UTC (Subject) Curriculum Narrative

Curriculum Intent

We believe that students deserve a creative and ambitious mathematics curriculum, rich in skills and knowledge, which ignites curiosity and prepares them well for everyday life and future employment.

Think Like An Engineer: We believe strongly in our curriculum pedagogy "**Think Like An Engineer**". The stages of this are as follows: Identify/Research/Plan/Create and Evaluate. Some examples of how we embed this pedagogy in our subject is as follows:

Identify: In mathematics we call on students to identify faults in logic or reasoning.
Research: We research strategies to embark on alternative solutions
Plan: We communicate to develop a systematic approach to problem-solving
Create: We explain our reasoning and create different forms of presentation having followed lines of statistical inquiry
Evaluate: We draw conclusions, reflect on our progress and look for opportunities to apply our mathematics in practical contexts
In short, as the language of the Scientist and the tool of the engineer, mathematics is the cornerstone of the school's curriculum.

Mathematics is a fundamental part of human thought and logic and integral to attempts at understanding the world and ourselves. It provides an effective way of building mental discipline and encourages logical reasoning and mental rigour. In addition, mathematical knowledge plays a crucial role in understanding the contents of other school subjects.

Mathematics has a transversal nature. If we reflect on the history of curriculum in general, then geometry and algebra were two of the seven liberal arts in Greece. This historical role supports the notion that mathematics provides the mental discipline required for other disciplines. Moreover, mathematical literacy is a crucial attribute of individuals living more effective lives as constructive, concerned and reflective citizens.

Mathematics is a part of our human cultural heritage, and we have a responsibility to develop it.

"Think like an Engineer"

Mathematics is a fundamental tool for modelling the behaviour of real-world environments and systems. In engineering it is used to explain observed phenomena and to predict the behaviour of objects which are designed or built. Mathematical models form the basis of Engineering theory and practice.

A career in any engineering or scientific field will require both basic and advanced mathematics. Without mathematics to determine principles, calculate dimensions and limits, explore variations, and prove concepts, there would be no mobile telephones, televisions, stereo systems, video games, microwave ovens, computers, or virtually anything electronic. There would be no bridges, tunnels, roads, skyscrapers, automobiles, ships, planes, rockets or most things mechanical. There would be no metals beyond the common ones, such as iron and copper, no plastics, no synthetics.

In accordance with work undertaken by The Centre for Real World Learning at the University of Winchester and commissioned by the Royal Academy of Engineering, our departmental ethos at UTC is underpinned by the afore-mentioned engineering "habits of mind".

Our Curriculum

White Rose Maths 1 Page Overview

As a department, our challenge is to inculcate these Engineering Habits of Mind throughout our curriculum and it is a challenge we relish.

We have chosen a Curriculum which offers learning experiences that enable students not only to become successful problem solvers, but to think of themselves positively as such, thereby developing greater resilience for learning in general. Students have opportunities to construct, test and discuss their own conjectures and so develop their self-confidence as 'doers' of mathematics.

This department believes that students who think like mathematicians should be:

Pattern Sniffers: Always on the lookout for patterns and the delight to be derived from finding hidden patterns and then using shortcuts arising from them in their daily lives

Experimenters: Performing tasks, playing with problems and conducting thought experiments allied to a healthy scepticism for experimental results

Describers: Able to play the maths language game. For example, giving precise descriptions of the steps in a process, convincing others and writing out proofs, questioning and offering opinions

Tinkerers: Taking ideas apart and putting them back together again

Inventors: Always inventing things – rules for a game, algorithms for doing things, explaining how things work, or axioms for a mathematical structure

Visualizers: Being able to visualise things that are inherently visual such as working out how many windows there are on the front of a house by imagining them, or using visualisation to solve more theoretical tasks

Conjecturers: Making plausible conjectures, initially using data and increasingly using more experimental evidence

Guessers: Using guessing as a research strategy, starting with a possible solution to a problem and working backwards to achieve the answer

We see these descriptors as wholly complementary to the "Think like an engineer" philosophy.

We have divided our curriculum into key strands for each of the National curriculum subject content areas (Number, Algebra, Ratio,Proportion and rates of change, Geometry and Measures, Probability and Statistics) and having ensured that every National Curriculum objective is met for each Focus Area of the Key Stages, we have supplemented them with **investigational activities.**

Investigations allow students to apply mathematical knowledge to solve problems whilst maintaining ownership of the steps they take in the process. They give students the opportunity to communicate mathematically: describing their thinking, writing definitions and conjectures, using symbols, justifying their conclusions, and writing and reading mathematics.

