OCR
Oxford Cambridge and RSA

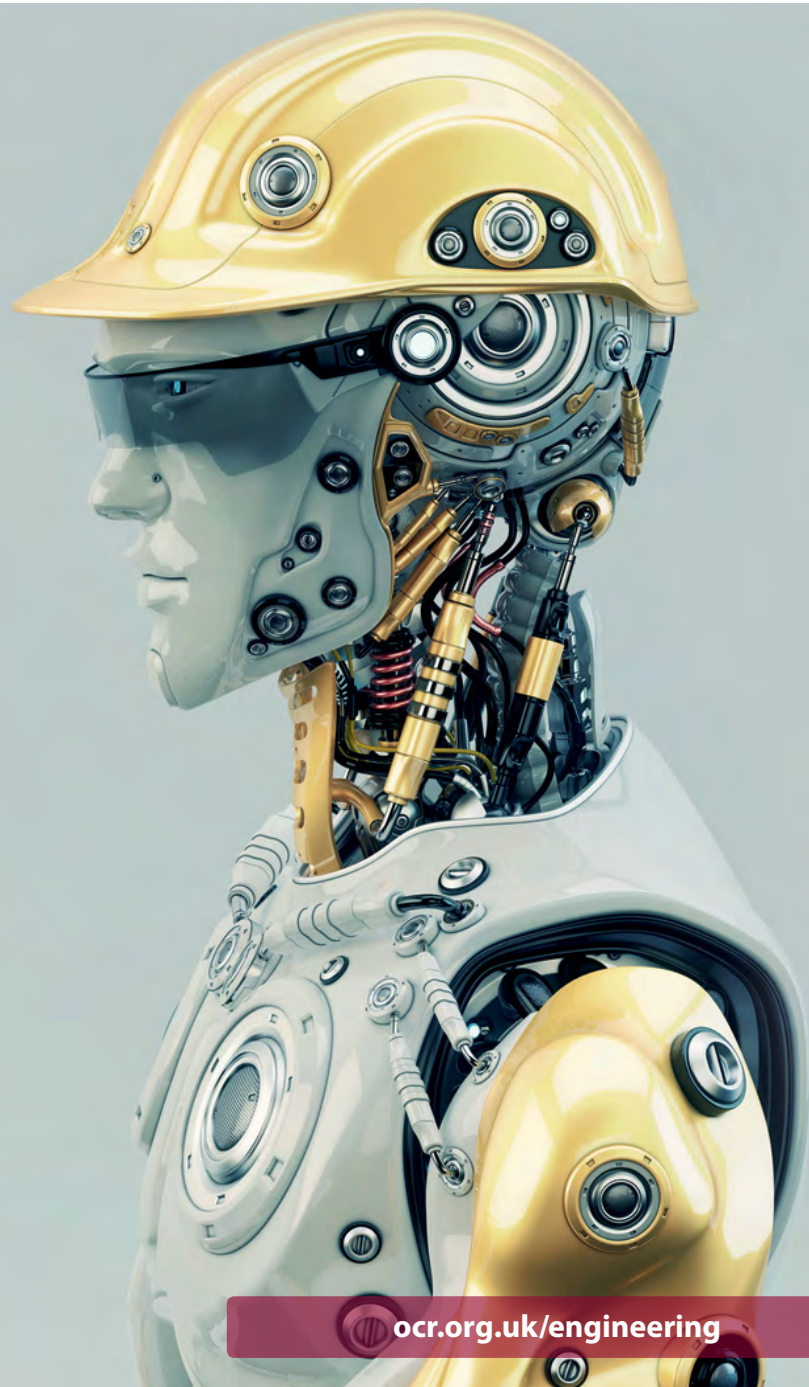
Cambridge **TECHNICALS LEVEL 3**

ENGINEERING

Cambridge TECHNICALS 2016

MAPPING GUIDE TO A LEVELS IN MATHEMATICS

Version 1



ocr.org.uk/engineering

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INTRODUCTION

This document lists five of the Level 3 Cambridge Technicals in Engineering units (Units 1, 2, 3, 4 and 23) and Learning Outcomes (LOs) which map to the relevant OCR Mathematics A Level units and LOs so that you can see where the LOs of the Cambridge Technicals in Engineering units align with OCR's A Levels in Mathematics. Links below to OCR's A Levels in Mathematics.

Mathematics – 3890-3892, 7890-7892
http://www.ocr.org.uk/qualifications/as-a-level-gce-mathematics-3890-3892-7890-7892/

Mathematics (MEI) – 3895-3898, 7895-7898
http://www.ocr.org.uk/qualifications/as-a-level-gce-mathematics-mei-3895-3898-7895-7898/

Mathematics A – H230, H240 (from 2017)
http://www.ocr.org.uk/qualifications/as-a-level-gce-mathematics-a-h230-h240-from-2017/

Mathematics B (MEI) – H630, H640 (from 2017)
http://www.ocr.org.uk/qualifications/as-a-level-gce-mathematics-b-mei-h630-h640-from-2017/

Core Maths Quantitative Problem Solving (MEI) Level 3 Certificate – H867
http://www.ocr.org.uk/qualifications/core-maths-quantitative-problem-solving-mei-level-3-certificate-h867/

Core Maths Quantitative Reasoning (MEI) Level 3 Certificate – H866
http://www.ocr.org.uk/qualifications/core-maths-quantitative-reasoning-mei-level-3-certificate-h866/

The intention is that learners can be taught knowledge and skills within these Cambridge Technicals in Engineering units which they can apply to relevant activities either devised by the centre or using one of OCR's employed devised Project Approaches which are available for each engineering pathway http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/ (teaching and learning resources – pathway options). In either case, the activities (once successfully completed by the learner) will provide the required underpinning knowledge for their final assessment.

When considering a holistic approach to delivery and learning through projects and Project Approach, it is important to consider the overall structure a programme of learning which will be exciting and engaging for learners. This document can be used to help structure learning and curriculum so that the relevant knowledge of a Mathematics A Level can be applied to meaningful engineering skills development.

The range of sizes of the Level 3 Cambridge Technicals in Engineering has been developed to meet the changing needs of the sector and prepare your learners for the challenges they'll face in Higher Education or employment. Designed in collaboration with experts spanning the breadth of the sector, the Cambridge Technicals in Engineering focuses on the skills, knowledge and understanding that today's universities and employers demand. Your learners will practically apply their skills and knowledge in preparation for further study or the workplace.

