ENGINEERING: OCR- CAMBRIDGE TECHNICAL - LEVEL 3

Year 13

What are the aims and intentions of this curriculum?

Cambridge Technical Engineering level 5 is practical, accessible, fun to teach and exciting to learn, it inspire students to develop real-world skills to prepare them for their future. Additionally, the course develops students so they are able to identify market opportunities and solve problems, which contribute to the development of mathematical and scientific new products and systems. This is a vocational qualifications designed with the workplace in mind and provide a high-quality alternative to A Levels. This qualification is about educating students in the knowledge and skills required for employment and for the community as a whole. It is also about developing the behaviours and attributes needed to progress and succeed in education and in work. It is for learners over the age of 16 who wish to specialise or progress into a specific sector or occupational group, through advanced/higher apprenticeships, further study or employment. This course seeks to develop your knowledge, understanding and skills required in industry. This course compliments Maths, Science, Physics, Business studies and creative subjects.

UNIT 4

Term	Topics	Knowledge and key terms	Skills developed	Assessment
Autumn 1	Understand fundamental electrical principles.	Application of the defining equations for: • resistance • power • energy • resistors connected in series • resistors connected in parallel Measurement of voltage, current and resistance in a circuit using a: • voltmeter • ammeter • ohmmeter • multimeter Circuit theory, i.e. • calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel • Kirchhoff's first law and its application	Use the appropriate equations for DC circuit analysis. Appropriate connection of meters to circuits to measure voltage, current and resistance. Correct range selection. Internal meter resistance requirements when measuring voltage, current or resistance. Define and apply appropriate laws and circuit theorem. Use circuit theory to analyse resistor networks supplied by a single DC voltage source.	Summative assessment. Class activities/worksheets Past paper questions.

		• Kirchhoff's second law and its application • the maximum power transfer theorem	Understand calculation of current, potential difference and/or power consumed for individual components of a circuit.	
Autumn 2	Understand alternating voltage and current.	What is meant by a simple generator? What is meant by an alternating current (AC) and generated electromotive force (e.m.f.) Diagrammatic representations of a sine wave. Diagrammatic representations of a sine wave. Phase difference and phase angle in alternating quantities. Circuit diagrams and phasor diagrams for: • a pure resistance being supplied by an alternating current • a pure inductance being supplied by an alternating current • a pure capacitance being supplied by an alternating current • a pure resistance and inductance in series • a pure resistance and capacitance in series Application of the defining equation for reactance (X) and impedance (Z) for: • pure resistance • pure inductance • pure capacitance Application of the defining equation for impedance for: • pure resistance and inductance in series • pure resistance and capacitance in series Circuit diagrams and phasor diagrams.	Interpreting and sketching graphs of AC waveforms. Quantifying phase in degrees or radians. 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.	Summative assessment. Class activities/worksheets Past paper questions.
Spring 1	Understand electric motors and generators.	The difference between motors and generators. Application of the defining equation for:	Understand the difference between motors and generators and the application of the defining equation for a motor and generator.	Summative assessment.

		• motor • 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 • shunt-wound DC motor 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 • 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 • shunt-wound DC motor DC motor starters to include a no-volt trip coil and an overload current trip coil.	Understand 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. Understand how the speed of a DC shunt motor and a series DC motor can be changed. 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.	Class activities/worksheets Past paper questions.
Spring 2	Understand power supplies and power system protection.	The meaning of: • an alternating current supply • a direct current supply The distribution of electrical energy using: • single-phase 2-wire system • single phase 3-wire system • three phase 3- wire Delta connected system • three phase 4-wire Star connected system How: • an alternating current can be rectified to a half wave direct current using a single diode • full wave rectification can be obtained by using two diodes	Understand power supplies and power system protection. The meaning of an alternating current supply and a direct current supply. Understand 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. Understand how an alternating current can be rectified to a half wave direct current using a	Summative assessment. Class activities/worksheets Past paper questions.

		• 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: • AC input • transformer • rectifier • smoothing circuit • stabilising circuit • DC output Power-system protection. How to explain, with the aid of labelled diagrams, how power supplies and electrical components can be protected by: • current limiting resistors • diodes • fuses • circuit breakers	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. Understand how power supplies and electrical components can be protected by current limiting resistors, diodes, fuses and circuit breakers.	
Summer 1	Understand analogue electronics. Understand digital electronics. Revision on all topics covered. Past papers	The definition of an analogue circuit. The characteristics of an operational amplifier (opamp. Labelled diagram of an op-amp. Characteristic properties of an ideal op-amp. How to draw a labelled diagram and explain the function of: • an inverting amplifier • a non-inverting amplifier	Understand analogue electronics. Explain the definition of an analogue circuit. Know the characteristics of an operational amplifier (op-amp) including ideal op-amp. How to draw a labelled diagram of an op-amp. Understand the function and application of an inverting amplifier, a non-inverting amplifier and a summing amplifier.	Class activities/worksheets Past paper questions.