Investigations are involving and interesting activities that absorb students. They stimulate holistic thinking and can be integrated naturally in every part of the curriculum. They promote complex thinking yet reinforce basic concepts and in the view of the department,they constitute an essential part of every mathematician's work.

We believe that investigational mathematics should form an important element of the young mathematicians diet at UTC. Investigations come in all shapes and sizes and may be framed variously as: a question to be answered, a problem to be solved, a task to be accomplished, or an issue to be explored.

Students partake in micro investigations such as open-ended questions that have no one correct answer or small-scale problems where they find the same solution using different routes and pathways. Alternatively, macro investigations can involve a range of maths skills and concepts and be used as an ongoing teaching tool throughout the term that step by step scaffolds understanding.

A simple but wonderfully rich investigational examination of square numbers is given here.

Our rationale: Mastery vs Spiral - or both?

Our curriculum adopts a nuanced and balanced view towards the **Mathematical Mastery** and **Spiral** approaches. This is supported by **White Rose** mathematics.

Mastery

Our students are taught to fully grasp topics rather than scraping the surface,so that by the time they move on to more advanced lessons they have a deep understanding of foundational concepts. As a result, students benefit from improved learning retention and they develop mathematical understanding, reasoning and problem-solving abilities that will stay with them for life.

By offering students a variety of resources, we keep maths lessons fresh and engaging, helping students to develop their maths skills and encouraging deep learning with different types of problems applied to different contexts. Not all students have the same learning style and so this variety helps engage all types of learners.

Teaching for mastery involves differentiated resources but differentiated within the class' learning objective to ensure that Higher attainers are challenged with problems involving a greater degree of complexity. This encourages deep learning and means the whole class will progress at a similar pace. No one falls behind or suffers a confidence knock after seeing classmates progress more rapidly.

The journey to maths mastery involves both consolidation of prior knowledge and the development of new problem-solving and reasoning skills. Our aim is to improve students' mathematical fluency as well as pushing them to develop their understanding.

At UTC we aim to develop students' procedural fluency and conceptual understanding in tandem rather than relying heavily on procedures and algorithms which often fail to develop a deep and connected understanding. For those students who grasp ideas quickly, acceleration into new content is avoided. Instead, these students are challenged by deeper analysis of the lesson content and by applying the content in new and unfamiliar problem solving situations.
In line with research from the National Centre for Excellence in Teaching mathematics (NCETM), we believe that Five Big Ideas underpin teaching for mastery:

Coherence

Lessons are broken down into small connected steps that gradually unfold the concept, providing access for all children and leading to a generalisation of the concept and the ability to apply the concept to a range of contexts.

Representation and Structure

Representations used in lessons expose the mathematical structure being taught, the aim being that students can do the maths without recourse to the representation

Mathematical Thinking

If taught ideas are to be understood deeply, they must not merely be passively received but must be worked on by the student: thought about, reasoned with and discussed with others

Fluency

Quick and efficient recall of facts and procedures and the flexibility to move between different contexts and representations of mathematics

Variation

Variation is twofold. It is firstly about how the teacher represents the concept being taught, often in more than one way, to draw attention to critical aspects, and to develop deep and holistic understanding. It is also

about the sequencing of the episodes.

Flashback 4's

Our Maths 'Do it Now's' are Flashback 4's. 4 Mathematical questions that build effectively over a block of work to support students' previous learning in previous years and current learning. These are fully sequenced to support recall and revision of taught skills.

Our **sequencing** involves 'blocks' of mathematics in each year group. Within these blocks we have small steps which again are sequenced in order of difficulty and dependency. The key mathematical components of **fluency**, **reasoning** and **problem-solving** are integrated within these smaller steps.

Our sequencing Overview for Years 7-11 is here.

However, it is vitally important that topics are reviewed and this is where we draw upon the **spiral** element of our curriculum approach. Students will revisit a topic in different contexts and in different years. This will enhance their ability to make connections between topic areas. This 'gleaning with review' will happen regularly on their path towards mastery.

