internally marked, externally verified	www.cityandguilds.com

Unit assessment overview

Assignments

The following tables are designed to offer a summarised overview of how the tasks in each assignments demonstrate achievement of the assessment criteria in the units.

Unit 503 Engineering project

Task	Description	Assessment Criteria	Task duration	Grading	Weighting per task
1	Identify and be able to research workplace problems. Produce project plans and proposals for improvements or developments *(demonstrate effective and appropriate communication skills)*	1.1, 1.2, 2.1, 2.2, 2.3	6 hours	P / M / D / X	1
2	Source information, concepts and principles relevant to engineering problems *(Apply underlying concepts and principles of their area of study to address an identified engineering problem or issue)*	3.1, 3.2	5 hours	P / M / D / X	1
3	Select project methods to address objectives *(Evaluate different approaches to the problem or issue identified)*	4.1, 4.2, 4.3	4 hours	P / M / D / X	1

Task	Description	Assessment Criteria	Task duration	Grading	Weighting per task
4	Execute the project *(Initiate and use strategies to address an identified engineering issue)*	5.1, 5.2, 5.3, 5.4	4 hours	P / M / D / X	1

Unit 504 Project management

Task	Description	Assessment Criteria	Task duration	Grading	Weighting per task
1	Report: The Principles of Project Management	1.1, 1.2, 2.1, 3.1, 3.2, 3.3, 4.1	4 hours	P / M / D / X	1
2	Research Task: Project Management Case Study	2.2, 2.3, 2.4, 2.5, 2.6. 2.7, 4.2	6 hours	P / M / D / X	1

Unit 512 Business management

Task	Description	Assessment criteria	Task duration	Grading	Weighting per task
1	Improve business performance	6.1, 5.3, 5.4, 3.2, 6.2, 6.3	20 hours	P / M / D / X	1
2	Evaluating and assessing organisations' policies, procedures and processes	1.2, 1.3, 4.2, 4.4	15 hours	P / M / D / X	1
3	Analyse the benefits of knowledge management to an engineering organisation	5.2	8 hours	P / M / D / X	1

Dated entry written exam papers

Test specifications for the dated entry written exam papers are included here.

Test specifications

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

Test: 9208-501 Advanced mathematics for electrical and electronic engineering

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome		Number of questions	%
501	1.	be able to use calculus to solve engineering problems	4	33
	2.	be able to apply numerical analysis to solve engineering problems	3	33
	3.	understand mathematical expressions used in waveform descriptions	3	34
		Total	**10**	**100**

Test: 9208-502 Electrical and electronic engineering principles

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome		Number of questions	%
502	1.	understand complex dc networks	3	28
	2.	understand the response of RLC circuits to alternating wave forms	3	28
	3.	understand the concepts of electromagnetic theory	2	28
	4.	be able to analyse electrical systems when modelled as two-port networks	2	16
		Total	**10**	**100**

Test: 9208-505 Instrumentation and control systems

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome	Number of questions	%
505	1. understand instrumentation sensors for measurement	4	31
	2. understand instrumentation systems	1	11
	3. be able to mathematically model parts of a physical control system	3	30
	4. understand the stability of a control system	2	19
	5. be able to design stable feedback control systems	1	9
	Total	**11**	**100**

Test: 9208-506 Electronic communication systems

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome	Number of questions	%
506	1. understand the fundamental principles of electronic communications for data transmission	2	25
	2. understand the fundamental principles of analogue communication systems	3	23
	3. understand the fundamental principles of digital communication systems	4	30
	4. understand point-to-point communication systems	1	12
	5. understand communication systems applications	2	10
	Total	**12**	**100**

Test: 9208-507 Digital design

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome	Number of questions	%
507	1. understand logic circuits	2	20
	2. understand the design of combinational logic circuits	2	25
	3. understand the design of sequential logic circuits	2	25
	4. understand the function and uses of current digital technologies	1	10
	5. understand microcontroller fundamentals	2	20
	Total	**9**	**100**

Test: 9208-509 Principles and operation of electrical machines

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome	Number of questions	%
509	1. understand the operation of three phase transformers	3	20
	2. understand the operation of three-phase induction machines	2	19
	3. understand the operation of three-phase synchronous machines	3	31
	4. understand commonly occurring fault conditions in electrical supply systems	1	13
	5. understand variable frequency ac motor drive systems and their applications	1	17
	Total	**10**	**100**

Test: 9208-510 Analogue design

Duration: 3 hours

Grading: Pass/Merit/Distinction

Unit	Outcome	Number of questions	%
510	1. understand the operation of electronically controlled power supplies	2	20
	2. understand amplifier circuit designs for different classes of operation	2	20
	3. understand operational amplifier circuit designs	2	16
	4. understand oscillator circuit designs	2	16
	5. understand active filter circuit designs	1	10
	6. understand the operation of data converters	1	10
	7. be able to apply Simulation Program with Integrated Circuit Emphasis (SPICE) software to evaluate circuit performance.	1	8
	Total	**11**	**100**

Question paper resources

The following examinations papers will require resource materials as listed below.

Unit no.	Required source material (required on day of exam)	City & Guilds or third party	Cost if third party	How to access
501	Mathematical formulae	City & Guilds	n/a	**www.cityandguilds.com** Copies will be provided with exam question answer booklets. It is recommended to print a copy from the **9208 webpage** to use throughout the course.
502	Smith chart paper	City & Guilds	n/a	Will be provided in the exam question answer booklets, where applicable.
505	Laplace Transforms	City & Guilds	n/a	**www.cityandguilds.com** Copies will be provided with exam question answer booklets. It is recommended to print a copy from the **9208 webpage** to use throughout the course.
513	Mathematical formulae and Laplace transforms	City & Guilds	n/a	**www.cityandguilds.com** Copies will be provided with exam question answer booklets. It is recommended to print a copy from the **9208 webpage** to use throughout the course.
514	Moody chart	City & Guilds	n/a	Will be provided in the exam question answer booklets, where applicable.
515	Thermodynamics and Transport Properties of Fluids: Rogers and Mayhew', SI Units, **5th edition**	Third party	£10	From the internet or through the centre's usual textbook sources. (It is important that it is the 5th edition as it contains data on the refrigerant 134a which is used in all new refrigeration systems.)
	Refrigeration and Air tables	City & Guilds	n/a	**www.cityandguilds.com** Copies will be provided with exam question answer booklets. It is recommended to print a copy from the **9208 webpage** to use throughout the course.