When developing the Certificate and Extended Certificate qualifications, we worked with universities to design the content and assessment of these qualifications – ensuring that your learners are prepared and have the skills to progress to degree level. For the Tech Levels we worked with universities, industry experts and employers to design the content and assessment of these qualifications – ensuring that your learners are prepared and have the skills to progress to degree level, an apprenticeship, or work.

The three Diplomas have vocational pathways that can be followed (at least one pathway must be achieved). Each pathway focuses on industry sectors and job roles that your learners will actually be able to do having completed a Cambridge Technicals in Engineering. We've worked in partnership with industry to make sure your learners can progress directly into the sector in job roles that are appropriate for their age and experience.

The three Diplomas have vocational pathways that can be followed (at least one pathway must be achieved). Each pathway focuses on industry sectors and job roles that your learners will actually be able to do having completed a Cambridge Technicals in Engineering. We've worked in partnership with industry to make sure your learners can progress directly into the sector in job roles that are appropriate for their age and experience.

TEACHING AND LEARNING RESOURCES

New resources are being developed to support your teaching of this new qualification. These will include Pathway Delivery Guides, a Qualifications Calculator and a Progress Tracker.

To find out more about this qualification please go to:

http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

OVERVIEW

In this section, we have provided an overview of the aligning between the Cambridge Technicals in Engineering with OCR's A Levels in Mathematics.

In the following sections, this is broken down into more detail.

OCR's A Level in Mathematics C1	OCR's Level 3 Cambridge Technicals in Engineering
C1 Algebra Fundamentals Laws of Indices Surds Multiplying Out Brackets Taking Out Common Factors Algebraic Fractions Simplifying Expressions	**Unit 1 Mathematics for engineering** LO1 Understand the application of algebra relevant to engineering problems **Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO5 Understand principles of dynamic systems **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles **Unit 23 Applied mathematics for engineering** LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems
C1 Quadratic Equations Sketching Quadratic Graphs Factorising a Quadratic Completing the Square The Quadratic Formula The Discriminant	**Unit 1 Mathematics for engineering** LO1 Understand the application of algebra relevant to engineering problems **Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO3 Understand fundamental scientific principles of electrical and electronic engineering LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams LO5 Understand principles of dynamic systems **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles

OCR's A Level in Mathematics C1	OCR's Level 3 Cambridge Technicals in Engineering
C1 Inequalities and Simultaneous Equations Linear Inequalities Quadratic Inequalities Simultaneous Equations Simultaneous Equations with Quadratics Geometric Interpretation	**Unit 1 Mathematics for engineering** LO1 Understand the application of algebra relevant to engineering problems **Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO3 Understand fundamental scientific principles of electrical and electronic engineering LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO2 Understand fundamental geometric properties LO4 Understand properties of beams LO5 Understand principles of dynamic systems **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles
C1 Coordinate Geometry and Graphs Coordinate Geometry Equations of Straight Lines Curve Sketching Graph Transformations Circles	**Unit 1 Mathematics for engineering** LO2 Be able to use geometry and graphs in the context of engineering problems **Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO3 Understand fundamental scientific principles of electrical and electronic engineering **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams LO5 Understand principles of dynamic systems **Unit 4 Principles of electrical and electronic engineering** LO2 Understand alternating voltage and current

OCR's A Level in Mathematics C1	OCR's Level 3 Cambridge Technicals in Engineering
C1 Differentiation	**Unit 1 Mathematics for engineering**
Differentiation	LO5 Understand calculus relevant to engineering problems
Finding Tangents and Normals	**Unit 2 Science for engineering**
Stationary Points	LO3 Understand fundamental scientific principles of electrical and electronic engineering
Increasing and Decreasing Functions	LO4 Understand properties of materials
Curve Sketching	LO5 Know the basic principles of fluid mechanics
Real-Life Problems	LO6 Know the basic principles of thermal physics
	Unit 3 Principles of mechanical engineering
	LO4 Understand properties of beams
	LO5 Understand principles of dynamic systems
	Unit 4 Principles of electrical and electronic engineering
	LO3 Understand electric motors and generators

OCR's A Level in Mathematics C2	OCR's Level 3 Cambridge Technicals in Engineering
C2 Polynomials	**Unit 1 Mathematics for engineering**
Factorising Cubics	LO1 Understand the application of algebra relevant to engineering problems
Algebraic Division	**Unit 3 Principles of mechanical engineering**
The Remainder and Factor Theorems	LO1 Understand systems of forces and types of loading on mechanical components
	LO5 Understand principles of dynamic systems
	Unit 4 Principles of electrical and electronic engineering
	LO1 Understand fundamental electrical principles
	Unit 23 Applied mathematics for engineering
	LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems

OCR's A Level in Mathematics C2	OCR's Level 3 Cambridge Technicals in Engineering
C2 Sequences and Series	**Unit 1 Mathematics for engineering**
Sequences	LO1 Understand the application of algebra relevant to engineering problems
Arithmetic Progressions	**Unit 2 Science for engineering**
Arithmetic Series and Sigma Notation	LO2 Understand fundamental scientific principles of mechanical engineering
Geometric Progressions	**Unit 3 Principles of mechanical engineering**
Sequence and Series Problems	LO4 Understand properties of beams
Binomial Expansions	LO5 Understand principles of dynamic systems
	Unit 4 Principles of electrical and electronic engineering
	LO1 Understand fundamental electrical principles
	Unit 23 Applied mathematics for engineering
	LO1 Be able to apply trigonometry and geometry to a range of engineering situations
	LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems

OCR's A Level in Mathematics C2	OCR's Level 3 Cambridge Technicals in Engineering
C2 Circles and Trigonometry	**Unit 1 Mathematics for engineering**
Arc Length and Sector Area	LO2 Be able to use geometry and graphs in the context of engineering problems
The Trig Formulas You Need to Know	LO4 Be able to use trigonometry in the context of engineering problems
Using the Sine and Cosine Rules	**Unit 2 Science for engineering**
Graphs of Trig Functions	LO3 Understand fundamental scientific principles of electrical and electronic engineering
Transformed Trig Graphs	LO4 Understand properties of materials
Solving Trig Equations in a Given Interval	LO5 Know the basic principles of fluid mechanics
	LO6 Know the basic principles of thermal physics
	Unit 3 Principles of mechanical engineering
	LO1 Understand systems of forces and types of loading on mechanical components
	LO2 Understand fundamental geometric properties
	LO3 Understand levers, pulleys and gearing
	LO4 Understand properties of beams
	LO5 Understand principles of dynamic systems
	Unit 4 Principles of electrical and electronic engineering
	LO2 Understand alternating voltage and current
	Unit 23 Applied mathematics for engineering
	LO1 Be able to apply trigonometry and geometry to a range of engineering situations
	LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problem