Alongside teachers' conventional good practice, assessments by examination occur during the year. A small assessment will occur after each block with larger ones at the end of each term. Setting will remain fluid, based on attainment and progress data. This will occur in fewer instances as the students continue their journey through the years but it is recognised that students develop mathematically at different stages on the pathway and those capable of achieving on the Higher route will be given that opportunity at the end of Year 10.

We have a responsibility to provide a broad and balanced curriculum for all pupils. Our curriculum is designed to give all learners the knowledge they need to succeed in life. It is inclusive. All students study the same topic areas and are offered support and challenges where appropriate.

We know that some students find concrete and pictorial representations useful as entry platforms to abstract concepts and we review topics in differing contexts.

Our Schemes of Learning clearly outline precursors to support staff and we have aimed to address potential problems with cognitive overload - an example being our use of calculators during the first Block of algebra in Year 7. The 'mastery through small steps' structure provides an opportunity for disadvantaged students or those with special educational needs and/or disabilities to progress at a suitable pace, whilst our approach to differentiation aims to cater also for those with high needs.
Our curriculum enables teachers to set suitable challenges, respond to diverse needs and to overcome potential barriers to learning. This may include 'parallel' activities.

Each of our eighty blocks which constitute the Year 7-11 curriculum has specifically tailored Lower Attainment Guidance for the Block. Furthermore, each Block contains half a dozen or so investigational Higher Attainment Activities (with teacher guidance). An example is here.

Assessment Cycle in Maths
We follow the above marking and feedback policy in Maths, which essentially means after each block of work students will be assessed formatively on what they have learnt, they will mark their work be given areas to develop which they will then work on in the next lesson in 'DIRT' and then resit that part or all of the assessment. Staff will 'presentation' mark students' books and give them a score. 1- being not good enough 2- being good and 3- being excellent.

Maths Homework System- Tassomai Rationale
In Maths our homework system is Tassomai. Students in KS3 must complete 30 minutes a week, in KS4 they must complete that plus will be given an additional 30 minutes to support revision towards exams.

Our Departmental SEN CPDs have used documentation such as - "Including students with SEN in secondary mathematics" (based on work originally initiated by the TDA). This led to a self-audit, raising awareness and drawing conclusions which led to greater focus and better practice.

We realise that students at different levels sometimes need a support programme to help them access and achieve in Mathematics, our interventions follow the UTC Graduated Wave Approach.
First and foremost we ensure teachers deliver 'quality first teaching' that is backed up by CPD and lesson observations to ensure quality assurance (this is a wave one intervention). A wave two intervention is put in place when a class finishes a block of work, students are formatively assessed using a block assessment and recognised at this stage as needing additional support. The following lesson follows the school 'DIRT' policy to re-teach the topic and re-assess the skill to see improvement.

Students are supported on each topic in this way for a full term as we recognise, for example, that a student might struggle on multiplying fractions but not on ratios. At the end of a full term students sit a summative assessment on everything they have learnt in that term. Students are then recognised for needing support in certain blocks and passed onto our intervention specialists for 6 weeks of 30 minutes intervention outside of Mathematics lessons and then retested on those topics.

Our setting procedures are rigorous and based on assessment data. We work with the Science department and Pastoral Teams to ensure that students are in the most appropriate class.

Resilience Pathway: Following the collection of internal data using national standards testing materials, there are three groups of students who will follow a **White Rose** pathway which is different to that followed by other groups in their cohorts. To be specific: 7M and 8R will follow the Year 5 pathway and 9M the Year 6 pathway. This will be regularly reviewed.