Time constraints

The following time constraints must be applied to the assessments of this qualification:

- each assignment has specific time constraints; please refer to the individual assignments and to the Assessor Guidance. Centre staff should guide learners to ensure excessive evidence gathering is avoided. Centres finding that assignments are taking longer, should contact the Qualification consultant for guidance
- all assignments must be completed and assessed within the learner's period of registration. Centres should advise learners of any internal timescales for the completion and marking of individual assignments
- all dated entry written exam papers must be sat within the learner's period of registration.

Assessment strategy

City & Guilds provide sample questions for each unit assessed by dated entry written exam paper. The purpose of these sample questions is to provide examples of the type of question that will be set, giving an indication of the breadth and depth of knowledge that is expected. It should be noted that these are sample questions and **not** a full sample question paper.

Dated entry examinations will take place twice a year, in June and November/ December.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

RPL is **not** allowed for this qualification.

6 Grade profile

Purpose and use of this qualification grade profile

City & Guilds has taken the decision to grade the individual assessments included in this qualification, and provide a grade associated with each unit. This decision is based on market research with employers and colleges that suggests grading can be of use both as a motivational tool within the learning environment, and also to learners presenting evidence of their skills to prospective employers.

For this reason, the tasks have been developed to extend learners beyond the minimum required for Pass. As a basis for developing the tasks and their related grading criteria, City & Guilds consulted a number of stakeholders to discover what the grades at each level should mean in practice, and how they might be used. The following descriptors are based on that consultation.

The descriptors were used in the development of the task grading criteria and should be used by assessors to understand the intended outcomes of the grading.

They should be referred to during the centre's standardising exercises in addition to the specific grading criteria for the unit to support a consistent understanding of the standard across units, centres and assessors.
The grades achieved by a learner would be considered by universities for subsequent entry into the correct year of a degree programme.

Aims

The Level 4 and 5 Diplomas in Engineering focus on advanced engineering, with a wide choice of units to provide a flexible route to career success as a professional engineer. The qualifications have been developed closely with both industry and the deliverers of learning in order to ensure fitness for purpose.

Both Level 4 and Level 5 for this qualification are presented here to allow comparison and better understanding of progression.

Levels

Level 4

The Level 4 Diplomas in Engineering focus on advanced engineering. The learners will have the potential to fulfil a role within Engineering that requires a high level of responsibility, for example within first level management, requiring the use of personal initiative and critical judgement.

Holders of these qualifications may also be able to advance into the second year of a selected university engineering degree programme.

Level 5

The Level 5 Advanced Technician Diplomas in Engineering focus on advanced engineering. The learner will have the potential to fulfil a role within Engineering that requires a high level of responsibility, for example leading to middle management and/or project management, requiring the use of personal initiative and critical judgement.

Holders of these qualifications may also be able to advance into the third year of a selected university engineering degree programme.

To take this qualification a learner must first achieve the 9208 Level 4 Diploma in Engineering.

Both levels are also ideal for people wanting to advance as an Engineering technician within the fields of Mechanical Engineering, Electrical and Electronic Engineering, or Civil Engineering.

Delivery of learning

Learning is delivered by approved colleges and training providers in simulated learning environments, not in the workplace. Learners will however have access to real work environments in which to further develop the breadth of their skills and their experience.

Grading

The majority of tasks are graded Pass / Merit / Distinction. Pass reflects the minimum requirements that are expressed in the unit, with Merit and Distinction showing progression in skills and knowledge as well as recognising behaviours important to the industry.

	Pass	**Merit**	**Distinction**
Level 4	**Learner:** Capable of making informed decisions, likely to have achieved a grade at Level 3 (Merit / Distinction), starting to have sufficient skills to bring value to the industry, is becoming comfortable with occupational systems and procedures. **Evidence:** Complex tasks may present some challenge, partial attempt at assessment, well defined tasks completed with a level of guidance, able to follow the required process, acceptable	**Learner:** Broader understanding of systems and procedures, can work with minimal guidance, determination to resolve issues, taking ownership and responsibility for own learning, desire to progress. **Evidence:** Full attempt at assessment, well defined tasks completed with minimal guidance, able to follow the required process, higher level skills / knowledge / competence displayed for the	**Learner:** High level of understanding and evaluation of overall systems and procedures, showing potential to achieve a higher level of academic study. Has an ability to carry out tasks without guidance and shows own initiative. **Evidence:** Full achievement of assessment completely independently, within the time given, ie efficient use of time. Detailed / in-depth reflection on the outcomes of the task with recommendations for

	Pass	Merit	Distinction
	skills / knowledge / competence displayed for the industry, can plan, can solve problems. Limited reflection on the outcomes of the task.	industry, can plan, can solve problems more effectively and confidently. Sufficient reflection on the outcomes of the task.	improvement / alternatives.
Level 5	**Learner:** Capable of making informed decisions, likely to have achieved a grade at Level 4 (Merit / Distinction), has sufficient skills to bring value to the industry, is fairly comfortable with occupational systems and procedures. **Evidence:** Complex tasks may present some challenge, but most assessments attempted, well defined tasks completed with a level of guidance, able to follow the required process, acceptable skills / knowledge / competence displayed for the industry, can plan, can solve problems. Satisfactory reflection on the outcomes of the task.	**Learner:** Full understanding of systems and procedures, can work with minimal to no guidance, determination to resolve issues, taking ownership and responsibility for own learning, desire to excel. **Evidence:** Full attempt at assessment, well defined tasks completed with minimal guidance, able to follow the required process, higher level skills / knowledge / competence displayed for the industry, can plan, can solve problems more effectively and confidently. Good reflection on the outcomes of the task.	**Learner:** High level of understanding, evaluation and competence in overall systems and procedures, clearly achieving a higher level of academic study. Has an ability to carry out tasks without guidance and shows own initiative. **Evidence:** Full achievement of assessment completely independently, within the time given, ie efficient use of time. Detailed / in-depth reflection on the outcomes of the task with recommendations for improvement / alternatives.