		• a summing amplifier Application of the defining equation for gain in: • an inverting amplifier • a non-inverting amplifier The definition of a digital electronic circuit. How to draw a labelled diagram (symbol) and explain the function of the logic gates: • AND • NAND • OR • NOR • NOT • XOR How to construct truth tables for: • AND • NAND • OR • NOR • NOT • XOR Boolean expressions. Circuit symbols	State and apply the formula for a summing amplifier Volt. Understand digital electronic. Explain 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 State and apply the formula for a summing amplifier. How to solve simple combinational logic problems. How to recognise simple Boolean expressions. How to explain with the aid of a circuit symbol the function of: • T type bi-stable flip-flop • D type bi-stable flip-flop Explain the behaviour of a rising-edge triggered D flip-flop	
Summer 2	Exam	June 2024		

UNIT 10

Term	Topics	Knowledge and key terms	Skills developed	Assessment
Autumn 1	Be able to produce 3D models using Computer Aided Design (CAD).	Modelling tools to produce 3D models. sketch-based features i.e. o sketch tools i.e. o lines, arcs, splines, polygons (e.g. rectangles, hexagons) o extrudes, revolves o sizing and dimensioning o applied features i.e. fillets, chamfers, shelling, holes, drafts Reference geometry i.e. work planes, axes, points, co-ordinate systems. Pattern features i.e. mirror, linear and circular arrays/patterns. Advanced solid modelling tools i.e.: • features i.e. • swept features • lofted/blended features • variable section features (e.g. creating loft/blend or swept • features with multiple sections) • helical sweeps (e.g. springs, coils or thread geometry) • Sheet metal (e.g. folds, pressings, flattened geometry).	Know how to use solid modelling tools to produce 3D models Know how to use advanced solid modelling tools. Use sketch-based features to create geometry. Use applied and pattern features to create solid models.	Class activities/worksheets
Autumn 2	Be able to produce 3D models using Computer Aided Design (CAD).	Projected or intersection geometry i.e. • projected curves or sketches • intersection curves • curves through XYZ or reference points	Use mathematical calculation to solve reference geometry problems for use within the production of CAD models.	Class activities/worksheets. Course work

		• configurations and table driven features e.g. • configured parts and product families • component geometry driven through formulas and tables Surface modelling i.e. • surface construction geometry e.g. curves, splines • extruded, revolved, swept and lofted/blended surfaces • boundary surfaces, planar/flat or filled surfaces • advanced curve geometry e.g. guide curves, intersection • curves, projected geometry	Use features, projected or intersection geometry and configuration and table-driven features to create geometry. Use surface modelling techniques to enhance a 3D model.	
Spring 1	Be able to create 3D assemblies of components within a CAD system.	Aspects of assembly i.e. • multiple component assemblies • patterning components • in-context modelling i.e. creating model geometry within an assembly • exploded views • animation • How to apply constraints or mates (e.g. coincident, parallel, tangent, offset, symmetric). • Standard parts (e.g. nuts, bolts, screws and fixings, motors, bearings). Automatic population of assemblies based on geometry (e.g. automatically adding bolts to standard hole specifications).	Create CAD assemblies with multiple components. Apply constraints within assemblies that appropriately define the position or movement of the model. Create exploded views and animations of 3D CAD assemblies.	Class activities/worksheets. Course work.
Spring 2	Be able to produce 2D CAD engineering drawings.	Formats and templates: • border templates • formats	Create a range of views within 2D engineering drawings. Create 2D engineering drawings that include appropriate dimensions and annotations.	Class activities/worksheets Course work.

		• standards • critical information Projection and units: • first and third angle projection • section views • detailed views • auxiliary views • isometric views • scale Dimensioning and annotations: • dimensioning styles e.g. linear, polar, baseline • manufacturing information e.g. surface finish, weld symbols, fit and tolerances. Assembly drawings: • tables and balloons • Bill of Materials (BOM) • parts lists • use of standard parts Different views: • exploded views • sub-assemblies Drawing standards (e.g. current British Standards e.g. BSI – BS 8888:2011; ISO, ANSI	Create detailed engineering drawings of assemblies. Create engineering drawings which conform to British or International Standards. Understand how to use formats and templates. Understand how to use projection and units. Know how to apply dimensioning and annotations.	
Summer 1	Understand the use of simulation tools within CAD systems.	Types of simulation: • motion i.e. ➢ movement of assemblies ➢ collision detection	Explain how simulation tools are used in the design of engineering components, products or systems.	Class activities/worksheets Course