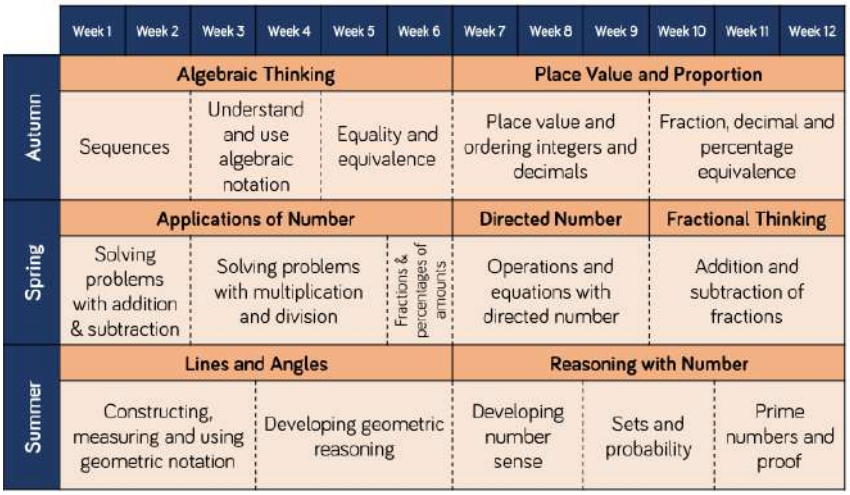
Key Stage 3 Curriculum

Literacy/Numeracy **Literacy and Numaracy Narrative Strategy**

Literacy in Mathematics

In Mathematics understanding key words is vital to students' success. They are used so regularly to describe specific skills that we have a key word definition list in our curriculum visible learning/PLCs that are located in the front of students' books that we refer to regularly in lessons.
In our do it now activities called 'Flashback 4s' students every day have a key word that they need to define to help strengthen their use of language.
Our marking and feedback policy focuses on 'presentation' marks of students books which includes correct spelling of key words used in do it now activities. Within the curriculum we must attend to the AO2 and AO3 Mathematical objectives of reasoning and problem solving. Students are asked to apply skills to context based questions and must be able to identify key words in the literature and draw at understanding to be able to answer the question at hand. Reasoning questions check whether students are able to articulate what is right and wrong and 'fix' incorrect questions using key word terminology. Students are therefore explicitly taught the importance of being precise and using keywords in their answers that make grammatical sense as well as fully answering the question.

Year 7



The journey begins with algebra -the language of generalisation. Students will arrive at UTC with a wide range of prior mathematical attainment and yet few will have studied much algebra. It's a fresh start, a new challenge and a level playing field. The focus will not be purely on procedures and routines. We want students to think like mathematicians as well as engineers. The tasks we recommend will encourage students to think, describe, reason, visualise, spot patterns, generalise and experiment - and to understand that algebra is powerful, beautiful and not an ill-digested farrago of rules.

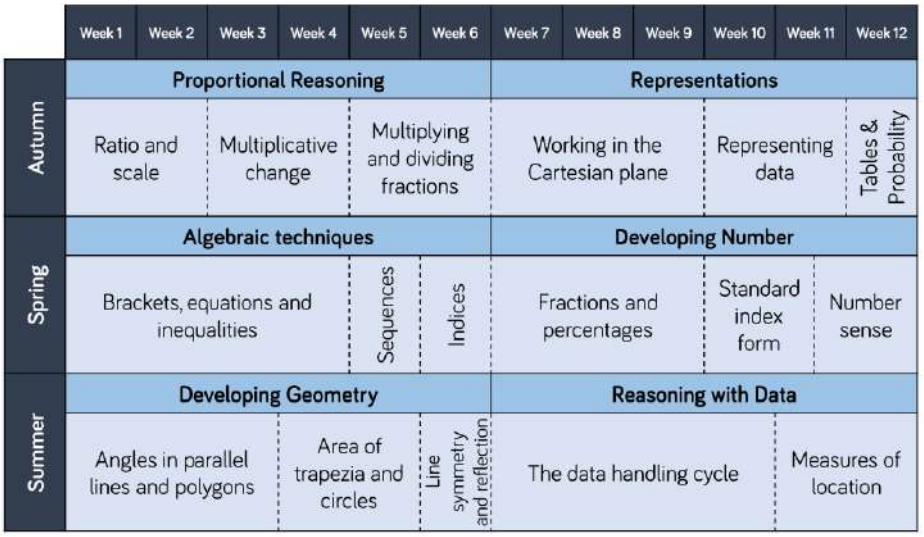
To level the field further, calculators will be made available for this block so that students' experience isn't impaired by their difficulties with numerical fluency. Furthermore, with no calculator paper at the end of KS2, algebra is a great vehicle for students to become more familiar with calculator functions. And perhaps most of all, it's fun!

Through interleaving, algebra will be revisited during the year.
Our curriculum places a heavy emphasis on Number in KS3. Our departmental analysis of recent test papers together with swathes of anecdotal evidence from our teachers, has drawn attention to issues surrounding the Number strand. Not only does this make other areas of the curriculum difficult to access but as stated above, low numeracy levels are linked to narrowed life chances.

