GCSE Engineering Curriculum Overview 2021-2022

Core aims of the subject at Key Stage 4

Our curriculum at Brine Leas strives to present a range of opportunities for students to develop their breadth and depth of technical skills and knowledge. The students can then apply these along with scientific principles and mathematical skills to project-based problems and theoretical scenarios, establishing good habits of learning which encourage life-long learning. Students develop practical and technical skills as they design and make prototypes and products that solve real life problems within a variety of contexts, considering both the needs, wants and values of themselves and others. We will encourage students to take risks in their design approaches and aim to develop resourceful, innovative and enterprising young learners who can go on to be the next generation of engineers and practitioners. We deliver life skills, engineering skills, health and safety, teamwork, facilitated learning, confidence, workshop skills, Computer Aided Design and Computer Aided Manufacture, management skills, working independently. We have fantastic facilities with engineering machinery that mirrors industry. The core skills of English, Maths and Sciences are applied to engineering problem solving, designing and building. The specification covers modern engineering technologies, materials and processes, and established engineering practices. The 'hands on' a and project-based areas of this course provide challenging opportunities for personal development and opportunities for the academic learning to be seen and experienced as applied to a real situation. Completing this GCSE Engineering course provides advantageous preparation for students wishing to undertake further Engineering or technology-based education at KS5 and also provides experience and knowledge sought by employers in the industrial engineering community.

Students taking this course are exposed to a wide range of engineering processes including Computer Aided Design, machining, heat treatment, welding, Fabrication and electronic circuits. Technically minded students will be inspired by these experiences and motivated to develop and apply their gained engineering knowledge during the major project task. Most pupils experience a massive sense of achievement as they complete the project and look back at their journey over the designing and engineering of a product and on their personal development.

Trips and visits

Not applicable

Assessment

Ongoing informal assessment will be mainly short and long written answers to examination style questions and drawing based exercises. The formal assessment which determines the final grade is in two parts;

1) NEA (Non-Exam Assessment): Practical engineering
What's assessed

• Application of skills, knowledge and understanding in a practical context.
• Analysis and evaluation of evidence.

How it's assessed

• A brief set by AQA released on 1 June in the first year of study.
• 80 marks
• 40% of GCSE

Questions

Students produce:

• Engineering drawings or schematics to communicate a solution to the brief.
• An engineering product that solves a problem.

2) Question paper: Externally assessed

What's assessed

Sections 1–6 from the subject content. Though the 'Practical engineering skills' section will predominantly be assessed through the NEA, some questions in the written exam will relate to practical contexts and students will need to apply their understanding within these contexts.

How it's assessed

• Written exam: 2 hours
• 120 marks
• 60% of GCSE Questions
• Multiple choice questions assessing breadth of knowledge.
• Short answer questions assessing in depth knowledge, including calculations.
• Multiple choice questions related to the application of practical engineering skills.
• Extended response questions drawing together elements of the specification.

Homework

Students are set home work to reinforce and practice the learning completed during lessons and to prepare for the external examination. Homework will be set fortnightly. Students are also expected to complete their coursework portfolio for the NEA (Non Exam Assessment).

Clubs and/or intervention

Students are welcome to attend the weekly Blacksmithing and Engineering club, to make use of the workshop facilities, computers and CNC machines.

Parental/Carer support

Monitor progress and encourage the completion of the NEA portfolio. Encourage the watching of 'how it's made', 'Forged in Fire', 'Mega Engineering' type of programs.

Helpful sources of information

The intranet contains various files and documents to assist with completion of this course and is available via the school computers and also from any internet linked home computers via the portal.

Useful websites:
https://www.heta.co.uk/
http://www.ceata.co.uk/
https://www.raf.mod.uk/
https://www.bbceng.info/
www.technologystudent.com.

Year 10 Overview

Term	Knowledge	Assessment	Connections to learning	Connections to future pathways
Autumn 1	What is Engineering? It is vital for students to develop their knowledge of what engineering is about in order for them to make informed decisions for their future position within the national and global economy. The UK is aiming to develop a new smart style of engineering for which engineers are needed, and the country is short of engineers. Engineering covers a wide range of disciplines that will enable students to apply their mathematical, scientific and engineering skills to real-life problems.			