7 Units

Structure of units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours
- unit aim
- relationship to NOS, other qualifications and frameworks
- endorsement by a sector or other appropriate body
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance.

Unit 501 Advanced mathematics for electrical and electronic engineering

Level:	5
GLH:	85
NLH:	200
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to enable learners to develop knowledge and understanding of advanced mathematical techniques and be able to apply them to the solution of electrical and electronic engineering problems. Through this unit, learners will develop an understanding of calculus and numerical analysis as well as mathematical expressions used in waveform descriptions.

Learning outcome
The learner will: 1. be able to use calculus to solve engineering problems.
Assessment criteria
The learner can: 1.1 evaluate **partial derivatives** for a function of several variables 1.2 obtain Laplace transforms for **complex functions** 1.3 obtain the inverse Laplace transforms for complex functions 1.4 obtain **integrals** of complex functions 1.5 form **ordinary differential equations** for solving problems 1.6 solve **ordinary differential equations**.

Range
Partial derivatives First- and second-order partial derivatives; the chain rule for partial derivatives, total differential, gradient, divergence, curl **Complex functions** Algebraic and trigonometric functions; Heaviside function, Dirac delta function; first and second order differential equations **Integrals** Indefinite, definite, standard **Ordinary differential equations** First order (variables separable; exact equations; linear equations using an integrating factor), second order (initial and boundary value problems; complementary functions and particular integrals)
Learning outcome

The learner will: 2. be able to apply numerical analysis to solve engineering problems.
Assessment criteria
The learner can: 2.1 use numerical **iterative methods** to find the roots of a function 2.2 apply **numerical methods** for the solution of **ordinary differential equation models** of engineering systems 2.3 apply **iterative numerical methods** to the solution of partial differential equation models of engineering systems 2.4 represent numerical values on **diagrams**.

Range
Iterative methods Bisection method; Secant method; Newton's method **Numerical methods** Euler and improved Euler; Taylor series; Runge-Kutta; forward, backward and central finite difference methods **Ordinary differential equation models** Initial value problems, boundary value problems **Iterative numerical methods** Finite difference methods for partial differential equations including forward, backward and central difference methods; solution of sets of linear equations by Jacobi iterative method; Gauss-Seidel iterative method **Diagrams** Bode, Nyquist, Nichols, log log, Argand

Learning outcome
The learner will: 3. understand mathematical expressions used in waveform descriptions
Assessment criteria
The learner can: 3.1 analyse a **periodic** waveform using mathematical **expressions** 3.2 analyse a **basic waveform** description using orthogonal functions 3.3 analyse a random waveform using elements of **probability theory** 3.4 analyse an **aperiodic** waveform using mathematical **expressions**.

Range
Expressions (Periodic) Polynomial, Taylor series, Fourier Series, vectors **Basic waveform** Square, triangular, saw-tooth, exponential, pulse waveforms **Probability theory** Joint and conditional probabilities, probability density function, autocorrelation function, power spectral density function **Expressions (Aperiodic)** Fourier transforms, Laplace transforms, pole-zero description, vectors

Unit 502 Electrical and electronic engineering principles

Level:	5
GLH:	91
NLH:	200
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to extend and deepen learners understanding of the principles of electrical and electronic engineering. These principles form the foundation for further study of more specialist applications of electrical and electronic engineering. Through this unit, learners will develop their understanding of complex dc networks, the response of RLC circuits to alternating wave forms and performance of multi-port networks. Learners will apply the understanding they develop to solve related electrical and electronic engineering problems.

Learning outcome
The learner will: 1. understand complex dc networks
Assessment criteria
The learner can: 1.1 model an equivalent circuit for resistor-capacitor-inductor circuits 1.2 evaluate **performance limits** of **dc circuits** under design conditions 1.3 evaluate circuit **performance** under variable **conditions**.

Range
Performance limits Current, power transfer **dc circuits** Series, parallel, series-parallel **Performance** Quality of circuit components, power supply, signal input, circuit tolerance **Conditions** Temperature, voltage, power supply, current, ripple, step change

Learning outcome
The learner will: 2. understand the response of RLC circuits to alternating wave forms
Assessment criteria
The learner can: 2.1 model dynamic **RLC circuits** 2.2 analyse **frequency** responses of tuned **RLC circuits** 2.3 analyse power factor correction requirements 2.4 evaluate the transient effect on RLC circuits 2.5 evaluate the practical use of transient effect.

Range
RLC circuits Series, parallel, series-parallel **Frequency** Tuned, harmonics, sub-harmonics, second, third

Learning outcome
The learner will: 3. understand the concepts of electromagnetic theory
Assessment criteria
The learner can: 3.1 analyse **static electric fields** 3.2 analyse **static magnetic fields** 3.3 avaluate **time changing electric and magnetic fields** 3.4 solve problems involving **electromagnetic waves and transmission lines**.

Range
Static electric fields The force between point charges, Coulomb's Law, electric field intensity, the electric field of several point charges, electric vectors **Static magnetic fields** Magnetic (dipoles, loops and solenoids), permeability, magnetic vectors, magnetic effects on electric currents **Time changing electric and magnetic fields** Faraday's Law (derived line integral form), Stoke's Theorem, Maxwell's equations, application of circuit and field theory **Electromagnetic waves and transmission lines** Coaxial, Two-wire and Field cell transmission lines, the infinite uniform transmission line, impedance of transmission lines, reflection coefficient, slotted line, Smith chart, scattering parameters

Learning outcome
The learner will: 4. be able to analyse electrical systems when modelled as two-port networks
Assessment criteria
The learner can: 4.1 convert circuit values using **parameters** from differentmodels 4.2 solve problems involving **gain** of two-port model networks.