OCR's A Level in Mathematics C2	OCR's Level 3 Cambridge Technicals in Engineering
C2 Logs and Exponentials Logs Exponentials and Logs	**Unit 1 Mathematics for engineering** LO1 Understand the application of algebra relevant to engineering problems LO3 Understand exponentials and logarithms related to engineering problems **Unit 2 Science for engineering** LO3 Understand fundamental scientific principles of electrical and electronic engineering **Unit 3 Principles of mechanical engineering** LO5 Understand principles of dynamic systems **Unit 4 Principles of electrical and electronic engineering** LO2 Understand alternating voltage and current **Unit 23 Applied mathematics for engineering** LO1 Be able to apply trigonometry and geometry to a range of engineering situations LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems
C2 Integration Integration The Trapezium Rule Areas Between Curves	**Unit 2 Science for engineering** LO3 Understand fundamental scientific principles of electrical and electronic engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams LO5 Understand principles of dynamic systems **Unit 23 Applied mathematics for engineering** LO3 Be able to use calculus to analyse a range of problems

OCR's A Level in Mathematics C3	OCR's Level 3 Cambridge Technicals in Engineering
C3 Algebra and Functions Functions and Mappings Composite Functions Inverse Functions Modulus Transformations of Graphs	**Unit 1 Mathematics for engineering** LO1 Understand the application of algebra relevant to engineering problems **Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles
C3 Exponentials and Logarithms e^x, In x and Graphs Using e^x and In x – Solving Equations	**Unit 1 Mathematics for engineering** LO3 Understand exponentials and logarithms related to engineering problems **Unit 2 Science for engineering** LO3 Understand fundamental scientific principles of electrical and electronic engineering **Unit 4 Principles of electrical and electronic engineering** LO2 Understand alternating voltage and current

OCR's A Level in Mathematics C3	OCR's Level 3 Cambridge Technicals in Engineering
C3 Trigonometry	**Unit 1 Mathematics for engineering**
Sin^{-1}, Cos^{-1} and Tan^{-1}	LO4 Be able to use trigonometry in the context of engineering problems
Secant, Cosecant and Cotangent	**Unit 2 Science for engineering**
Using Trigonometric Identities	LO3 Understand fundamental scientific principles of electrical and electronic engineering
The Addition Formulas	LO5 Know the basic principles of fluid mechanics
The Double Angle Formulas	LO6 Know the basic principles of thermal physics
The R Addition Formulas	**Unit 3 Principles of mechanical engineering**
More Trigonometry Stuff	LO1 Understand systems of forces and types of loading on mechanical components
	LO3 Understand levers, pulleys and gearing
	LO4 Understand properties of beams
	Unit 4 Principles of electrical and electronic engineering
	LO2 Understand alternating voltage and current
	Unit 23 Applied mathematics for engineering
	LO1 Be able to apply trigonometry and geometry to a range of engineering situations
	LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems

OCR's A Level in Mathematics C3	OCR's Level 3 Cambridge Technicals in Engineering
C3 Differentiation and Integration	**Unit 1 Mathematics for engineering**
Chain Rule	LO5 Understand calculus relevant to engineering problems
Differentiation of e^x and ln x	**Unit 2 Science for engineering**
Product Rule	LO3 Understand fundamental scientific principles of electrical and electronic engineering
Quotient Rule	LO5 Know the basic principles of fluid mechanics
More Differentiation	LO6 Know the basic principles of thermal physics
Relating Rates of Change	**Unit 3 Principles of mechanical engineering**
Integration of e^x and 1/x	LO4 Understand properties of beams
Volumes of Revolution	**Unit 4 Principles of electrical and electronic engineering**
	LO3 Understand electric motors and generators
	Unit 23 Applied mathematics for engineering
	LO1 Be able to apply trigonometry and geometry to a range of engineering situations
	LO2 Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems
	LO3 Be able to use calculus to analyse a range of problems
C3 Numerical Methods	**Unit 1 Mathematics for engineering**
Location of Roots	LO5 Understand calculus relevant to engineering problems
Iterative Methods	**Unit 4 Principles of electrical and electronic engineering**
Numerical Integration	LO3 Understand electric motors and generators

OCR's A Level in Mathematics C4	OCR's Level 3 Cambridge Technicals in Engineering
C4 Algebra and Functions Simplifying Expressions Algebraic Division Partial Fractions	**Unit 1 Mathematics for engineering** LO1 Understand the application of algebra relevant to engineering problems **Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles
C4 Parametric Equations Parametric Equations of Curves Using Parametric Equations Parametric and Cartesian Equations	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO4 Understand properties of materials **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams **Unit 23 Applied mathematics for engineering** LO3 Be able to use calculus to analyse a range of problems
C4 Binomial Expansions Approximating with Binomial Expansions	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO4 Understand properties of materials **Unit 23 Applied mathematics for engineering** LO3 Be able to use calculus to analyse a range of problems

OCR's A Level in Mathematics C4	OCR's Level 3 Cambridge Technicals in Engineering
C4 Differentiation Differentiation of Sin, Cos and Tan More Trig Differentiation Differentiation with Parametric Equations Implicit Differentiation	**Unit 1 Mathematics for engineering** LO5 Understand calculus relevant to engineering problems **Unit 2 Science for engineering** LO3 Understand fundamental scientific principles of electrical and electronic engineering LO5 Know the basic principles of fluid mechanics **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams **Unit 23 Applied mathematics for engineering** LO3 Be able to use calculus to analyse a range of problems
C4 Integration Integration of Sin and Cos Integration of f′(x)/f(x) Integration Using the Chain Rule Backwards Integrating Trig Things Using Trig Identities Integration by Substitution Integration by Parts Tough Integrals Differential Equations	**Unit 1 Mathematics for engineering** LO5 Understand calculus relevant to engineering problems **Unit 2 Science for engineering** LO3 Understand fundamental scientific principles of electrical and electronic engineering LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO4 Understand properties of beams **Unit 4 Principles of electrical and electronic engineering** LO3 Understand electric motors and generators **Unit 23 Applied mathematics for engineering** LO3 Be able to use calculus to analyse a range of problems
C4 Vectors Vectors Vector Equations of Lines Scalar Product	**Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO2 Understand fundamental geometric properties LO3 Understand levers, pulleys and gearing LO4 Understand properties of beams