	Students should have increasing confidence in the knowledge required to perform the following: • Read and understand orthographic drawings. E.g. the conventions of dimensioning and tolerances. • Measuring and marking out methods.	• Application of skills through completion of set practical tasks. • Application of knowledge through written short answer questions and completion of set drawing exercises.	Prior learning in D&T (Y7-9) • Templates and drawings to follow and create. • Manufacture of products • Evaluation of outcomes Future learning in Engineering • Read an engineering drawing when responding to an engineering brief (Y11)	Careers • Mechanical technician • Maintenance technician • Mechanical engineer • Production engineer • Automotive engineer • Maintenance engineer • Design engineer • Structural engineer • Design • General Engineering • Electrical Engineering

	• Turning, using manual or CNC lathe. • Cutting using hand tools.			• British Aerospace • The Forces • British Space Industry • Renewable Sector • Environmental Sustainability • Construction • Civil Engineering Future learning • Engineering • Product Design • Physics • Maths
	• Drilling, using both pillar drill and lathe, Using a jig • Know how to calculate Areas, Volumes for a range of 2D and 3D complex shapes. • Know how to calculate Density	• Examination style written questions.		

Autumn 2	**What is it made of?** Using the right materials in particular applications is a key factor to the success of most engineering projects. Students should have knowledge and understanding of the following groups/classifications of engineering materials. Students should be able to identify these materials based on their physical appearances and the following properties: • toughness/brittleness • ductility • malleability • hardness strength and stiffness. Students should also be able to demonstrate knowledge and understanding of the behavioural characteristics of materials during handling/machining.

	Students should have increasing confidence in the knowledge required to perform the following: ○ Bending and forming sheet metal and small bar. ○ Material hardness testing ○ Hot working/forging case hardening.	○ Application of knowledge through a mixture of short and long answer written questions, design challenges and production of technical drawings, ○ Application of skills through completion of set practical tasks. ○ Comparison of test results and summarising conclusions.	Future learning in Engineering ○ Creating a specification when responding to an engineering brief (Y11)	Careers ○ Design engineer ○ Structural engineer ○ Metallurgists Future learning ○ Engineering ○ Product Design ○ Physics ○ Maths
Spring 1	**Standard Materials and processes** It is ok to have a brilliant idea, but if it needs to be made of a material or via a process which is not available, then it may cost more or take longer to make than the idea is worth. If it can be made from standard materials and via standard processes, then the idea can be quickly realised. Students should have knowledge and understanding of the cost, availability, form and supply of common engineering materials, and be familiar with the capabilities of commonly used engineering processes.			

	Students should have increasing confidence in the knowledge required to perform the following: • Shaping and finishing, filing, milling, use of abrasives • Following a provided production plan • Awareness of health and safety. Using PPE and conducting risk assessments. • Adhere to workshop safety. Procedures.	• Application of knowledge through written short answer questions and production of technical drawings, • Application of skills through completion of set practical tasks. • Examination style written questions.	Future learning in Engineering • Creating a Production plan and risk assessments when responding to an engineering brief (Y11)	Careers • Health and safety officer • Production planner • Automotive finish specialist Future learning • Engineering • Product Design • Physics • Maths

	Know how to calculate using: • metric units and standard form • Ohm's law and resistance			
Spring 2	**Engineering Electronic Systems** Many, if not most, engineered products contain electronic systems of varying complexity. Engineering such systems to perform safely and seamlessly is a well paid profession and is an area of engineering with particularly high demand for competent engineers. Students should have knowledge and understanding of the use and role of control systems within engineering settings. Students should be familiar with the function of system building blocks and be able to describe the way in which parts of a system can be divided into sub-systems.			

	Students should have increasing confidence in the knowledge required to perform the following: • To program a system to respond to its environment. • Using Pickaxe, a graphical programming language. Program a microcontroller based device to control a system. • To be able to include sensors in a circuit	• Completion of building and programming a microprocessor controlled electronic system. Comparing the system with a specification and summarising conclusions from the challenge. • Examination style written questions.	Future learning in Engineering • Creating a program when responding to an engineering brief (Y11)	Careers • Electronics Engineer • Mechatronics Engineer • Automotive Engineer • Aerospace Engineer • Robotics Engineer Future learning

	and adjust sensitivity and switching points. • To be able to include low powered output devices in to a circuit. Know how to calculate: • Stress, strain and Youngs modulus • Pressure and factors of safety			

Summer 1	**Mechanical Systems** Nearly all products contain simple mechanical systems, many products contain countless and complex mechanical systems. From a bottle opener to the landing gear on an aircraft, mechanical systems enable us to make otherwise impossible changes with minimum effort. Understanding the principles of these systems will enable students to apply them to new situations and problems as well as to be able to maintain and to fix existing systems when they stop working.			
	Students should have increasing confidence in the knowledge required to describe and specify the following: ○ Mechanisms ○ Gearing ○ Transmitting power using shafts, gearing systems, belts and pulleys, chains and sprockets ○ Linkages, push-pull, bell crank, cranks and four bar mechanisms	○ Completion of practical experiments ○ Application of knowledge through examination style questions.	Future learning in Engineering ○ Creating a specification when responding to an engineering brief (Y11)	Careers ○ Mechanical technician ○ Maintenance technician ○ Mechanical engineer ○ Production engineer ○ Automotive engineer ○ Maintenance engineer ○ Design engineer Future learning ○ Engineering ○ Product Design ○ Physics ○ Maths
	including crank-slider, parallel motion ○ Cams ○ The need for bearings.			