Range
Parameters Z (impedance model); Y (admittance model) and h (hybrid model); elementary matrix algebra **Gain** Low frequency; mid-band; high frequency

Unit 503 Engineering project

Level:	5
GLH:	20
NLH:	200
Assessment method:	Assignment
Aim:	The purpose of this unit is to enable learners to • apply underlying concepts and principles of their area of study to address an identified engineering problem or issue • evaluate different approaches to the problem or issue identified • initiate and use strategies to address an identified engineering issue • demonstrate effective and appropriate communication skills.

Learning outcome
The learner will: 1. be able to research engineering problems
Assessment criteria
The learner can: 1.1 investigate processes, practices or structures in engineering to identify an area for development 1.2 propose project ideas.

Learning outcome
The learner will: 2. be able to set project objectives
Assessment criteria
The learner can: 2.1 identify information required for inclusion in the engineering project proposals 2.2 produce project proposals to **required scope** 2.3 produce project objectives.

Range
Required scope Generate new focussed information about the problem or issue; increase efficiency; improve customer satisfaction; deliver services more effectively; improvements in quality and output; increase organisation competitive edge; opportunities to expand services; more flexibility; other (to be specified in proposal)

Learning outcome
The learner will: 3. be able to source information, concepts and principles relevant to engineering problems
Assessment criteria
The learner can: 3.1 review theories and practices relevant to **engineering project proposal** 3.2 select key **sources of data and information** to support project.

Range
Engineering project proposal Determined by sector / subject **Sources of data and information** Quantitative and qualitative information; relevant materials; published research

Learning outcome
The learner will: 4. be able to select project methods to address objectives
Assessment criteria
The learner can: 4.1 evaluate the strengths of **methods** in relation to project objectives 4.2 justify selected method(s) used to address project objectives 4.3 identify strategies appropriate to carry out selected method.

Range
Methods Qualitative research (may include interviews; forums; observation; shadowing, research journal articles, books); quantitative research (may include small sample surveys; questionnaires, sector data, organisational data); application / test of a theory; examination / evaluation of a process

Learning outcome
The learner will: 5. be able to execute a project
Assessment criteria
The learner can: 5.1 produce **work plans** to meet objectives 5.2 implement work plans 5.3 review work plan, adjusting timescales and deliverables accordingly. 5.4 prepare a report on the results obtained during project execution

Range
Work plan must • include phases and tasks • include task distribution • include project requirements against objectives • include time constraints • use SMART principles • record objectives in project plan

Unit 504 Project management

Level:	5
GLH:	50
NLH:	150
Assessment method:	Assignment
Aim:	The purpose of this unit is to enable learners to develop an understanding of the principles of project management and how projects are set up. Learners will gain an understanding of how to mitigate for risks and develop their skills in using management tools to monitoring and reviewing projects.

Learning outcome
The learner will: 1. understand why organisations use project management.
Assessment criteria
The learner can: 1.1 describe the **principles** of project management 1.2 explain the **benefits** of project management to organisations and individuals.

Range
Principles Business justification; learning from experience; defined roles and responsibilities; manage by stages; manage by exception; focus on products; objectives; constraints; lifecycle **Benefits** Possible benefits will include: Increased efficiency; improved customer satisfaction; organisations may be more effective in delivering services; improvements in quality and output; development opportunities within the project team; increase in an organisation's competitive edge; opportunities to expand services; more flexibility; improved Risk Assessment

Learning outcome
The learner will: 2. understand how to set up projects.
Assessment criteria
The learner can: 2.1 explain the **considerations** when reviewing project proposals 2.2 explain **how to set clear goals** for projects 2.3 analyse project **resource requirements** 2.4 explain **how roles and responsibilities are allocated** within project teams 2.5 identify project **communication needs** 2.6 assess **possible risks** to successful completion of projects 2.7 explain how to **mitigate** for possible risks.

Range
Considerations Financial viability of the project; time; legal; resource; budget; constraints; dependencies; confidentiality eg restrictions in relation to the Data Protection Act, who has access to data and project documentation **How to set clear goals** Identify stakeholders; identify needs; use SMART principles; record goals in project plans **Resource requirements** Project requirements against goals; time constraints; budget; human resources; training needs; communication needs; IT requirements **How roles and responsibilities are allocated** Use of experts from different areas of the organisation; use of key stakeholders; identify training needs; meeting schedules; timing of reports **Communication needs** Formal/informal communication; identifying who requires communication e.g. stakeholders, management, team members **Possible risks** Safety issues; optimistic time and cost estimates; unexpected budget costs; unclear roles and responsibilities; stakeholder needs not sought; changing requirements after the start of the project; new requirements; poor communication; lack of commitment **Mitigate** Health and safety training; regular project review meetings; appropriate communication; training and monitoring

Learning outcome
The learner will: 3. be able to use management tools to maintain, control and monitor projects
Assessment criteria
The learner can: 3.1 describe different **management tools** for monitoring and control of projects 3.2 justify the use of management tools for monitoring and controlling projects 3.3 use management tools to **monitor** projects.

Range
Management tools Progress reports; budget monitoring reports; GANTT charts; Critical Path Analysis; use of relevant and current project software packages **Monitor** Updating task status; re-scheduling uncompleted tasks; updating project elements

Learning outcome
The learner will: 4. be able to review projects at all stages
Assessment criteria
The learner can: 4.1 explain **reasons** for reviewing projects after completion 4.2 review projects against original proposals.

