Unit	Staff	Term	Pathway delivered in	Year delivered in	Why this unit now?	Key knowledge/content to learn and retain	Why this topic now?	Link to other units / subjects	Anticipated misconceptions	Links to KS4	SMSC & British Values	Cultural Capital / Big Picture	Visit / talk opportunities	Career links
Unit 1 - Maths for Engineering	**MKN**	**Autumn**	**All**	**12**	This unit will develop the mathematical skills that underpin the course in all units.	A1. Basic Algebra; A2. Logs and Trigonometry	Algebra skills necessary for further work. Logs important for analysis of systems and Trig essential for electrical systems and mechanics	A Level Maths mapping guide https://www.ocr.org.uk/Images/346191-a-level-mathematics-mapping-guide.pdf A level Physics mapping guide https://www.ocr.org.uk/Images/343978-a-level-physics-mapping-guide.pdf	Using correct formulas and techniques to answer problems. Use of radians instead of degrees.	Extension of GCSE Maths. Introduction of advanced topics.		Application of maths skills to engineering problems. Northern Power Grid sessions. Links to A level maths and physics, spiralises curriculum and understanding from this.	Northern Power Grid	Any Engineering role, statistical process controller
		Spring				Sp1. Geometry; Sp2. Differentiation	Geometry necessary for wider understanding of 3D world. Differentiation essential for understanding further work.		Using correct formulas and techniques to answer problems.	Some extension of GCSE Higher topics. Introduction of advanced topics				
		Summer				Su1. Integration; Su2. Statistics	Integration completes the calculus picture and Statistics helps the students collect and analyse data.			Extension/Revision of Statistics. Introduction of Integration.				
Unit 2 - Science for Engineering	**EPE**	**Autumn**	**All**	**12**	This unit will develop the scientific skills that underpin the course in all units.	Understand applications of SI units and measurement. Understand fundamental scientific principles of mechanical engineering	SI units is core for all scientific work. Fundamental principles of mechanical has to be secure to build on for fluids and thermal later in the year.	A Level Maths mapping guide https://www.ocr.org.uk/Images/346191-a-level-mathematics-mapping-guide.pdf A level Physics mapping guide https://www.ocr.org.uk/Images/343978-a-level-physics-mapping-guide.pdf	Difference between accuracy and precision. Application of scalars and vectors. pplication of the equations of motion.	Extension of GCSE Science. Introduction of advanced topics.				Chemical Engineer, Aerospace Engineer, Automotive Engineer, Electrical Engineer
		Spring				Understand fundamental scientific principles of electrical and electronic engineering. Understand properties of materials			Difference between power, work and energy. Phenomena of capacitance and inductance.	Some extension of GCSE Higher/tripple topics. Introduction of advanced topics				
		Summer				Know the basic principles of fluid mechanics. Know the basic principles of thermal physics	Most complex topics covered, spiralises with POME, A level phyiscs and A level maths		Difference between laminar and turbulent fluid flow. The gas laws. Relationships between heat energy terms: specific, sensible and latent heat					
Unit 3 - Principles of Mechanical Engineering	**MKN**	**Autumn**	**All**	**12 - Diploma 13 - Extended Certificate**	This unit will develop learners' knowledge & understanding of the fundamental principles that underpin mechanical engineering.	A1. Shapes; A2 Forces	Principles of shapes willl underpin other units. Forces necessary for further units.	A Level Maths mapping guide https://www.ocr.org.uk/Images/346191-a-level-mathematics-mapping-guide.pdf A level Physics mapping guide https://www.ocr.org.uk/Images/343978-a-level-physics-mapping-guide.pdf	Using correct formulas and techniques to answer problems.	GCSE Maths and Sciences	Rule of law - calculations and safety factors for mechanical systems.	Links to A level physics, spiralises curriculum and understanding from this.	North Sea Winches	Mechanical Engineer Aerospace Engineer Automotove Engineer Civil Engineer
		Spring				Sp1. Centroids and Intro to Dynamics; Sp2. Complete Dynamics and Materials.	Extend force ideas into practical situations. Introduce motion and particles. Analyse forces applied to materials.							
		Summer				Su1. Energy and Intro to Machines; Su2. Complete Machines and Beams	Further extension of force ideas into work done. Application of mathematical ideas to basic machines.							