OCR's A Level in Mathematics (Mechanics M1)	OCR's Level 3 Cambridge Technicals in Engineering
M1 Vectors and Forces, Vectors, Forces and Modelling, Forces are Vectors, Friction	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO4 Understand properties of beams **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles
M1 Kinematics, Constant Acceleration Equations, Motion Graphs, Displacement, Velocity and Acceleration	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO5 Understand principles of dynamic systems
M1 Dynamics, Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO3 Understand fundamental scientific principles of electrical and electronic engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO3 Understand levers, pulleys and gearing LO5 Understand principles of dynamic systems

OCR's A Level in Mathematics (Mechanics M2)	OCR's Level 3 Cambridge Technicals in Engineering
M2 Centre of Mass Discrete Groups of Particles in 1 Dimension, Discrete Groups of Particles in 2 Dimensions, Standard Uniform Laminas Composite Shapes Centres of Mass in 3 Dimensions Laminas in Equilibrium	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO2 Understand fundamental geometric properties LO4 Understand properties of beams
M2 Statics of Rigid Bodies Moments, Rigid Bodies Rigid Bodies and Friction Laminas and Moments	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO2 Understand fundamental geometric properties LO3 Understand levers, pulleys and gearing LO4 Understand properties of beams
M2 Projectiles	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering
M2 Uniform Circular Motion Circular Motion Conical Pendulums	**Unit 2 Science for engineering** LO3 Understand fundamental scientific principles of electrical and electronic engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics

OCR's A Level in Mathematics (Mechanics M2)	OCR's Level 3 Cambridge Technicals in Engineering
M2 Energy, Work and Power Work done Kinetic and Potential Energy The Work-Energy Principle Power	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering LO4 Understand properties of materials LO5 Know the basic principles of fluid mechanics LO6 Know the basic principles of thermal physics **Unit 3 Principles of mechanical engineering** LO1 Understand systems of forces and types of loading on mechanical components LO2 Understand fundamental geometric properties LO5 Understand principles of dynamic systems **Unit 4 Principles of electrical and electronic engineering** LO1 Understand fundamental electrical principles
M2 Collisions Impulse Collisions Complex Collisions Collisions and Energy	**Unit 2 Science for engineering** LO2 Understand fundamental scientific principles of mechanical engineering

In more detail

By completing **Unit 1 Mathematics for engineering**, learners will develop an understanding of:

- Algebra relevant to engineering problems.
- The use of geometry and graphs in the context of engineering problems.
- Exponentials and logarithms related to engineering problems.
- The use of trigonometry in the context of engineering problems.
- Calculus relevant to engineering problems.
- How statistics and probability are applied in the context of engineering problems.

By completing **Unit 2 Science for engineering**, learners will develop an understanding of:

- Applications of SI units and measurement.
- Fundamental scientific principles of mechanical engineering.
- Fundamental scientific principles of electrical and electronic engineering.
- Properties of materials.
- Basic principles of fluid mechanics.
- Basic principles of thermal physics.

By completing **Unit 3 Principles of mechanical engineering**, learners will develop an understanding of:

- Systems of forces and types of loading on mechanical components.
- The fundamental geometric properties relevant to mechanical engineering.
- Levers, pulleys and gearing.
- The properties of beams.
- The principles of dynamic systems.

By completing **Unit 4 Principles of electrical and electronic engineering**, learners will develop an understanding of:

- Fundamental electrical principles.
- Alternating voltage and current.
- Electric motors and generators.
- Power supplies and power system protection.
- Analogue electronics.
- Digital electronics.

By completing **Unit 23 Applied mathematics for engineering**, learners will:

- Apply trigonometry and geometry to a range of engineering situations.
- Apply knowledge of algebra, equations, functions and graphs to engineering problems.
- Use calculus to analyse a range of problems.
- Understand applications of matrix and vector methods.
- Apply mathematical modelling skills.

Unit 1 Mathematics for engineering

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 1
C1 Algebra Fundamentals Laws of Indices, Surds, Multiplying Out Brackets, Taking Out Common Factors, Algebraic Fractions, Simplifying Expressions	Understand the application of algebra relevant to engineering problems Application of algebra in engineering includes:
C2 Polynomials Factorising Cubics, Algebraic Division, The Remainder and Factor Theorems	Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM)
C3 Algebra and Functions Functions and Mappings, Composite Functions, Inverse Functions, Modulus, Transformations of Graphs **C4 Algebra and Functions** Simplifying Expressions, Algebraic Division, Partial Fractions	Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems
C2 Sequences and Series Sequences, Arithmetic Progressions, Arithmetic Series and Sigma Notation, Geometric Progressions, Sequence and Series Problems, Binomial Expansions	Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers
C1 Inequalities and Simultaneous Equations Linear Inequalities, Quadratic Inequalities, Simultaneous Equations, Simultaneous Equations with Quadratics, Geometric Interpretation	Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods
C1 Quadratic Equations Sketching Quadratic Graphs, Factorising a Quadratic, Completing the Square, The Quadratic Formula, The Discriminant	Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
C1 Coordinate Geometry and Graphs Coordinate Geometry, Equations of Straight Lines, Curve Sketching, Graph Transformations, Circles	Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of $y = kx^n$ and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication

MAPPING

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 1
C2 Logs and Exponentials Logs, Exponentials and Logs **C3 Exponentials and Logarithms** e^x, In x and Graphs, Using e^x and In x – Solving Equations	Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax, ey = x, ln x = y and to use inverse function and log laws
C2 Circles and Trigonometry Arc Length and Sector Area, The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval	Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians)
C3 Trigonometry Sin^{-1}, Cos^{-1} and Tan^{-1} ,Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas	Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3
C1 Differentiation Differentiation, Finding Tangents and Normals, Stationary Points, Increasing and Decreasing Functions, Curve Sketching. **C3 Differentiation** Chain Rule, Differentiation of e^x and In x, Product Rule, Quotient Rule, Relating Rates of Change **C4 Differentiation** of Sin, Cos and Tan, with Parametric Equations, Implicit Differentiation	Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions
C2 Integration The Trapezium Rule, Areas Between Curves, **C3 Integration** of e^x and 1/x, Volumes of Revolution, Numerical Methods, Location of Roots, Iterative Methods, Numerical Integration	Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/n + 1 + constant C, integrate functions of the form, integrate sine and cosine function
C4 Integration of Sin and Cos, of f′(x)/f(x), Using the Chain Rule Backwards, Using Trig Identities, Integration by Substitution and by Parts, Differential Equations	Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral
S1 Representation of Data Histograms, Stem and Leaf Diagrams, Mean, Median and Mode, Interquartile Range, Cumulative Frequency Graphs, Standard Deviation, Variation and Outliers, Coding, Comparing Distributions. **S1 Probability** Random Events and Venn Diagrams, Tree Diagrams, Conditional Probability, Independent Events, Arrangements and Selections	Be able to apply statistics and probability in the context of engineering problems the terms "data handling" and "sampling" problem solving involving histograms, frequency polygons and cumulative frequency curves

Unit 2 Science for engineering

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 2
S1 Representation of Data Histograms, Stem and Leaf Diagrams, Location: Mean, Median and Mode, Variation: Interquartile Range Cumulative Frequency Graphs, Variation: Standard Deviation, Variation and Outliers, Coding, Comparing Distributions	Understand applications of SI units and measurement, the formulae for relative and absolute error, absolute and relative correction Calculate the standard deviation and the standard error of the mean
M1 Vectors and Forces Vectors, Forces and Modelling, Forces are Vectors, Friction	Understand fundamental scientific principles of mechanical engineering Force and motion, scalar and vector quantities, resultant of two coplanar vectors (vector triangle), resolve perpendicular vectors
M1 Kinematics Constant Acceleration Equations, Motion Graphs, Displacement, Velocity and Acceleration **M1 Dynamics** Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum	Kinematics, Displacement, speed, velocity and acceleration, use of graphical methods to represent distance travelled, displacement, speed, velocity and acceleration. Speed – time graph, velocity gradient (displacement – time graph)
C1 Quadratic Equations Sketching Quadratic Graphs, Factorising a Quadratic, Completing the Square, The Quadratic Formula, The Discriminant **C1 Coordinate Geometry and Graphs** Coordinate Geometry, Equations of Straight Lines, Curve Sketching, Graph Transformations, Circles	Acceleration, gradient of a velocity – time graph. Uniformly accelerated motion in a straight line.
M2 Section 1 – Centre of Mass Discrete Groups of Particles in 1 Dimension, Discrete Groups of Particles in 2 Dimensions, Standard Uniform Laminas, Composite Shapes, Centres of Mass in 3 Dimensions, Laminas in Equilibrium	Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

MAPPING

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 2
M2 Energy, Work and Power Work done, Kinetic and Potential Energy, The Work-Energy Principle, Power **C1 Algebra Fundamentals** Laws of Indices, Surds, Multiplying Out Brackets, Taking Out Common Factors, Algebraic Fractions, Simplifying Expressions **C2 Polynomials** Factorising Cubics, Algebraic Division, The Remainder and Factor Theorems **C3 Algebra and Functions** Functions and Mappings, Composite Functions, Inverse Functions, Modulus, Transformations of Graphs **C4 Algebra and Functions** Simplifying Expressions, Algebraic Division, Partial Fractions **M1 Vectors and Forces** Vectors, Forces and Modelling, Forces are Vectors, Friction	Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque
M1 Dynamics Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum	Force, work and power Watts, the formula for energy or work done (W)
M2 Energy, Work and Power Work done, Kinetic and Potential Energy, The Work-Energy Principle, Power	Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
C2 Sequences and Series Sequences, Arithmetic Progressions, Arithmetic Series and Sigma Notation, Geometric Progressions, Sequence and Series Problems, Binomial Expansions	Scientific principles of electrical and electronic engineering
C1 Inequalities and Simultaneous Equations Linear Inequalities, Quadratic Inequalities, Simultaneous Equations, Simultaneous Equations with Quadratics, Geometric Interpretation	Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy Efficiency, ratio of work output to work input, resistivity formula for resistivity (ρ), temperature coefficient of resistance
C1 Quadratic Equations Sketching Quadratic Graphs, Factorising a Quadratic, Completing the Square, The Quadratic Formula, The Discriminant	Use of graphs to show the variation with temperature of a pure resistor and of a negative temperature coefficient thermistor

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 2
C1 Coordinate Geometry and Graphs Coordinate Geometry, Equations of Straight Lines, Curve Sketching, Graph Transformations, Circles	Use of the formula for the magnitude of the uniform electric field strength (E) between charged parallel plates
C2 Logs and Exponentials Logs, Exponentials and Logs **C2 Integration** The Trapezium Rule, Areas Between Curves, **C3 Exponentials and Logarithms** e^x, In x and Graphs, Using e^x and In x – Solving Equations	Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
M2 Section 1 – Centre of Mass Discrete Groups of Particles in 1 Dimension, Discrete Groups of Particles in 2 Dimensions, Standard Uniform Laminas, Composite Shapes, Centres of Mass in 3 Dimensions, Laminas in Equilibrium	Drift velocity and root mean square (r.m.s.) speed of an electron which forms part of an electric current in a solid Properties of materials
M2 Statics of Rigid Bodies Moments, Rigid Bodies, Rigid Bodies and Friction, Laminas and Moments	Deformation is caused by a tensile or compressive force, Hooke's law, elastic limit, stress, strain
C2 Circles and Trigonometry Arc Length and Sector Area, The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval	Young's modulus, elastic and plastic deformation of a material, calculate strain energy in a deformed material from a force – extension graph Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials Principles of fluid mechanics
C3 Trigonometry Sin^{-1}, Cos^{-1} and Tan^{-1} ,Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas **M1 Kinematics** Constant Acceleration Equations, Motion Graphs, Displacement, Velocity and Acceleration	Fluids at rest, pressure, gauge pressure, absolute pressure, pressure exerted on any point on a surface in a fluid is always at right angles to the surface, pressure at any point in a fluid is the same in all directions at that point, pressure due to a column of liquid