Hence, the next few half-terms are devoted to Number - reinforcing KS2 content, closing gaps and applying skills in a wide variety of new contexts.

In the summer we turn our attention to Geometry. Students build on their KS2 skills using rulers, protractors and other equipment to construct and measure increasingly complex diagrams. We introduce new notation and geometric language. Angle rules will be introduced to form short chains of reasoning.

Year 8



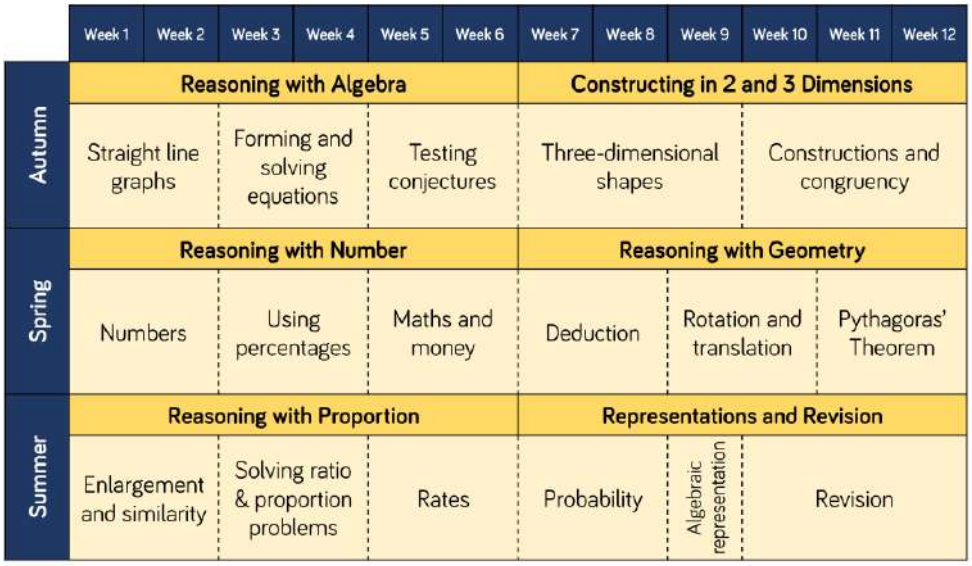
Literacy has value as a means and an end. Numeracy has value as a means - it facilitates access to things that are valuable. The department's view of the minimum that an adult needs are adequate written and mental calculation, statistical literacy and proportional reasoning.
In the Autumn Term of Year 8, the journey continues with ratio, concepts surrounding proportion and the use of data to inform statistical reasoning. Both ratio and operations with fractions will have been met briefly at the end of KS2 and students revisit ideas here, whilst making further progress with new concepts. There are numerous opportunities to explore investigational mathematics and encourage students to explicitly Think Like an Engineer. Many activities, seemingly unrelated to Engineering, are included within this curriculum but TheThink Like an Engineer philosophy is developed with activities such as here.

In the Spring we return to Algebra and Number and draw upon fresh contexts due to our recent understanding of concepts surrounding ratio and geometry, again reflecting our view that interleaving is an important facet of the curriculum. An example of the subtle blend of recently attained algebra and geometry is Q13 from a Spring Assessment here.

In the summer, we initially review content from year 7 with our analysis of Angles and at a later point we further review symmetry and reflection from years 5 and 6. However, we are now able to embrace content from the study of Geometry in Year 7 and we take advantage of that.

Indeed, much of the summer will involve new material as we continue with our coverage of the National Curriculum content. We embark on a fresh Data Handling cycle with its inherent opportunities for data collection - often with that engineering focus so prevalent e.g. here.