Unit 4 - Principles of Electrical Engineering	**MBR**	**Autumn**	**All**	**12 - Diploma 13 - Extended Certificate**	This unit will develop learners' knowledge & understandiong of the fundamental principles that underpin electrical and electronic engineering.	Au1: Understand fundamental electrical principles Au2: Understand alternating voltage and current.	To reinforce / refresh learners' understanding of electrical units and defining electrical equations. Underpins theory required for U5 EED.	A level physics and maths: mathematical theory of alternating waveforms, including the terms amplitude, frequency and periodic time.	Difference between power and enerygy; applying Kirchhoffs Laws, Using radians for angular fequency; determining overall impedance and phase angle using phasor diagrams	Physics and electrical topic in Science. OCR Cambridge Nationals Programmable systems		Big picture thinking - how new electrical and electronic innovations create opportunities to bring about major infrastructure change - the difficulty associated with battery technology and development of novel and smart materials. Development of infrastructure and long term power grid requirements e.g. Hornsea One, Two and Three; Electric Car Charging points. Issues to do with sustainability and electrical / electronic waste and building for repair (or not) Skills shortages and the need to be flexible and dynamic in response to challenges.	Deep Sea Electronics	Electrical Engineer, Electronics Engineer, Automation Engineer, Space System Engineer; Satellite Engineer, Satellite Systems Engineer; Renewable Energy Engineer; Industrual Internet of Things (IoT) Engineer. Emedded Systems Engineer; Robotics Engineering; Radio Frequency (RF) Engineer. Telecom Engineering. Control Systems Engineer. Special Effects Technician, Sound Engineeer, Broadcast Engineer, Project Manager, Nuclear Engineer, Software Engineer. Intelligence Analyst.
		Spring				Sp1: Understand electric motors and generators. Sp2: Understand power supplies and power system protection	Beginning to apply theoretical content from Faraday and Lenz's laws and applying them in context.	A level physics and maths.	Application of motor and generator defining equations.				Castle Group Northern Power Grid	
		Summer				S1: Understand analogue electronics. S2: Understand digital electronics	At this stage, to identify the differences between analogue and digital circuits, introducing learners to the concept of circuits that contain both analogue and digital electronics- research the advantages, disadvantages and applications of both techniques	A level / Level 3 Computer Science, A level physics, A level maths	Operating an op-amp circuit with different parameters and applications.				Schneider Electric	
Unit 5 - Electrical and Electronic Design	**RSH**	**Autumn**	**Electrical - Ext. cert & Dip**	**12**	Builds core and foundation knowledge needed for unit 6,7 and 8 whilst also secures understanding from unit 4.	Be able to apply AC and DC circuit theory to circuit design	Foundation knowledge needed for rest of unit. Also embeds and spiralies content from unit 4	Unit 1 - maths for Engineering Unit 2 - Science for Engineering Unit 4 - Principles of Electrical Engineering	Kirchoffs laws and manipulation of Ohms law	Physics and electrical topic in Science. OCR Cambridge Nationals Programmable systems	The benefit of electrical engineers and electronic engineers in society: Government Catapult Networks and UKRI		Deep Sea Electronics Castle Group	Electrical Engineer, Electronics Engineer, Automation Engineer, Space System Engineer; Satellite Engineer, Satellite Systems Engineer; Renewable Energy Engineer; Industrual Internet of Things (IoT) Engineer. Emedded Systems Engineer; Robotics Engineering; Radio Frequency (RF) Engineer. Telecom Engineering. Control Systems Engineer. Special Effects Technician, Sound Engineeer, Broadcast Engineer, Project Manager, Nuclear Engineer, Software Engineer. Intelligence Analyst.
