Key Stage 4 Curriculum Overview 2020 – 2021 – GCSE Engineering

Year	Key learning	Term 1	Term 2	Term 3	Term 4	Term 5	Term 6
Year 10	Topic/ Key ideas	<u>Engineering Materials</u> Materials and properties. Costs and supply. Factors influencing design solutions. <u>Manufacturing processes</u> Additive Manufacturing. Material removal. Shaping and forming. Manufacturing a Simple Candle Holder (Basic workshop Practice)	<u>Manufacturing processes</u> Casting and moulding. Joining and assembly. Heat and chemical treatment. Surface finishing. <u>Systems</u> Structural systems. Pneumatic systems 3D CAD Modelling/ Manufacturing a Engineers Clamp Team Project	<u>Systems</u> Mechanical systems. Electrical systems. Electronic systems. 3D CAD Modelling/ Manufacturing a Engineers Clamp Team Project/Using Programmable microprocessors	<u>Systems</u> Electronic systems. 3D CAD modelling techniques/PCB design and manufacturing	<u>Testing and investigation</u> Modelling and calculating. Testing. Aerodynamics. PCB design and manufacturing	<u>The impact of modern technologies</u> <u>Engineering skills</u> Engineering drawings and schematics. CAD/CAM/CNC. Testing materials. NEA introduction and section 1.
	Learning objectives	**<u>Materials and Properties:</u> Metals and Alloys** Physical appearances and the following properties: • toughness/brittleness • ductility • malleability • hardness • strength and stiffness Ferrous metals and alloys: • cast iron • low and high carbon steels • steel alloys (stainless steel). Non-ferrous metals and alloys: • aluminium • copper • lead • zinc • alloys (brass and bronze). Mechanical properties of these metals • the addition of materials to form alloys • methods which affect the grain size (heating) • cold working • hardening and quenching • corrosion • addition/subtraction of carbon in steels. **Polymers** Thermoplastics: • ABS • acrylic • nylon • polycarbonate • polystyrene. Thermosetting polymers: epoxy • polyester and	**<u>Manufacturing processes cont…</u>** **Turning**: • cylindrical • tapered • boring. **Drilling**: • using a pillar drill • centre drilling in the lathe. **Milling**: • face • slot. Drilling: • using a pillar drill • centre drilling in the lathe. **Chemical etching:** • PCB manufacture **Casting and moulding.** • Pressure die casting. • Sand casting. • Injection . **Joining and assembly.** Permanent and temporary methods: • rivets • threaded fastenings • soldering (soft and hard) • brazing • welding. **Heat and chemical treatment.** • Normalising. • Annealing. • Hardening. • Quenching. **Surface finishing.** • Normalising. • Annealing. • Hardening. • Quenching. **<u>Systems</u>** **Systems descriptions** • system block diagrams (input, process and	**<u>Systems cont…</u>** **Mechanical systems.** Linkages • Conversion of motion including rotary to reciprocating and linear to oscillating. • Gear trains including chains and sprockets • Cams and followers (including the use of cams within an engine). Ratio of simple gears and mechanical advantage • Pulleys (how pulleys can be used as a means of reducing effort when lifting loads or transferring power within a system). • Bearings **Electrical systems.** Electrical systems comprising: • power supplies (mains and batteries) • input control devices (for example relays and switches) • output devices (motors, buzzers, bells, lamps and solenoids). The difference between Alternating and Direct Current. **Electronic systems will start as described in term 4.**	**<u>Systems cont…</u>** **Electronic systems.** Electronic systems comprising: • inputs (for example light or temperature sensors) • analogue and digital signals • process devices: • timers • counters • comparators • logic (AND, OR and NOT). Programmable devices: microcontrollers eg peripheral interface controller (PIC) used to perform more complex operations or replace discrete process integrated circuits. Interfacing components: drivers required for loads that process or programmable devices cannot supply (transistor, field-effect transistor (FET)). The use of analogue to digital conversion (ADC) in a programmable device. • Output components • LEDs • 7 segment display • buzzer • piezo sounder	**Electronic systems will continue into this term. Additionally:** **<u>Testing and investigation</u>** **Modelling and calculating.