Range
Reasons Improve future projects; enables ability to learn from experience; identify key resources for future projects; ensures comparison against achievements to original objectives; highlights any issues e.g. health and safety, problems, training needs, shortages in terms of resources, increases in costs, allows for the ability to revise and update plans, enables completion of an end of project report

Unit 505 Instrumentation and control systems

Level:	5
GLH:	89
NLH:	150
Assessment Method	Dated Written Paper
Aim:	The purpose of this unit is to extend and deepen learners understanding of instrumentation and control engineering. Through this unit, learners will develop their understanding of advanced instrumentation systems and in particular acquire the mathematical and analytical tools to understand and design control systems.

Learning outcome
The learner will: 1. understand instrumentation sensors for measurement
Assessment criteria
The learner can: 1.1 calculate **parameters** of an orifice plate 1.2 calculate the volumetric flow rate through a venturi nozzle. 1.3 calculate parameters of **measurement** tranducers 1.4 analyse the operation of electro-magnetic level sensors 1.5 explain the operating principle of Linear Variable Differential Transformer (LVDT) 1.6 explain how error correction is achieved using a Gray coded angular position encoder 1.7 analyse the different wiring configurations for Resistance Temperature Detectors (RTDs) 1.8 explain how Steinhart-Hart is used for calibrating of thermistor.

Range
Parameters Pressure, volume flow rate, diameter. **Measurement** Level, pressure, temperature, load, displacement

Learning outcome
The learner will: 2. understand instrumentation systems.
Assessment criteria
The learner can: 2.1 analyse the function of **elements** of instrumentation systems 2.2 design a signal conditioning system for a multiple sensor Gray coded input.

Range
Elements Multiplexer, computer, display, sensor, transducer

Learning outcome
The learner will: 3. be able to mathematically model parts of a physical control system
Assessment criteria
The learner can: 3.1 derive the **differential equation** for a **complex physical system** 3.2 derive a differential equation model for an underdamped system using an electrical or mechanical analogy 3.3 derive the Laplace transformation for a **complex physical system** 3.4 derive the transfer function of a complex linear system.

Range
Differential equation First order, second order **Complex physical system** Mass-spring-damper system, rotational mass, rotational damper, fluid inertia, fluid resistance, RLC circuit

Learning outcome
The learner will: 4. understand the stability of a control system
Assessment criteria
The learner can: 4.1 evaluate the stability of linear feedback systems 4.2 evaluate the stability of linear feed forward systems 4.3 analyse the frequency response of a feedback control system 4.4 explain how the transfer function relates to the operation of three term controllers (PID) 4.5 tune a PID controller using the Ziegler-Nichols methodology.

Learning outcome
The learner will: 5. be able to design stable feedback control systems
Assessment criteria
The learner can: 5.1 design a simple compensated stable control system 5.2 **analyse compensated** stable control systems.

Range
Analyse compensated Series, parallel and external (input/output) by block diagrams, transfer functions.

Unit 505 Instrumentation and control systems

Supporting information

Evidence requirements:

1.3 Each 'measure' should be assessed each time

Guidance

This unit contains advanced mathematical concepts and should not be attempted without thorough background knowledge of the necessary mathematical theory.

Unit 506 Electronic communication systems

Level:	5
GLH:	72
NLH:	150
Assessment method:	Dated written paper
Aim:	The purpose of this unit is for learners to develop an understanding of analogue and digital communications systems at the signal and subsystem level. Topics include the relationship between time domain and frequency domains, bandwidth requirements of various modulation schemes and noise effects.

Learning outcome
The learner will: 1. understand the fundamental principles of electronic communications for data transmission.
Assessment criteria
The learner can: 1.1 explain how the **elements** contribute to a communication system 1.2 evaluate different **types** of transmission media for different **applications** 1.3 evaluate the relative **advantages and disadvantages** of analogue and digital **transmission** 1.4 explain how to reduce noise and interference from **different sources** 1.5 explain the **factors** which affect signal quality in data **transmission** 1.6 explain the **effects** of bandwidth limitations on data **transmission**.

Range
Elements Tuner, mixer, modulator, amplifier, detector, demodulator, oscillator, radio communications system **Types** Coaxial cable, twisted pair (shielded and unshielded), optical fibre (step index, graded index), radiowaves, microwaves, infrared, transmitting/ receiving components **Applications** Satellite, telephone, television, radio, data transmission **Advantages and disadvantages** Information theory; Electromagnetic interference (EMI); radio spectrum **Transmission** Satellite, telephones, radio, data **Different sources** Intrinsic, extraneous **Factors** Resistance, radiation, dielectric material, electro magnetic interference (emi) **Transmission** Analogue, digital **Effects** Interference, crosstalk, SNR reduction, Baud rate limitations, Shannon-Hartley Theorem, Nyquist theorem, Nyquist Bit Rate.

Learning outcome
The learner will: 2. understand the fundamental principles of analogue communication systems
Assessment criteria
The learner can: 2.1 explain how analogue **techniques** are used to modulate **signal** transmission 2.2 explain how analogue **techniques** are used to demodulate **signal** transmission 2.3 calculate analogue **spectra** from the **modulated** wave 2.4 plot analogue **spectra** from the **modulated** wave 2.5 explain the function of electronic circuit **elements** in analogue communication systems.

Range
Techniques Amplitude (AM), frequency (FM), Angle (phase) modulation (PM), Quadrature (QAM), frequency spectrum, phasor representation, power, DSB, SSB, DSB-SC, SSB-SC, PCM, phase locked loops (PLL), AM – envelope/diode detector, synchronous/product detector, FM – phase disc discriminator **Signal** Baseband (a.f.), heterodyning (i.f.), carrier (r.f.) **Spectra** AM and FM (modulated signals, bandwidth, sidebands) **Modulated** Message signal, carrier wave **Elements** Tuner, mixer, modulator, amplifier, detector, demodulator, oscillator, phase locked loops (PLL)

Learning outcome
The learner will: 3. understand the fundamental principles of digital communication systems
Assessment criteria
The learner can: 3.1 explain how digital **techniques** are used to modulate **signal** transmission 3.2 explain how digital **techniques** are used to demodulate **signal** transmission 3.3 explain digital transmission **issues and errors** 3.4 calculate **spectra** from the **modulated** wave 3.5 plot **spectra** from the **modulated** wave 3.6 explain the function of electronic circuit **elements** in digital communication systems.