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 2
C1 Differentiation **M2 Energy, Work and Power** Work done, Kinetic and Potential Energy, The Work-Energy Principle, Power Differentiation, Finding Tangents and Normals, Stationary Points, Increasing and Decreasing Functions, Curve Sketching. **C3 Differentiation** Chain Rule, Differentiation of e^x and In x, Product Rule, Quotient Rule, Relating Rates of Change **C4 Differentiation** of Sin, Cos and Tan, with Parametric Equations, Implicit Differentiation **C3 Integration** of e^x and 1/x, Volumes of Revolution, Numerical Methods, Location of Roots, Iterative Methods, Numerical Integration	Archimedes' principle, fluid flow, ideal fluid, streamline or laminar turbulent flow, boundary layers, definition of viscosity Know the basic principles of thermal physics, non-flow energy equation, the steady flow energy equation that the internal energy of a system is the sum of a random distribution of kinetic and potential energy concerned with the molecules of the system. What is meant by the term thermodynamic scale and state that on the Kelvin scale, absolute zero is the temperature at which all substances have a minimum internal energy. Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation
M1 Dynamics Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum	Specific heat capacity, formula heat energy or sensible heat (Q) and the efficiency equation. Sensible and latent heat application of formulae

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Unit 3 Principles of mechanical engineering

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 3
C1 Algebra Fundamentals Laws of Indices, Surds, Multiplying Out Brackets, Taking Out Common Factors, Algebraic Fractions, Simplifying Expressions	Understand systems of forces and types of loading on mechanical components, different types of loading that could be applied to a mechanical component including direct forces, turning forces (moments, torque, shear forces)
C2 Polynomials Factorising Cubics, Algebraic Division, The Remainder and Factor Theorems	Resolve a force into its orthogonal components
C3 Algebra and Functions Functions and Mappings, Composite Functions, Inverse Functions, Modulus, Transformations of Graphs **C4 Algebra and Functions** Simplifying Expressions, Algebraic Division, Partial Fractions **C2 Arc Length and Sector Area** The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval **C3 Trigonometry** Sin^{-1}, Cos^{-1} and Tan^{-1}, Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas	Systems of co-planar forces, concurrent forces and non-concurrent forces Diagrammatic representations of engineering problems using force diagram How mechanical engineering situations can be represented by particle mechanics and rigid bodies Conditions of equilibrium for systems of forces How to determine the resultant of a set of co- planar forces and hence determine the equilibrant of those forces
M1 Vectors and Forces Vectors, Forces and Modelling, Forces are Vectors, Friction	How materials respond to direct axial loading, both in tension and compression
M2 Section 1 – Centre of Mass Discrete Groups of Particles in 1 Dimension, Discrete Groups of Particles in 2 Dimensions, Standard Uniform Laminas, Composite Shapes, Centres of Mass in 3 Dimensions, Laminas in Equilibrium **M2 Statics of Rigid Bodies** Moments, Rigid Bodies, Rigid Bodies and Friction, Laminas and Moments **M1 Dynamics** Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum	The terms stress, strain and Young's modulus, and application of formulae to calculate direct stress and strain in axially loaded components including stress = force/cross-sectional area, strain = change in length/original length and use of Young's modulus (E) = stress/strain Representation of material behaviour on a generic stress versus strain graph including elastic deformation, elastic limit, in-elastic and plastic deformation, ultimate stress and factor of safety

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 3
C2 Circles and Trigonometry Arc Length and Sector Area, The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval	How to apply formulae to calculate the shear stress in a component under shear loading including shear stress = shear force/shear area
C3 Trigonometry Sin^{-1}, Cos^{-1} and Tan^{-1}, Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas	Understand fundamental geometric properties to include calculations of the area of irregular 2D shapes, the volume of a regular prism of known cross sectional area and length, the mass of a body of known volume and uniform density
C2 Circles and Trigonometry Arc Length and Sector Area, The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval	The significance of the centroid of a body as its centre of gravity/centre of mass The use of axes of symmetry of a uniform 2D figure to find its centroid
C3 Trigonometry Sin^{-1}, Cos^{-1} and Tan^{-1}, Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas	The position of the centroid of common non- symmetrical 2D shapes including right-angled triangle and semi-circle
C1 Inequalities and Simultaneous Equations Linear Inequalities, Quadratic Inequalities, Simultaneous Equations, Simultaneous Equations with Quadratics, Geometric Interpretation	The use of moment of area of uniform regular 2D shapes to find the position of the centroid of more complex uniform irregular shapes
C2 Circles and Trigonometry Arc Length and Sector Area, The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval **C3 Trigonometry** Sin^{-1}, Cos^{-1} and Tan^{-1}, Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas	The three classes of lever as class one, class two, class three Understand levers, pulleys and gearing including the concepts of mechanical advantage (MA) and velocity ratio (VR) applied to levers, systems of pulleys and gears Types of gears and gear systems, and their applications including spur gears, compound spur gears, idler gears, chain driven sprockets, bevel gears, rack and pinion and worm-gear and worm-wheel Calculation of MA and VR for spur gears and MA and VR for simple compound spur gear systems Different types of pulley and belt drive systems and their applications including V-belts, flat belts and toothed belts and calculation of their MA and VR
C1 Quadratic Equations Sketching Quadratic Graphs, Factorising a Quadratic, Completing the Square, The Quadratic Formula, The Discriminant	Understand properties of beams and different types of beams and their support conditions including simply supported, cantilever and continuous