Summer 2	**Pneumatic systems** Used in fake sharks in film studios, nuclear plants, factories, brakes and suspension on large vehicles and trains and those doors on the Starship Enterprise, pneumatic systems are used to control and to do work which would be unsuitable for systems utilising electrical power. This unique system has its own sets of standards of diagrams, health and safety procedures and operating knowledge. It also has its own advantages and disadvantages and quirks.			
	Students should have increasing confidence in the knowledge required to describe and specify the following: ○ Pneumatics ○ Using or demonstrating how pneumatics can be used to activate or control mechanical systems ○ Single and double acting cylinders ○ Applications, bus/train doors, testing rigs eg IKEA, tailgate operation on hatchback cars.	○ Completion of practical pneumatic systems ○ Application of knowledge through examination style questions. ○ Mock Examination.	Future learning in Engineering ○ Designing a product when responding to an engineering brief (Y11)	Careers ○ Production engineer. ○ Test engineer ○ Automotive technician ○ Special effects engineer Future learning ○

Year 11 Overview

Term	Knowledge	Assessment	Connections to learning	Connections to future pathways

Autumn 1	**NEA (None Examination Assessment) Independent project.** Each year, the examination board release a new theme for which this project is based upon. The project is designed to simulate aspects of working on a real engineering project whilst maintaining a manageable project within the limitations of school facilities. It is also very much an opportunity for pupils to continue learning whist producing a portfolio upon which they are assessed. There is a common structure for students to follow in completing this project, however the level of complexity, ingenuity and accuracy with which students complete each step will allow students to push themselves to different levels governed by their ability and effort. This is the opportunity for students to apply and extend their existing engineering understanding, to their own individual design and make project.			
	Students should be confident in the knowledge of the following: ○ Overview of project structure and assessment objectives. ○ The examination board annual project theme. ○ Familiarisation with similar existing solutions, the situation and context of the problem to be solved ○ Problem analysis ○ Problem solving ○ Design sketches	○ Completion of Problem Analysis section of the portfolio ○ Completion of the problem solving section of the portfolio ○ Examination style written questions.	○ Application of learning completed during Y10	Careers ○ Mechanical technician ○ Maintenance technician ○ Mechanical engineer ○ Production engineer ○ Automotive engineer ○ Maintenance engineer ○ Design engineer Future learning ○ Engineering ○ Product Design ○ Physics ○ Maths

	• Quick modelling techniques. • CAD modelling Know how to calculate: • Gear ratio and mechanical advantage • Know how to interpret and plot graphs • Know how to determining gradients of graphs			
Autumn 2	**Planning and Production of a prototype** Having analysed and defined an engineering problem/opportunity, designed and developed a solution, the next big phase of the project is to plan and make a working prototype. Real world engineers regularly face the same task, the decisions made at this stage regarding the materials, processes, methods determine the level of success of the prototype. Nobody gets it perfect first time (that's why we make prototypes before we make the final solution). The design process is cyclic not linier, we design then make, then we evaluate and improve the design and re make it better. Then we start again from a more informed position, and so it goes on. Modern cars are obvious examples of this continuous cycle of improvements. During this project students complete one cycle of the design process.			

	Students should have the knowledge required to complete the following portfolio sections. ○ manufacturing diary ○ production plans that are appropriately annotated and, for the higher marks, self documenting ○ (an approach that identifies and explains	○ Planning section of the portfolio completed ○ Photographic evidence of the manufacturing process completed ○ Photographic evidence of the completed prototype ○ Detailed notes justifying the processes chosen compared t alternative methods which could have been used	○ Application of learning completed during Y10	Careers ○ Mechanical technician ○ Mechanical engineer ○ Production engineer ○ Automotive engineer ○ Design engineer Future learning ○ Engineering ○ Product Design ○ Physics ○ Maths

	different production methods as appropriate, ○ alternative material possibilities and production methods, and the quality control methods that could be adopted). ○ evidence of the solution that is made clear in detailed photographs of the product. ○ Evaluation of the process and prototype ○ Know how to perform calculations using trigonometry	○ Detailed notes explaining how quality control methods have been applied to the making process ○ Detailed written evaluation of the process and prototype and suggested improvements ○ Examination style written questions.		