Range
Techniques Sampling theorem, Nyquist rate, aliasing, Binary PAM, Duobinary PAM, M-ary signalling schemes, Binary ASK (coherent, noncoherent), Binary PSK (coherent, differentially coherent), Binary FSK (coherent, noncoherent), error control coding (ECC) **Signal** Baseband (data), carrier (r.f.) **Issues and errors** Noise; error rate; error correction **Spectra** AM , FM and FSK (modulated signals, bandwidth, sidebands) **Modulated** Message signal, carrier wave **Elements** Source encoder, channel encoder, modulator, demodulator, channel decoder, source decoder

Learning outcome
The learner will: 4. understand point-to-point communication systems
Assessment criteria
The learner can: 4.1 evaluate **methods** of multiplexing for data channel sharing 4.2 represent the operation of a point-to-point communication **system** as a block diagram.

Range
Methods Time Division Multiplexing (TDM); Frequency Division Multiplexing (FDM), Asynchronous TDM, Code Division Multiplexing (CDM) **System** Multiplex, non-multiplex

Learning outcome
The learner will: 5. understand communication systems applications
Assessment criteria
The learner can: 5.1 explain **telephone** communication systems applications 5.2 explain radio communication **systems** for different **purposes** 5.3 explain how the **elements** contribute to **television communication systems** 5.4 evaluate types of satellite **orbit** for specific applications 5.5 describe **satellite** communication systems.

Range
Telephone PSTN, Cellular (mobile) network **System** Transmitter, receiver **Purposes** Type of data transmitted, location of sender and receiver **Elements** Luminance, chrominance, scanning, tuner, time base, sound channel, video channel, primary colour filters, colour signal mixing, display (CRT, LCD, PDP) **Television communication systems** Monochrome, colour, infrared **Orbit** Geostationary, low-earth-orbiting, Molniya, elliptical, mid-earth-orbiting **Satellite** Telephone, TV, radio, Internet, transport navigation, military

Unit 506 Electronic communication systems

Supporting information

Guidance

Noise in Baseband systems, SNR, Noise in Modulation systems, noise figure, noise temperature, interference in modulation systems [Shannon-Hartley theorem]

Unit 507 Digital design

Level:	5
GLH:	58
NLH:	150
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to provide learners with an understanding of logic design and logic synthesis tools. On completion of this unit, learners will be able to apply their understanding to the design, simulation, analysis and verification of moderately complex digital circuits.

Learning outcome
The learner will: 1. understand logic circuits.
Assessment criteria
The learner can: 1.1 explain integrated circuit design for **logic functions** using electronic components, for different logic **families** 1.2 assess the suitability of semi-conductor **families** for a circuit specification 1.3 explain how the **input/output** characteristics are produced in logic systems. 1.4 assess **operational performance** of different logic family **variants**.

Range
Logic functions AND; OR; NOT; EXOR; NAND; NOR **Families** CMOS, TTL **Input/output** Tri-state output, Schmitt trigger operation **Operational performance** Speed, power, cost and interface requirements **Variants** High speed, low-power, low voltage supply CMOS

Learning outcome
The learner will: 2. understand the design of combinational logic circuits
Assessment criteria
The learner can: 2.1 simplify Boolean functions for the design of glitch-free **logic circuits** 2.2 determine minimised solutions to 4 and 5 input Boolean expressions using the **laws** of Boolean algebra 2.3 illustrate minimised Boolean expressions as **universal gates** 2.4 design a combinational logic circuit for real-world applications.

Range
Logic circuits Full adders, BCD-to-Decimal decoder, Priority Encoders, hardware multiplier **Laws** Commutative; associative; distributive; duality; de Morgan **Universal gates** NAND, NOR

Learning outcome
The learner will: 3. understand the design of sequential logic circuits
Assessment criteria
The learner can: 3.1 explain the operation of different **types** of sequential **logic devices** 3.2 analyse **state diagrams** for the operation of sequential circuits 3.3 produce state-transition tables for sequential **logic devices** and their **state diagrams** 3.4 design sequential **logic devices** to meet specifications.

Range
Types Synchronous, Asynchronous **Logic devices** Shift Register, RAM, Bidirectional Register, Digital delay line, Sequence Generator, Ring Counter **State diagrams** Mealy machine, Moore machine

Learning outcome
The learner will: 4. understand the function and uses of current digital technologies
Assessment criteria
The learner can: 4.1 explain typical **digital technologies** and their limitations 4.2 explain the concepts of Moore's Law and its limitation.

Range
Digital Technologies VLSI; FPGA; PSoC; Flash memory; Static RAM

Learning outcome
The learner will: 5. understand microcontroller fundamentals
Assessment criteria
The learner can: 5.1 explain the functions of **microcontroller fundamentals** 5.2 explain the functions of the **three main areas** of micro-processor-systems 5.3 explain simple microcontroller design.

Range
Microcontroller fundamentals Computer architecture ALU ,CPU Von Neumann structure, ALU, key components elements, Fetch- execute cycles, Accumulator, data and program memory, program counter, clock and I/O, fetch- execute cycles, control unit **Three main areas** CPU, Memory, I/O

Unit 507 Digital design

Supporting information

Evidence requirements

To assessment team
Outcome 2: ac e
Real-world situation example: 4-sensor automatic safety-guard cut-out

Outcome 4: ac d
Simple microprocessor design using architecture diagrams

Guidance

Purpose

Number of gates on an IC, reduction in number of IC's, reduce redundancy, power consumption, speed, costs, size of final circuit.

Methods

Algebraic methods; graphical methods (Karnaugh Mapping and variable entry mapping (VEM) techniques)

Simple microprocessor

The Intel 8-bit 8051, or similar

Unit 509 Principles and operation of electrical machines

Level:	5
GLH:	96
NLH:	200
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to enable learners to develop a further understanding of electrical machines and systems in engineering operations. The focus of the unit is on three phase transformers induction motors and synchronous machines.