** Using mathematics or computer modelling to predict performance of systems, design and test electronic circuits and calculate hydraulic/pneumatic forces. The ability to calculate: • area • volume • stiffness • density • Young's Modulus • factors of safety • forces within/applied to a component or a system • conversion of load/extension to stress/strain (when investigating tensile strength of a material) • resistance in series and parallel, current or voltage. **Testing.** Methods of testing and evaluating materials and structural behaviour under load, including determining tensile/compressive strength. Using calculations, simulations and modelling either manually or with Computer Aided Design (CAD) to: • design and test electronic circuits • calculate hydraulic/pneumatic forces.	**<u>Engineering skills</u>** Analyse and evaluate existing solutions to problems using flowcharts and block diagrams. **Engineering drawings and schematics.** Produce and work to a series of engineering drawings or schematics. Both mechanical and electrical/ electronic, which must be drawn using current conventions such as drawings in: • orthographic (3rd angle) • 3D representation (Isometric) • assembly • section view. **CAD/CAM/CNC.** Use CAD to assist in the creation of a solution. : • CAD in both 2D and 3D. • Examples of 2D being Circuit diagrams, PCB layout, orthographic views. • 3D being solid modelling, isometric views. • CAM can be 2D or 3D. • Laser cutting, vinyl cutting, PCB routing or hole drilling, turning. • Rapid prototyping, milling/ routing. Use Computer Numerical Control (CNC)/Computer Aided Manufacture

		melamine resins • polyurethanes • vulcanised rubber. The effects of heat on these materials **Composites** Fibre reinforced polymers (FRP): • carbon-fibre reinforced polymer • glass reinforced plastic (GRP). • Plywood. • Medium Density Fibre board (MDF). • Oriented Strand Board (OSB). **<u>Factors influencing design solutions.</u>** Energy production methods: • wind • solar • tidal • nuclear • fossil fuels • biomass. Engineered lifespans. • Planned obsolescence. • • Sealed parts. • • Maintenance requirements The need for and methods of maintenance of engineered products. to: • ensure safety in operation • • enable efficiency of operation. T The reasons for the following types of maintenance work: • lubrication • • avoiding corrosion • • compensating for wear • • End of Life (EOL), disposal and recovery of materials . Understand that statistics can be used to predict service intervals and expected lifetime of components. Engineered solutions can be inhibited by the availability and forms of materials— cost is affected by the availability of materials, and using non-standard forms will increase cost. **<u>Costs and supply.</u>** The cost, availability, form and supply of the materials in the engineering materials section. Calculation of costs to manufacture/ produce items.	output) • schematic drawings • flow charts. **Structural systems.** Students should know how simple imposed, dynamic (live) and static (dead) loads are applied and transmitted, including space frame and monocoque structures, leading to bending and torsion/buckling. The uses of and differences between pneumatic and hydraulic circuits. Exam questions may focus on the specific circuits and students may be expected to provide an example of when the different types of circuits could be used and why. Examples include: • robotics • process/factory automation • machinery. **Pneumatic systems** The uses of and differences between pneumatic and hydraulic circuits. When the different types of circuits could be used and why. Examples include: • robotics • process/factory automation • machinery.		Discrete components within a circuit: • resistors (fixed and variable) • diodes (signal, rectifying) • capacitors (polarised and nonpolarised). Simple programming for monitoring and controlling processes: using flow charts for explanation, limited to three inputs and three outputs within an engineered system eg a pick and place machine used in the production of electronic circuits.	Destructive and non-destructive testing. Testing control programs for programmable devices through modelling and enactment. Modifying a program to improve performance. Quality control methods. **Aerodynamics.** Understanding lift, drag and thrust.	(CAM) in the manufacture of a solution. **Testing Materials** Test materials and their structural behaviour under load in order to ascertain suitable material(s) for a chosen component.