Spring 1	**Application of Science and Maths.** The IMechE's (Institute of Mechanical Engineers) definition of engineering is "the profitable application of science and technology", whilst this is only one opinion, it implies that engineers need to understand 'science', 'technology' and maths in order to apply these profitably. Whilst most engineers earn a relatively good rate of pay, the best engineers, I.e. chartered, well qualified or with an excellent track record, can command high salaries. All engineers, at whatever level need to have a sound understanding of the science, technology and maths. The next term is about developing this understanding and preparing for the final examination at GCSE level. Success here could be considered as a stepping stone to a rewarding and well rewarded career.			
	Students should know how to describe and specify the following: ○ Metals and alloys ○ Ferrous metals and alloys:	○ Application of knowledge through examination style questions. ○ Completion of past examination paper.	○	Careers ○ Mechanical technician ○ Mechanical engineer ○ Production engineer ○ Automotive engineer ○ Design engineer

	• cast iron • low and high carbon steels • steel alloys (stainless steel). ○ Non-ferrous metals and alloys: • Aluminium • Copper • Lead • Zinc • alloys (brass and bronze) Polymers Thermoplastics: • ABS • Acrylic • Nylon • Polycarbonate • polystyrene. ○ Thermosetting polymers: • Epoxy • polyester and melamine resins • polyurethanes • vulcanised rubber. Composites • Fibre reinforced polymers(FRP)	○ Application of knowledge through examination style questions. ○ Application of knowledge through examination style questions. ○ Application of knowledge through examination style questions. ○ Application of knowledge through examination style questions. ○ Application of knowledge through examination style questions. ○ Application of knowledge through examination style questions.		Future learning ○ Engineering ○ Product Design ○ Physics ○ Maths

	• carbon-fibre reinforced polymer • glass reinforced plastic (GRP). • Plywood. • Medium Density Fibre board (MDF). • Oriented Strand Board (OSB). • Structural concrete. Other materials • Timbers (structural grades) • Ceramics ○ Cost, availability, form and supply of the metals, alloys, polymers, composites and other materials listed. ○ Calculation of costs to manufacture/produce items to inform the development of an engineered solution in industry. ○ The ability of engineering materials to be:			

	machined
	treated shaped
	recycled.
	
	- Energy production methods:
	  • Wind
	  • Solar
	  • Tidal
	  • Nuclear
	  • fossil fuels
	  • biomass
	
	- Engineered lifespans.
	
	- The need for and methods of maintenance of engineered products.
	
	- Engineered solutions can be inhibited by the availability and forms of materials.
	
	- How user requirements affect material choice and manufacturing process.
	
	- Cutting:
	  • sawing • shearing
	  • laser.			

	○ Turning: • cylindrical • tapered • boring ○ Milling: • face • slot ○ Drilling: • using a pillar drill • centre drilling in the lathe ○ Chemical etching: • PCB manufacture ○ Shaping by forming and manipulation: • bending • folding • press forming • composite lay up • punching • stamping ○ Casting and moulding • Pressure die casting. • Sand casting. • Injection moulding. ○ Permanent and			

	temporary joining methods:			

	• rivets • threaded fastenings • soldering (soft and hard) • brazing • welding ○ Heat and chemical treatment • Normalising. • Annealing. • Hardening. • Quenching. ○ Surface Finishing • Painting. • Dip coating. • Electroplating. • Galvanising. • Polishing. Systems ○ System block diagrams. ○ Students should know and be familiar with the following: 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). • Pulleys (how pulleys can be used as a means of reducing effort when lifting loads or transferring power within a system). • Bearings. Electrical systems • 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 • 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 • Interfacing components: drivers • required for loads that process or • programmable devices cannot supply • (transistor, fieldeffect transistor • (FET)). • The use of analogue to digital • conversion (ADC) in a programmable • device. 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. Pneumatic systems • 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. • Students should know and be familiar with the following: Modelling and calculating • Predicting performance in any of the systems referred to in Systems • 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. Know how to perform calculations regarding cost and averages Know how to perform calculations using Pythagoras' theorem.			
Spring 2	Examination Practice and Revision.			

	Students should know and be familiar with the following: Testing	○ Application of knowledge through examination style questions, and past examination papers.	○	Careers ○ Mechanical technician ○ Mechanical engineer ○ Production engineer ○ Automotive engineer ○ Design engineer
	○ Methods of testing and evaluating materials and structural behaviour under load, including determining tensile/compressive strength.			Future learning ○ Engineering ○ Product Design ○ Physics ○ Maths
Summer 1	Examination Practice and Revision Continued.			
	○ Practice papers	○ Application of knowledge through examination style questions, and past examination papers. ○ Final external examination.	○	○

Summer 2				