		Spring				Understand the application of electromagnetism in electrical design. Be able to apply a systems approach to electrical design	Develops from AC and DC knowledge, spiralises unit 4 and 6		Manipulation of motor and generator formula					
		Summer				Be able to use semiconductors in electrical and electronic design. Understand the application of programmable process devices in electronic design	Provides knowledge for unit 6, spiralises unit 4 and 6		Understanding of N and P type materials. Understanding of programmable control systems					

Unit 6 - Circuit Simulation and Manufacture	**NGR**	**Autumn**	**Electrical - Ext. cert & Dip**	**12 - Diploma 13 - Extended Certificate**	Develops and applies knowledge from unit 4 and 5	Be able to use Computer Aided Design (CAD) for circuit design and simulation	Building on Level 2 knowledge, CAD skills are essential to draft and develop circuits. The rapid ability to create a circuit and then use a wide range of virtual test equipment is valuable in terms of validating circuit design.	Unit 2 - Science for Engineering Unit 4 - Principles of electronic and electrical engineering Unit 5 - Electrical and electronic design	Most circuit simulation software packages require the connection of a 'ground' terminal in order for the simulation to run. They also require all wires to be connected to a node in the circuit (i.e. no stray or unconnected wires). Design rule error checking may detect errors if the simulation fails to run. Learners may need to be reminded of the requirements of the particular software being used in order for their simulations to run correctly.	Physics and electrical topic in Science. OCR Cambridge Nationals Programmable systems	SMSC- what are the moral implications for creating more and more complex circuitry which uses greater densities of componensts and is harder and harder to recycle - these are big issues - electronics and sustainability need to have a beter relationship - linking to UN SDG's.	Big picture thinking - circuit design and simulation - the need for a working simulation to test a circuit or programming - field testing and re-iteration of solutions. Moral aspects relating to finite resources and space exploration. Product disposal and reclamation of materials - who is responsible? Circular design ideas - cradle to cradle thinking - how can electronics engineers be more sustainable - or is this someone else's problem? Sustainable Development Goals and how relevant (IE Essential) engineering innovation is to achieving them.	Deep Sea Electronics Castle Group	Electrical Engineer, Electronics Engineer, Automation Engineer, Space System Engineer; Satellite Engineer, Satellite Systems Engineer; Renewable Energy Engineer; Industrual Internet of Things (IoT) Engineer. Emedded Systems Engineer; Robotics Engineering; Radio Frequency (RF) Engineer. Telecom Engineering. Control Systems Engineer. Special Effects Technician, Sound Engineeer, Broadcast Engineer, Project Manager, Nuclear Engineer, Software Engineer. Intelligence Analyst.
		Spring				Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs). Be able to manufacture and construct electronic circuits safely.	After virtual testing and circuit verification, it is essential to practice both PCB design and verification - the process of design, test, review will be understood by this point.		Learners may need to be reminded that physical components have value tolerances which are sometimes not present in 'ideal' components used in simulation. Resistors typically have a tolerance of +/- 10% and capacitors of +/- 20%. Component tolerances may result in differences in simulation results and tests on physical circuits.					
		Summer				Be able to test and perform fault-finding on electronic circuits. Understand commercial circuit manufacture.	Building on content from Unit 4, 7 and 8. Live testing and fault finding - there are a range of strategies which can be used, and at this point, learners can interpret their data, and rectify any faults.		Learners often misread measurements taken with measuring instruments (e.g. multi-meter or oscilloscope). Multi-meters often have an auto-range function which scales voltage, current and resistance measurement readings. Learners may misread this value. Teachers might reinforce the importance of checking the setting or range selection on measuring instruments					
Unit 7 - Electronic Devices	**MBR**	**Autumn**	**Electrical - Dip**	**13**	Develops and applies knowledge from unit 4, 5 and 6	Understand semiconductor and programmable devices. Understand electrical sensors and actuators.	This builds on prior programmable systems knowledge, but goes in to more depth -the use of data sheets and how silicon can be doped to induce specific qualities.	Unit 1 - Maths for engineering Unit 2 - Science for engineering Unit 4 - Principles of electronic engineering Unit 5 - Electrical and electronic design Unit 6 - Circuit simulation and manufacture	Learners often have difficulty in understanding the operation of semiconductor devices. Practical experiments using physical devices in simple switching circuits may be a way to overcome this. Rotary actuators often work on the principle of servo motor control (e.g. a motor having some form of feedback).	Physics and electrical topic in Science. OCR Cambridge Nationals Programmable systems	Links to wider issues in society around programming and the increasing technological advances that happen. Morally - robotics and artificial intelligence. Morally - coding and bias, oversight and legislation - how do lawmakers keep up with the rapid pace of development?	Big picture thinking - signals processing and data - privacy and the rights of the individual (discuss) Security and snooping - the rights of the state to intercept and monitor citizens for the benefit and protection of all. GDPR and personal data - Programming is interconeected with all society and almost every aspect of human behaviour. Are robots innately good? What is the singularity? Discuss AI and potentially what the benefits and threats may be. Massive opportunity links to SMSC discussion - has to be limited though to enable unit completion. . .	Deep Sea Electronics Castle Group	Electrical Engineer, Electronics Engineer, Automation Engineer, Space System Engineer; Satellite Engineer, Satellite Systems Engineer; Renewable Energy Engineer; Industrual Internet of Things (IoT) Engineer. Emedded Systems Engineer; Robotics Engineering; Radio Frequency (RF) Engineer. Telecom Engineering. Control Systems Engineer. Special Effects Technician, Sound Engineeer, Broadcast Engineer, Project Manager, Nuclear Engineer, Software Engineer.