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 3
C1 Differentiation Finding Tangents and Normals, Stationary Points, Increasing and Decreasing Functions, Curve Sketching. **C3 Differentiation** Chain Rule, Differentiation of e^x and In x, Product Rule, Quotient Rule, Relating Rates of Change **M2 Section 1 – Centre of Mass** Discrete Groups of Particles in 1 Dimension, Discrete Groups of Particles in 2 Dimensions, Standard Uniform Laminas, Composite Shapes, Centres of Mass in 3 Dimensions, Laminas in Equilibrium **M2 Statics of Rigid Bodies** Moments, Rigid Bodies, Rigid Bodies and Friction, Laminas and Moments	Different types of loading applied to beams including point loads and uniformly distributed loads and how to calculate, using conditions of static equilibrium, the reactions of beams including simply supported and cantilever How to calculate the bending moment at any point in simply supported or cantilever beams with point loading and how to draw a bending moment diagram for a simply supported or cantilever beam with point loading
C4 Differentiation of Sin, Cos and Tan, with Parametric Equations, Implicit Differentiation **C2 Integration** The Trapezium Rule, Areas Between Curves **C3 Integration** of e^x and 1/x, Volumes of Revolution, Numerical Methods, Location of Roots, Iterative Methods, Numerical Integration **C4 Integration of Sin and Cos** of f′(x)/f(x), Using the Chain Rule Backwards, Using Trig Identities	Understand principles of dynamic systems How to apply Newton's Laws of Motion in a mechanical engineering context and the constant acceleration formulae to problems set in a mechanical engineering context to include $v^2 - u^2 = 2as$, $s = ut + \frac{1}{2}at^2$, $v = u + at$, $s = \frac{1}{2}(u+v)t$ and $s = vt - \frac{1}{2}at^2$
M1 Kinematics Constant Acceleration Equations, Motion Graphs, Displacement, Velocity and Acceleration **M1 Dynamics** Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum **M1 Kinematics** Constant Acceleration Equations, Motion Graphs, Displacement, Velocity and Acceleration **M1 Vectors and Forces** Vectors, Forces and Modelling, Forces are Vectors, Friction	The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = $\frac{1}{2}mv^2$ and work done = force × distance

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 3
M2 Projectiles **M2 Uniform Circular Motion** Circular Motion, Conical Pendulums **M2 Energy, Work and Power** Work done, Kinetic and Potential Energy, The Work-Energy Principle, Power **M2 Collisions** Impulse, Collisions, Complex Collisions, Collisions and Energy	The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation $F \leq \mu N$ and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions

Unit 4 Principles of electrical and electronic engineering

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 4
C1 Algebra Fundamentals Laws of Indices, Surds, Multiplying Out Brackets, Taking Out Common Factors, Algebraic Fractions, Simplifying Expressions **C2 Polynomials** Factorising Cubics, Algebraic Division, The Remainder and Factor Theorems **C3 Algebra and Functions** Functions and Mappings, Composite Functions, Inverse Functions, Modulus, Transformations of Graphs **C4 Algebra and Functions** Simplifying Expressions, Algebraic Division, Partial Fractions	Understand fundamental electrical principles Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem Understand fundamental electrical principles
C2 Sequences and Series Sequences, Arithmetic Progressions, Arithmetic Series and Sigma Notation, Geometric Progressions, Sequence and Series Problems, Binomial Expansions **C1 Inequalities and Simultaneous Equations** Linear Inequalities, Quadratic Inequalities, Simultaneous Equations, Simultaneous Equations with Quadratics, Geometric Interpretation	Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem Understand electric motors and generators The difference between motors and generators and the application of the defining equation for a motor and generator The type of field winding and action of a separately excited DC generator, series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor
C1 Quadratic Equations Sketching Quadratic Graphs, Factorising a Quadratic, Completing the Square, The Quadratic Formula, The Discriminant **C1 Coordinate Geometry and Graphs** Coordinate Geometry, Equations of Straight Lines, Curve Sketching, Graph Transformations, Circles **C2 Logs and Exponentials** Logs, Exponentials and Logs **C3 Exponentials and Logarithms** e^x, In x and Graphs, Using e^x and In x – Solving Equations	Application of the defining equations for a separately excited DC generator, series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor Applications for a separately excited DC generator, series wound self-excited DC generator ,shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor DC motor starters to include a no-volt trip coil and an overload current trip coil How the speed of a DC shunt motor and a series DC motor can be changed Understand power supplies and power system protection

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 4
C2 Circles and Trigonometry Arc Length and Sector Area, The Trig Formulas, Using the Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval **C3 Trigonometry** Sin^{-1}, Cos^{-1} and Tan^{-1}, Secant, Cosecant and Cotangent, Using Trigonometric Identities, The Addition Formulas, The Double Angle Formulas, The R Addition Formulas	The meaning of an alternating current supply and a direct current supply The distribution of electrical energy to consumers by a single-phase 2-wire system, single phase 3-wire system, three phase 3- wire Delta connected system and a three phase 4-wire Star connected system How an alternating current can be rectified to a half wave direct current using a single diode and full wave rectification can be obtained by using two diodes but full wave rectification can be obtained by using four diodes in a bridge configuration The capability of load regulation to maintain a constant voltage or current level on the output of a power supply regardless of changes in the supply load How to draw a labelled block diagram of a stabilised power supply showing a AC input, transformer, rectifier, smoothing circuit, stabilising circuit and DC output The use of power-system protection How power supplies and electrical components can be protected by current limiting resistors, diodes, fuses and circuit breakers Understand analogue electronics The definition of an analogue circuit The characteristics of an operational amplifier (op-amp) including ideal op-amp The function and application of an inverting amplifier, a non-inverting amplifier and a summing amplifier State and apply the formula for a summing amplifier Vout Understand digital electronics The definition and function of a digital electronic circuit logic gates including truth tables for AND, NAND, OR, NOR, NOT, XOR and solve simple combinational logic problems Recognise simple Boolean expressions

Unit 23 Applied mathematics for engineering

OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 23
Application of: **C2 Logs and Exponentials** Logs, Exponentials and Logs, **C3 Solving Equations** e^x, In x and Graphs, Using e^x and In x – **C2 Circles and Trigonometry** Arc Length and Sector Area, Sine and Cosine Rules, Graphs of Trig Functions, Transformed Trig Graphs, Solving Trig Equations in a Given Interval **C3 Trigonometry** Sin^{-1}, Cos^{-1} and Tan^{-1}, Secant, Cosecant and Cotangent, Trigonometric Identities, Addition Formulas, Double Angle Formulas, The R Addition Formulas	Be able to apply trigonometry and geometry to a range of engineering situations. Decompose composite shapes into triangles, circles, circle segments and other shapes (volume, surface area of solids with straight and curved sides). Frequency, amplitude and phase angle in periodic functions, simple harmonic motion Common trigonometric identities, relationships between angles and lengths in given geometric configurations
Application of: **C1 Algebra Fundamentals** **C2 Polynomials** Factorising Cubics, Algebraic Division, **C3 Algebra, Functions and Mappings** Composite Functions, Inverse Functions, Modulus, Transformations of Graphs, **C4 Simplifying Expressions** Algebraic Division, Partial Fractions **C2 Sequences and Series** Arithmetic Progressions, Arithmetic Series and Sigma Notation, Geometric Progressions, Sequence and Series Problems, Binomial Expansions **C3 Algebra and Functions and Mappings** Composite Functions, Inverse Functions, Modulus, Transformations of Graphs	Be able to apply knowledge of algebra, equations, functions and graphs to engineering problems Evaluate composite expressions including polynomials, trigonometric terms, exponential terms, logarithmic terms and terms involving negative and fractional powers. Indices and logarithms with different bases, manipulate and rearrange algebraic equations using fundamental laws of algebra, solve equations involving one unknown using basic algebraic manipulation and evaluation