Learning outcome
The learner will: 1. understand the operation of three phase transformers
Assessment criteria
The learner can: 1.1 evaluate the use of **tapchangers** for voltage control 1.2 evaluate the method of three phase power transformer earth fault detection using current transformers 1.3 evaluate the buchholz relay system of transformer protection 1.4 calculate on-load transformer heating and cooling times 1.5 calculate efficiencies and regulation of loaded transformers from equivalent circuit parameters derived from test values.

Range
Tapchangers Off-line, online, manual, automatic, solid state (thyristor)

Learning outcome
The learner will: 2. understand the operation of three-phase induction machines
Assessment criteria
The learner can: 2.1 determine **practical values** for equivalent circuits 2.2 evaluate the **performance** of three phase induction motors 2.3 solve problems involving induction machines.

Range
Practical values Stator resistance, stator leakage reactance, stator loss components, rotor resistance, rotor leakage reactance **Performance** Copper losses, input/output powers, slip frequency vs speed of rotation, efficiency, maximum power factor, maximum torque, circle diagrams

Learning outcome
The learner will: 3. understand the operation of three-phase synchronous machines
Assessment criteria
The learner can: 3.1 analyse the **performance** of an ideal synchronous machine using phasor diagrams 3.2 produce an operating chart for a three phase cylindrical machine 3.3 determine the load share for parallel operation of three phase alternators 3.4 explain the conditions for synchronising three phase alternators to infinite busbars 3.5 understand how a three-phase synchronous machine can be started using a variable –frequency supply 3.6 understand how a three-phase synchronous machine can be started as an induction motor 3.7 determine an equivalent circuit 3.8 solve problems involving synchronous machines.

Range
Performance Offload or onload

Learning outcome
The learner will: 4. understand commonly occurring fault conditions in electrical supply systems
Assessment criteria
The learner can: 4.1 calculate values of short circuit **levels** for **symmetrical faults** 4.2 express **circuit parameters** as symmetrical components 4.3 calculate values of short circuit **levels** for **asymmetrical faults**.

Range
Levels kVA, MVA **Symmetrical faults** Line-line-line, line-line-line-earth **Circuit parameters** Currents, voltages and impedances **Asymmetrical faults** Line-line, line-line-earth, line-earth

Learning outcome
The learner will: 5. understand variable frequency ac motor drive systems and their applications
Assessment criteria
The learner can: 5.1 explain the operation of **power switching devices** 5.2 analyse the operation of **three-phase bridge inverters** 5.3 analyse pulse width modulated **inverter systems** for induction motors 5.4 analyse the harmonic content of inverter output waveforms.

Range
power switching devices TRIACs, DIACs, transistors, firing circuits **three-phase bridge inverters** Voltage source inverters, current source inverters **inverter systems** Sinusoidal PWM, space vector PWM, gear changing **Applications** ac generator, e.g fuel cell thermo-electric, magneto-hydrodynamic (MHD), constant speed operation, power factor control

Unit 509 Principles and operation of electrical machines

Supporting information

Evidence requirements:

1.1 The calculation will also require the fault current calculated as part of this calculation

3.1 Data should be provided for this ac

Guidance

1.1 The calculation will also require the fault current calculated as part of this calculation

2.1 Standards phasor diagrams doesn't have to be BS standards but the standards used in a host country

Unit 510 Analogue design

Level:	5
GLH:	162
NLH:	150
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to provide learners with an understanding of standard analogue electronic circuit configurations, including the design of power supplies, operational amplifiers applications and oscillators.

Learning outcome
The learner will: 1. understand the operation of electronically controlled power supplies
Assessment criteria
The learner can: 1.1 evaluate **types** of power supply for different applications 1.2 analyse the **purpose** of **electronic components** used in power supplies.

Range
Types dc and ac sources, Fixed and Variable Power supplies, linear voltage regulator, overview of switched mode power supply (Buck converter, boost regulator, flyback regulator, the charge pump), uninterruptable power supplies **Purpose** Conversion of ac to dc or dc to ac, Reduction of rectified ripple voltage, Regulation, over voltage and over current protection, voltage and current limiting, constant and variable voltage and current sources **Electronic components** Capacitors, Rectifier diodes, Zener diodes, FET's, BJT's, Darlington Pair, Rectifier Bridge, TRIAC's, Thyristors, Diacs

Learning outcome
The learner will: 2. understand amplifier circuit designs for different classes of operation
Assessment criteria
The learner can: 2.1 explain the **types of amplifier classification** 2.2 analyse different types of **class A** amplifier circuit design 2.3 analyse types of **class B** amplifier circuit design 2.4 analyse types of **class C** amplifier circuit design.

Range
Types of amplifier classification Class A, AB, B, C, D **Class A** Fully stabilised voltage amplifier, Tuned amplifier, push-pull design, Use of Darlington pair, Linsley-Hood class A amplifier, output characteristics, biasing **Class B** Class B power stage, Class B Push-pull Transformer Amplifier Circuit, Class B Transformerless Output Stage, Audio Amplifier, output characteristics, biasing **Class C** Power amplifier, Bridge configuring the output, RF transmitter amplifier, PWM amplifier, output characteristics, biasing

Learning outcome
The learner will: 3. understand operational amplifier circuit designs
Assessment criteria
The learner can: 3.1 analyse the types of **operational amplifier** circuits 3.2 analyse the **properties** of **the** different **types of operational amplifier** configurations 3.3 calculate the component values for the operational amplifier circuit of **specified applications**.

Range
Operational amplifier Buffer, Inverting, Non-inverting, multi-stage, mixer, adder, differential/ subtractor, instrumentation, comparator, integrator **Properties** Ideal Op amp, Gain, input impedance, Zin, output impedance, Zout, input offset voltage, input current, bandwidth, feedback factor, CMRR, slew rate, Gain Bandwidth Product (GBP). **Specified applications** Instrumentation, bridge measurement, , comparator, integrator, mixer

Learning outcome
The learner will: 4. understand oscillator circuit designs
Assessment criteria
The learner can: 4.1 analyse the **types of oscillator** circuits 4.2 analyse the **properties** of the different **types of oscillator** configurations 4.3 calculate the component values for the oscillator circuit of **specified applications** at given frequencies.