		Spring				Understand how to use signal conditioning techniques and signal conversion devices.	Having understood the nature of voltage signals, and analog and digital data - learners can begin learning about types and methods of signla processing.		Practical experiments (using simple model remote control servos) may be a way in which to improve understanding. The operation of simple A to D and D to A converters might be explained using the R-2R ladder principles. Learners could build (or simulate) and test the operation of the R-2R ladder. Learners often confuse the terms bit rate and baud rate. This online article explains the difference between bit and baud rate. Learners could practice solving problems where both are identical, and nonidentical.					
		Summer				Understand the application of smart and modern materials in electrical devices	Once data and its' manipulation and processing is understood, sensor and switch deisgn and actuators have been developed and have novel applications.							

Unit 8 - Electrical Operations	**MBR**	**Autumn**	**Electrical - Dip**	**13**	Develops and applies knowledge from unit 4, 5 and 6	Understand operating and performance characteristics of electrical and electronic components and devices. Be able to work safely with electricity.	It is vital that learners explore and deepen their knowledge of components.Using data sheets and breadboarding to exemplfiy compoennt performance is an accessible way to practically explore components - using the typical and absolute data values on data sheets. This links and will spiralise into learning for Unit 4,5,6 and 7.	Unit 1 - Maths for engineering Unit 2 - Science for engineering Unit 4 - Principles of electronic engineering Unit 5 - Electrical and electronic design Unit 6 - Circuit simulation and manufacture	Learners may need to be reminded that physical components have value tolerances which are sometimes not present in 'ideal' components used in circuit design or simulation. Resistors typically have a tolerance of +/- 10% and capacitors of +/- 20%. Component tolerances may result in differences in calculations and tests on physical circuits Learners often confuse the differences between Legislation, Codes and Standards. Teachers might introduce learners to various pieces of specific Legislation and electrical Codes and Standards – highlighting the differences in their legal standing.	Physics and electrical topic in Science. OCR Cambridge Nationals Programmable systems	Rule of Law: Working on electrical and electronic equipment and performing electrical operations are covered by Legislation and Codes of Practice (e.g. IET wiring regulations (BS7671), Health & Safety at Work Act). Standards are often used as a means of complying with a piece of Legislation. A Standard can be defined as a set of technical definitions and guidelines that function as instructions for designers, manufacturers, operators, or users of equipment.	The benefit of electrical engineers and electronic engineers in society: Typically they are responsible for selecting methods of circuit protection, creating detailed safe working method statements and risk assessments (including identification of appropriate PPE) We rely on skilled and trained engineers to use a variety of fault-finding procedures and test equipment to establish faults in electrical equipment in order to keep us safe.	Deep Sea Electronics Castle Group	Electrical and Electronic Engineer
		Spring				Be able to construct electrical and electronic circuits	This spirlaises U5 and U6 topics, and supports the development of a range of circuits which can be tested using a range of equipment next term.		Learners might perform suitable calculations and select cables for given applications using cable manufacturers or suppliers data sheets.					