		➢ gears, drives, motors or pulleys Manufacturability: • draft analysis • mould flow • tooling production • shrinkage allowance • machining simulation • jig and fixture development Finite Element Analysis: • pressure testing • loads/forces applied to components • torsional testing of components • meshing of geometry Computational Fluid Dynamics (CFD) e.g. • mould flow • material flow • thermal conductivity • fluid flow • aerodynamic efficiency	Assess the advantages and disadvantages of using simulation tools to assist engineering design. Understand manufacturability and the use of its tools. Explain and assess how CAD software might be used to perform simulation (e.g. motion analysis, finite element analysis, computational fluid dynamics). It is not required for learners to perform simulation using CAD software for this LO, which is considered in detail in another unit.	
Summer 2	Course work final submission			

UNIT 11 – MATERIAL SCIENCE

Term	Topics	Knowledge and key terms	Skills developed	Assessment
Autumn 1	Understand material structure and classification.	Material classifications and their microstructures, and how the microstructures affect the properties of the materials i.e. • atomic structures • amount of bonding • periodicity • classification of engineering materials • the crystalline structure of ferrous and non-ferrous metals and alloys, space lattice structures, grain sizes, crystal growth and solidification • the composition and structure of: ➢ plastics ➢ thermo-plastics ➢ long chain molecules ➢ thermo-setting plastics ➢ cross linking ➢ co-polymerisation • the crystalline structure of ceramics and glass and the properties of engineering ceramics e.g. tungsten carbide • the composition and structure of elastomers i.e. ➢ natural rubber ➢ styrene-butadiene ➢ polychloroprene ➢ butyl ➢ ethylene-propylene	Explain the relationship between material structure and classification. Analyse the effect of periodicity on the properties of materials.	Class activities/worksheets
Autumn 2	Understand properties, standard forms and failure modes of materials.	Definitions of material properties i.e. • hardness • toughness • elasticity/plasticity • ductility	Define the properties of materials.	Class activities/worksheets.

		• malleability • stiffness • conductivity/resistivity • machinability • fusibility • corrosion resistance • compressive strength • tensile strength • sheer strength • torsional strength Standard forms in which materials are supplied i.e. • sheet • bar • flat stock • ingot/billet • granules • liquid Safety factors and modes of failure i.e. • Failure Mode and Effects Analysis (FMEA) • work hardening • overstressing • fatigue • creep • sudden loads • expansion • thermal cycling • degradation	Describe the standard forms in which materials are available. Outline safety factors and modes of failure of materials. Explain how standard forms in which materials are available are influenced by their material properties. Explain the causes and effects of different modes of failure of materials.	
Spring 1	Understand material processing techniques.	The effects of different forming methods on the crystal forms/grain structures and properties of materials i.e. • different casting methods • press forming of sheet metal • hot forged components and comparison with cold formed or wasted component manufacture. • extrusion	Describe the effects of different forming methods in relation to material properties, composition and machinability. Analyse the effects of different heat treatment methods on material and component characteristics. Justify how engineering components benefit from being subject to a specific production process.	Class activities/worksheets. Course work

		The relationship between the machinability of a material and its composition / structure / properties / performance. Heat treatment and its use in modifying material and component characteristics and stress relief i.e. • the interpretation of thermal equilibrium diagrams and their application • annealing • normalising • hardening • tempering • case hardening e.g. carburising, nitriding The effects of alloying on melting points and strength. The heating and forming of thermo plastic and thermo setting materials and the effects on the properties of the materials.	Analyse the effects of different heat treatment methods on material and component characteristics. Describe the effects of common processing methods for forming thermo setting and thermo plastic materials Interpret a thermal equilibrium diagram for ferrous and non-ferrous alloys.	
Spring 2	Know the applications and benefits of modern and smart materials.	key features of modern materials i.e. • Glass Reinforced Plastic • carbon fibre • MDF • composites Key characteristics and properties of smart materials. i.e. • shape-memory alloys • shape-memory plastics • Quantum Tunnelling Composite (QTC) • nano materials • conductive polymers • self-healing polymers	Describe typical applications of modern materials with reference to their features and characteristics. Describe typical applications of smart materials with reference to their features and characteristics. For a given product or component analyse how a modern material has replaced a traditional material. For a given product or component analyse how a smart material has replaced a traditional material.	Class activities/worksheets Course work

		Applications of modern and smart materials with reference to their features and characteristics (e.g. heat and pressure sensors, contact sensors, reflective signs and clothing, security markers, mechanical power transmission, active dampers).		
Summer 1	Be able to test the suitability of materials for different applications.	How to carry out practical investigations to prove the suitability of materials for various applications i.e. • abrasion resistance • resistance to corrosion • electrical conductivity/resistivity • thermal conductivity • toughness • thermal expansion	Carry out tests to prove the suitability of a range of materials for their intended applications. Evaluate the suitability of a selection of materials for their intended applications. Justify the use of alternative materials for their intended applications.	Class activities/worksheets Course work
Summer 2	Final submission of course work.			