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 23
C1 Quadratic Equations Sketching Quadratic Graphs, Factorising a Quadratic, Completing the Square, The Quadratic Formula, The Discriminant	Solve quadratic equations by factorisation, completing the square and by using the standard formula
C1 Inequalities and Simultaneous Equations Linear Inequalities, Quadratic Inequalities, Simultaneous Equations, Simultaneous Equations with Quadratics, Geometric Interpretation	Solve linear simultaneous equations with up to two unknowns, graphs of functions of a single independent variable, interpret values, given numerical data from graphs Calculate constants in functions of a known general form given sufficient numerical information Derive equations of straight lines that are tangential to and normal to a given function at a given point, represent inequality relationships in graphical form, identify poles, zeroes and asymptotes of functions Express functions that have a polynomial denominator as a sum of partial fractions Complex numbers, express complex numbers, determine the conjugate of a complex number, simplify complex expressions, manipulate expressions and solve equations involving complex numbers
C1 Tangents and Normals Stationary Points, Increasing and Decreasing Functions, Curve Sketching **C3** Chain Rule, Differentiation of e^x and In x, Product Rule, Quotient Rule, Relating Rates of Change **C4** Sin, Cos and Tan, with Parametric Equations, Implicit Differentiation	Standard derivatives, how to apply differentiation methods to a range of functions and applications, differentiation of functions containing trigonometric, exponential and logarithmic terms, differentiation of functions involving products, quotients and functions of a function, identification of stationary points of a function, using second derivatives to identify local maximum and minimum values Relate first and second order derivatives to physical rates of change such as speed and acceleration
C2 The Trapezium Rule Areas Between Curves **C3** e^x and 1/x, Volumes of Revolution, Numerical Methods, Location of Roots, Iterative Methods, Numerical Integration **C4** Sin and Cos, of f′(x)/f(x), Using the Chain Rule Backwards, Using Trig Identities, Integration by Substitution and by Parts, Differential Equations	Standard integrals, apply integration methods to a range of functions and applications, integration of a range of algebraic functions including those containing trigonometric and exponential terms, integration by parts using the formula, by using other related methods e.g. integration by substitution

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 23
C1 Algebra Fundamentals Laws of Indices, Surds, Multiplying Out Brackets, Taking Out Common Factors, Algebraic Fractions, Simplifying Expressions **C2 Polynomials** Factorising Cubics, Algebraic Division, The Remainder and Factor Theorems **C3 Algebra and Functions** Functions and Mappings, Composite Functions, Inverse Functions, Modulus, Transformations of Graphs **C4 Algebra and Functions** Simplifying Expressions, Algebraic Division, Partial Fractions	Understand applications of matrix and vector methods Learners will be taught matrix notation, rectangular matrix, column vector and a row vector
C2 Sequences and Series Sequences, Arithmetic Progressions, Arithmetic Series and Sigma Notation, Geometric Progressions, Sequence and Series Problems, Binomial Expansions	The notation for an element in the ith row and jth column in a matrix is ij a and the representation of matrices and matrix elements Transpose of a matrix AT, how to represent linear simultaneous equations with two unknowns in matrix notation, calculate the value of a 2 by 2 determinant, perform addition, subtraction and multiplication of matrices and vectors with two rows and two columns, the concept of the matrix inverse A–1, how to determine the inverse of a 2 by 2 matrix, that A–1.A = A .A–1 = I
C1 Inequalities and Simultaneous Equations Linear Inequalities, Quadratic Inequalities, Simultaneous Equations, Simultaneous Equations with Quadratics, Geometric Interpretation **M1 Vectors and Forces** Vectors, Forces and Modelling, Forces are Vectors, Friction **M1 Kinematics** Constant Acceleration Equations, Motion Graphs, Displacement, Velocity and Acceleration	Solve linear simultaneous equations with two unknowns using matrix methods How to represent position vectors and direction vectors in component form, perform vector operations of addition, dot product and cross product and calculate the magnitude of a vector, use vector notation and vector operations to solve problems involving spatial position, velocity and forces Mathematical modelling skills

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OCR's A Levels in Mathematics	OCR's Level 3 Cambridge Technical in Engineering – Unit 23
M1 Dynamics Newton's Laws, Friction and Inclined Planes, Connected Particles, Momentum **M2 Section 1 – Centre of Mass** Discrete Groups of Particles in 1 Dimension, Discrete Groups of Particles in 2 Dimensions, Standard Uniform Laminas, Composite Shapes, Centres of Mass in 3 Dimensions, Laminas in Equilibrium **M2 Statics of Rigid Bodies** Moments, Rigid Bodies, Rigid Bodies and Friction, Laminas and Moments **M2 Uniform Circular Motion** Circular Motion, Conical Pendulums **M2 Energy, Work and Power** Work done, Kinetic and Potential Energy, The Work-Energy Principle, Power **M2 Collisions** Impulse, Collisions, Complex Collisions, Collisions and Energy	Represent aspects of physical problems in terms of abstract mathematical formulae, manipulate given formulae to derive mathematical models and solve problems How to formulate and solve mathematical models of practical problems using common laws of physics including Newton's laws of motion, Ohm's law, Kirchhoff's laws, Hooke's law, Newton's law of cooling and the principles of energy conservation Interpret numerical results in the context of the problem being solved, reflect on results in order to verify their feasibility and validity, the importance of recognising the implications of simplifying assumptions in mathematical models

The small print

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