		Summer				Be able to fault find in electrical and electronic equipment	Strong links at this point with Unit 6 - and building on experience with Unit 7 signal processing. Confidence with a wide range of test equipment, and signal interpretation will enable successful fault finding, analysis and rectification of any faults.		Learners often misread measurements taken with measuring instruments (e.g. multi-meter or oscilloscope). Multi-meters often have an auto-range function which scales voltage, current and resistance measurement readings. Learners may misread this value. Teachers might reinforce the importance of checking the setting or range selection on measuring instruments					
Unit 9 - Mechanical Design	**NGR**	**Autumn**	**Mechanical - Ext. cert & Dip**	**12**	Builds core engineering knowledge of mechanical design, materials and manufacturing processes. Prepares students for unit 10, 11, 13 and 17.	Be able to use graphical and engineering drawing techniques to communicate design solutions. Be able to select appropriate engineering materials to achieve design solutions.	Fundamental skills needed for the unit to be built upon.	Unit 1 - maths for Engineering Unit 2 - Science for Engineering Unit 3 - Principles of Mechanical Engineering Unit 10 - CAD Unit 11 - Materials Science Unit 13 - Mechanical Operations	Details and layouts requirements for BS8888 standards	OCR Cambridge Nationals Engineering Design and Manufacture	Rule of law - British Standards. Using DFMA principles for sustainability.	Designing real world components for local industry. Using British Standards BS8888 and DFMA principles. Understanding of different cultures - first and third angles used around the world.	Design Engineer, Draftsman	Deep Sea Electromnics Unison
		Spring				Be able to select appropriate engineering materials to achieve design solutions. Be able to design components that can be successfully manufactured	Design needs to of been considered to select materials and processes		Selection and justification of appropriate materials and processes					
		Summer				Be able to design components that can be successfully manufactured. Be able to optimise design to improve performance	Requires design to of been completed to undertake DFMA developments and modifications		Undertaking DFMA analysis and application of statistics for optimisation					
Unit 10 - Computer Aided Design	**NGR**	**Autumn**	**Mechanical - Ext. cert & Dip**	**12 - Diploma 13 - Extended Certificate**	Builds core engineering knowledge of Computer Aided Design and Solidworks (industry standard CAD software). Spiralises understanding from U9 and prepares students for unit 17.	Be able to produce 3D models using a range of modelling tools	Unable to access rest of unit without this key skills development.	Unit 1 - Maths for engineering Unit 2 - Science for engineering Unit 3 - Principles of mechanical engineering Unit 9 - Mechanical Design Unit 17 - CAM	Reminder about key aspects of Solidworks	OCR Cambridge Nationals Engineering Design and Manufacture	Rule of law - British Standards.	All CAD sessions are master classes from Unison CAD Engineer	Design Engineer CAD Engineer Mechanical Design	Unison
		Spring				Be able to create 3D assemblies of components within a CAD system. Be able to produce 2D engineering drawings.	More complex as joining multiple drawings - having to get multiple components to exactly match eachother on mating surface.		Types of mating and where to mate components.					
		Summer				Understand the use of simulation tools within CAD systems	Simulation requires deep understanding of components and software in order to conduct tests like CFD and FEA.		Set up of simulation					

Unit 11 - Materials Science	**NGR**	**Autumn**	**Mechanical - Dip**	**13**		Understand material structure and classification. Understand properties, standard forms and failure modes of materials.		Unit 1 - maths for Engineering Unit 2 - Science for Engineering	Different crystalline structures are sometimes difficult to understand, and vary within materials. Giving examples of crystalline structure for different materials may be useful.	OCR Cambridge Nationals Engineering Design and Manufacture. Chemistry - materials and elements	Rule of law - materials meeting required standards for application.	Work along side University of Hull and loacl engineering companies to conduct real world material testing	University of Hull CU Scarborough	Material Scientist Metallurgist
		Spring				Understand material processing techniques. Know the applications and benefits of modern and smart materials.			Understanding alloying and thermal equilibrium diagrams (TEDs)					
		Summer				Be able to test the suitability of materials for different applications								
Unit 13 - Mechanical Operations	**RSH**	**Autumn**	**Electrical & Mechanical Dip**	**13**		Planning for production, bench processes and using the centre lathe	Bench fabrication develops and retreives accuracy, measurements and marking techniques ready for machining	Unit 1 - Maths for engineering Unit 11 - Material science	Being accurate when using hand tools and ensuring tolerance is met.	OCR Cambridge Nationals Manufacture R014 and R015	Rule of law - machined to certain tolerance. Respect and tolerance - workshop proceedures	Manufacturing real world engineered products as part of assessment - Unison component - drawn in CAD unit.	BDC Machinery	Machinist, fitter, Manufacturing engineer
		Spring				Using centre lathes and milling machines	Develops from hand fabrication - uses more axis at a time and builds complexity		Being accurate when turning. Using more complex features such as thread cutting and turning between centres					
		Summer				Using milling machines and quality control of components	Develops from turning - uses more axis at a time and builds complexity and QC is evaluation of final products		Being accurate when milling, ensuring level work piece and using indexing head.					