Range
Types of Oscillator R-C , phase-shift, Wien bridge, Tuned collector, Colpitts, Hartley, Twin T, relaxation, crystal, Multivibrators (monostable, bistable and astable) **Properties** Oscillation amplitude, frequency range, frequency stability and drift, phase noise, jitter. **Specified applications** Tuned collector, Colpitts, Hartley, Twin T, relaxation, multivibrators (monostable, bistable and astable), 555 Timer

Learning outcome
The learner will: 5. understand active filter circuit designs
Assessment criteria
The learner can: 5.1 analyse the **types of active filters** 5.2 analyse the **properties** of the different **types of active filters** configurations

Range
Types of active filter Active low-pass, High-pass, Band-pass, voltage-controlled voltage source (VCVS) switched capacitor cascaded biquads **Properties** Gain, cut-off frequency, component values, -3dB levels. Transfer functions, filter responses stability, sensitivity analysis **Specified applications** Noise rejections ,Transmissions & communications ,audio and video signals

Learning outcome
The learner will: 6. understand the operation of Data Converters
Assessment criteria
The learner can: 6.1 explain the configurations of converter **digital to analogue (D to A) circuitry** 6.2 explain the configurations of converter **analogue to digital (A to D) circuitry**.

Range
Digital to analogue (D to A) circuitry Binary weighted resistors, digitally controlled switches, ladder type D/A Converter, multiplying D/A Converter **Analogue to digital (A to D) circuitry** A/D Converters, Successive approximation A/D Converter, Parallel-Comparator A/D Converter, Ratiometric (Dual-Slope) A/D Converter

Learning outcome
The learner will: 7. be able to apply Simulation Program with Integrated Circuit Emphasis (SPICE) software to evaluate circuit performance.
Assessment criteria
The learner can: 7.1 explain the **application** of SPICE.

Range
Application SAC analysis (linear small-signal frequency domain analysis), dc analysis (nonlinear quiescent point calculation), dc transfer curve analysis, noise analysis (small signal analysis), transfer function analysis (small-signal input/output gain and impedance), transient analysis

Unit 512 Business management

Level:	5
GLH:	45
NLH:	100
Assessment method:	Assignment
Aim:	The purpose of this unit is to develop in learners key business management principles and approaches that apply to engineering organisations and processes.

Learning outcome
The learner will: 1. understand how risk is managed in the engineering workplace
Assessment criteria
The learner can: 1.1 evaluate **information and data** to determine risk levels 1.2 evaluate health and safety policies 1.3 evaluate operating procedures and processes 1.4 recommend how risk is **managed**.

Range
Information and data Accident, incident and near miss records, employee data eg working hours, environmental data eg lighting levels **Managed** Remove need, staff training, standard procedures, control of substances and materials, regular inspection, use of (PPE)

Learning outcome
The learner will: 2. understand the management of people in engineering
Assessment criteria
The learner can: 2.1 explain **working relationships** in engineering organisations 2.2 analyse the relationship between employee motivation and business success in engineering 2.3 analyse the effect of **employment contractual issues** on business success 2.4 analyse **human factors** affecting performance in the engineering workplace.

Range
Working relationships Between levels of management, between management and staff, between different functional areas, between organisation and stakeholders **Employment contractual issues** sub-contractor, zero hours, casual, agency staff **Human factors** Working environment, work patterns, work load, employee health, motivation

Learning outcome
The learner will: 3. understand approaches to quality assurance of engineering operations
Assessment criteria
The learner can: 3.1 compare ways in which quality assurance applies in different areas of engineering operations 3.2 review an **area of engineering operations** for weaknesses 3.3 apply quality assurance methods to an area of engineering operation.

Range
Areas of engineering operations Installation, production, maintenance, engineering support functions

Learning outcome
The learner will: 4. understand the effect of change on organisations
Assessment criteria
The learner can: 4.1 explain the **factors** that contribute to the need for change in organisations 4.2 assess **processes** for managing change in organisations 4.3 explain the role of leadership and management in the change process 4.4 evaluate the change process in an organisation.

Range
Factors Internal (eg strategic; organisational; sector led objectives; resources), external (PESTLE political; economic; social; technological; legal; environmental) **Processes** Learners should be encouraged to refer to current theories and processes eg Kotter's 8 Steps, Kubler Ross 5 Stage Model.

Learning outcome
The learner will: 5. understand the importance of knowledge management
Assessment criteria
The learner can: 5.1 explain the relationships between **data, information, knowledge and wisdom** 5.2 analyse the **benefits** of knowledge management to an organization 5.3 assess knowledge assets of an area within an organisation 5.4 evaluate organisations knowledge management framework.

Range
Data, information, knowledge and wisdom Data: one off event Information: when data is added to data Knowledge: the ability to use the information. Wisdom: think and act using knowledge, experience and insight **Benefits** Efficient processing of data; positive impact on organisation goals; improved productivity; improved customer service

Learning outcome
The learner will: 6. understand the need for business improvement in organisations
Assessment criteria
The learner can: 6.1 explain **tools** used to improve business performance 6.2 review an area of an organisation for improvement opportunities 6.3 **plan** business improvement for an area of an organisation.

Range
Tools Learners should be encouraged to refer to current approaches eg six sigma,5S, Kaizen, process flow analysis **Plan** SMART targets

Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on **www.cityandguilds.com**.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Useful contacts

International learners General qualification information	Please contact your regional office. Details can be found at **www.cityandguilds.com** or alternatively E: **intcg@cityandguilds.com**

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City & Guilds
5 - 6 Giltspur Street
London EC1A 9DE

www.cityandguilds.com