		The ability of engineering materials to be machined, treated, shaped or recycled. **<u>Manufacturing Processes</u>** Knowledge and understanding of the following manufacturing processes and techniques including: • which process is appropriate for specific materials • how these processes would be carried out. • **Additive Manufacturing:** • Fused deposition. • Sintering (for metals). • Rapid prototyping (for polymers) **Material removal:** • **Cutting**. • sawing • shearing • laser. **Shaping and forming.** Shaping by forming and manipulation: • bending • folding • press forming • composite lay up • punching • stamping. **Practical skills include; marking out, cutting, bending, drilling, sheet metal work and machining.**	**Practical skills include; marking out, cutting, bending, drilling, sheet metal work and machining**	**Practical skills include: Using Solidworks, 2D design, laser cutter, 3D printing.**	**Practical skills to include; electromechanical interfacing, using prototype board and manufacturing PCBs**	**Practical skills to include; electromechanical interfacing, using prototype board and manufacturing PCBs**	**NEA structure/assessment and section 1**
	Key Assessment and when? **Key homework and resources to support learning**	**Classwork assessed to feed DD1** **Ongoing assessment of practical work** **Student resources located in studentapps/common data. Online resources from Hodder** **Homework to reinforce theory** **Homework related to research for practical element**	**End of term test on theory to feed DD2** **Summative assessment of practical work** **Student resources located in studentapps/common data. Online resources from Hodder**	**Ongoing assessment of classwork** **CAD project submission to feed parent's Evening** **Student resources located in studentapps/common data. Online resources from Hodder**	**End of term test on theory to feed DD3** **Ongoing assessment of practical work** **Student resources located in studentapps/common data. Online resources from Hodder**	**Ongoing assessment of classwork** **Ongoing assessment of practical work** **Student resources located in studentapps/common data. Online resources from Hodder**	**Mocks and Summative assessment of practical work feed DD4** **Student resources located in studentapps/common data. Online resources from Hodder**
Year 11	**Topic/ Key ideas** **Learning objectives**	**<u>Engineering skills</u>** **Production plans.** **Predicting performance.** **Selecting materials, parts, components, tools and equipment.** **NEA sections 2, 3 and 5** **<u>Production plans</u>** Produce and follow a production plan taking into account: materials, processes, time and safety. **<u>Selecting materials, parts, components etc</u>** Select and safely use a range of appropriate:	**<u>Engineering skills</u>** **Selecting and using processes.** **Applying QC** **Designing tests to assess fitness for purpose.** **NEA sections 3, 4, 5 and 6** **<u>Testing/QC</u>** Apply quality control methods and techniques during the manufacture of a product. Methods and techniques will include: • working to necessary	**Theory mop up and exam prep** **NEA 'mop up'** **Theory mop up**	**Theory mop up and exam prep** **Revision for exam**	**Revision/Exam** **Revision for exam**	

		• materials • parts • components • tools • equipment. In order to manufacture a working solution. **<u>Predicting performance</u>** Using calculations and modelling. Through systems modelling and data analysis.	tolerances • demonstrating the ability to check tolerances through the use of tools (Vernier calipers, micrometers and depth gauges) • using software (CNC/CAM) to ensure that all parts/ components fit together allowing the solution to function. Design a range of tests to assess the fitness for purpose and performance of a completed product, taking into account how areas for improvement/ modification could be identified and suggest alternative solutions. **<u>Selecting processes.</u>** Select and use appropriate processes in order to manufacture a working solution. Examples include: • measuring • marking • turning • milling • drilling • forming • bending • casting • joining • fastening • folding • shaping • finishing.				
		Completion NEA sections 2, 3 and 5	**Completion of NEA sections 3, 4, 5 and 6**	**NEA response to initial draft submission.**			
	Key Assessment and when?	**Theory tested through lesson and Homework. Controlled assessment through deadlines and review sessions**	**Theory tested through lesson and Homework. Controlled assessment through deadlines and review sessions Mock Exams**	**Theory tested through lesson and Homework. Controlled assessment through deadlines and review sessions**	**Theory tested through lesson and Homework. Practice Papers and questions**	**Practice Papers and questions**	
	Key homework and resources to support learning	**Student resources located in studentapps/common data. Online resources from Hodder Homework to reinforce theory Homework related to Controlled Assessment**	**Student resources located in studentapps/common data. Online resources from Hodder Homework to reinforce theory Homework related to Controlled Assessment**	**Student resources located in studentapps/common data. Online resources from Hodder Homework to reinforce theory Homework related to Controlled Assessment**	**Student resources located in studentapps/common data. Online resources from Hodder Homework to reinforce theory Homework related to Controlled Assessment**	**Student resources located in studentapps/common data. Online resources from Hodder Homework to reinforce theory Practice Papers**	