Unit 14 - Automation Control and Robotics	**NGR**	**Autumn**	**Electrical & Mechanical Dip**	**13**	Develops from core engineering units from year 12. Develops understanding and application of Electrical and Mechanical units.	Understand control system theory in engineering. Understand the implementation of control in automated systems.	Core understanding to be build on	Unit 7 - Electrical Devices Unit 15 - EMHCP	That a programmable logic computer is an industrial personal computer. What is the difference between an analogue and a digital signal? The difference between on-line and off-line robot programming	OCR Cambridge Nationals Engineering Design, Manufacture & Programmable systems	Social understanding automation can lead to job losses in engineering sector	Application of knowledge from other units	Xandor	Control and instrumentation Engineer
		Spring				Understand sensors and actuators used in automation control systems. Know about industrial network systems.	Application of autumn term							
		Summer				Know about maintenance in automation control systems. Understand the application of robotics in automation control systems.	Application of developed knowledge of systems to be able to maintain them							
Unit 15 - Electrical, Mechanical, Hydraulic and Pneaumatic Control	**NGR**	**Autumn**	**Electrical & Mechanical Dip**	**13**	Develops from core engineering units from year 12. Develops understanding and application of Electrical and Mechanical units.	Understand mechanical elements of control systems.	Recap and embeds types of motion, mechanical elements in producing motion and friction	Unit 2 - Science for Engineering Unit 3 - Principles of mechanical engineering Unit 4 - Principles of electrical engineering Unit 7 - Electrical devices Unit 14 - Automation control and robotics	Angular motion produces centripedal not centrifugal forces. SI units for rotational speed are not revs/minute. Friction is dependant upon contact area. That hydraulic pumps produce pressure	Physics for motion types and friction. OCR Cambridge Nationals Programmable systems for electrical control.	Rule of law - high pressure components, mechanical safety factors and electrical failure rates	Some content spiralised with unit 14. Using Festo training boards as do Royal Navy engineering apprentices. Royal Navy Master Classes	Royal Navy Xandor Severfield	Electrical Engineer, Mechanical Engineer, Instrumentation and control Engineer
		Spring				Understand the electrical elements of control systems	Develops from mechanical and investigates sensors and actuators for control							
		Summer				Understand simple hydraulic and pneumatic systems	Applies knowledge from Autumn and Spring							

Unit 17 - Computer Aided Manufacture	**RSH**	**Autumn**	**Electrical & Mechanical Dip**	**13**	Develops on from Unit 10 CAD delivered in Y12	Be able to produce CNC programmes for the manuafcture of components, be able to set up and operate CNC machines	Develops on from CAD unit in Year 12 and deepens understanding of CNC manufacture. Students need to develop understanding about how the machines work and how they are programmed	Unit 10 - CAD Unit 13 - Mechanical operations	Solidworks set up and usage - if not undertaken in Y12 (electrical)	Develops on from OCR Cambridge Nationals Manufacture R014 and R016 and OCR Cambridge Nationals Design	Social understanding CAM can lead to job losses in engineering sector. Sharing information around the world from CAD and components can be made anywhere.	Spiralised from unit 10, develops and applies knowledge from CAD to CAM. Developed understanding of programming language G code.	IGUS UK	CAD Design Engineer, CNC operator, CNC programmer, Manufacturing Engineer, Quality controller / varience reduction Engineer
		Spring				Be able to set up and operate CNC machines, understand how computers are used in manufacturing	Application and development of Autumn term knowledge from G code and programming to operate the machine		G Code and programme understanding					
		Summer				Be able to produce components using additive manufacture	Application and development of Spring term knowledge from CNC router set up and operation							