Year 9



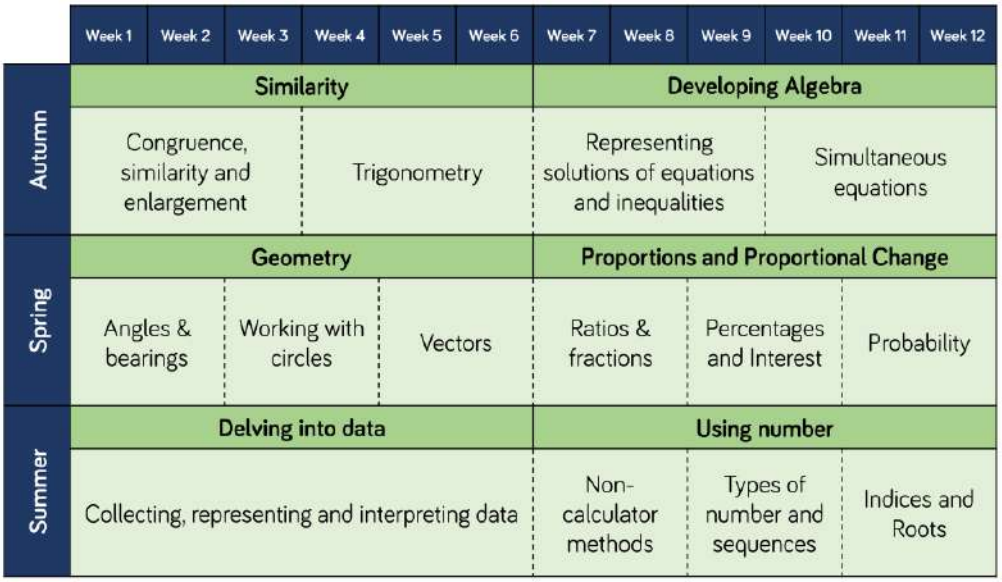
The final year of the KS3 journey. Many of the blocks build on previous material giving opportunities to review concepts and/or close gaps.
In particular, the Summer 2 representations block is aimed at reviewing the Key Stage in fresh contexts and preparing for Key stage 4. Teachers will receive support in using assessment data coupled with their professional judgements to determine the content of this block i.e. it will be driven by the needs of their students. In layman's terms, we "mop up".

Whilst there is a greater emphasis on mathematical reasoning this year, developing fluency, reasoning and problem-solving are embedded throughout the KS3 curriculum, rather than treated separately. Much of the work involving fluency is within the Algebraic Reasoning block. This is deliberate. It is the department's medium -term goal that an increasing number of students take the Higher pathway at GCSE where Algebra constitutes 27-33% of the content. We must support each student and afford them every opportunity to show that they can proceed at that level. Hence algebra is embedded within all blocks of the Year 9 experience. And yet again, investigational work will continue to play a prominent role as we develop the mathematical ability of our young engineers.
Within Algebraic Reasoning, after developing graphing skills and solving more complex equations, 'testing conjectures' is a versatile block with an emphasis on mathematical rigour and the introduction of concepts surrounding proof. It is a generalised block and focuses on developing reasoning rather than on a single topic area. We then turn our attention to both two and three dimensional work within our Geometry - learning to analyse and adapt to more complicated structures whilst exploring ideas surrounding congruence.

In the Spring we return to Number with a review of our KS3 experience in new contexts. An emphasis towards the end of the block will be using skills with practical applications and especially those involving money. Rotation, translation and enlargement are new topics as is Pythagoras' theorem.
Students are now familiar with the rigour from the 'testing conjectures' block and so proofs will be explored. Again, the investigational approach (an example here) will be employed to explore this beautiful theorem, first implicitly referenced on a babylonian tablet (circa 1600 B.C.).

Key Stage 4 Curriculum

Year 10



We enter a new Key Stage and the fourth year of our five year journey from the end of KS2 to preparation for KS5. Our setting has settled, whilst we remain constantly vigilant of students' progress should an alternative Tier of Entry for GCSE be deemed more appropriate. Intervention packages are in place for students who move strands.

We recognise the time which has been lost due to COVID interruptions and so Blocks include the opportunity to review and revisit KS3 material. These opportunities are especially prevalent in the Foundation strand.

In KS4, there is a delicate balancing act. To ensure that the Engineering Habits of Mind act as a driver in delivering a curriculum befitting our institution. To ensure that investigational mathematics remains at the forefront of the minds of those delivering the curriculum (rather than an afterthought) and to ensure that the National Curriculum Objectives are met in a timely fashion.
Mathematics is not just about building the softer skills such as problem-solving and critical thinking and so coverage of the NCOs is absolutely essential. Teachers are supported in this respect with training and with their classes undertaking an assessment after each Block. We trust our staff as professionals and these assessments are made available to them as an aid and guidance, prior to the teaching of the Block.

The Block titles above are broad, enabling **all** students to study material within the same Block **irrespective** of their proposed Tier of Entry. Sometimes Higher tier students will study the **same** topic to a greater degree of mastery but more often the differentiation will reflect the variance in the specificifications.

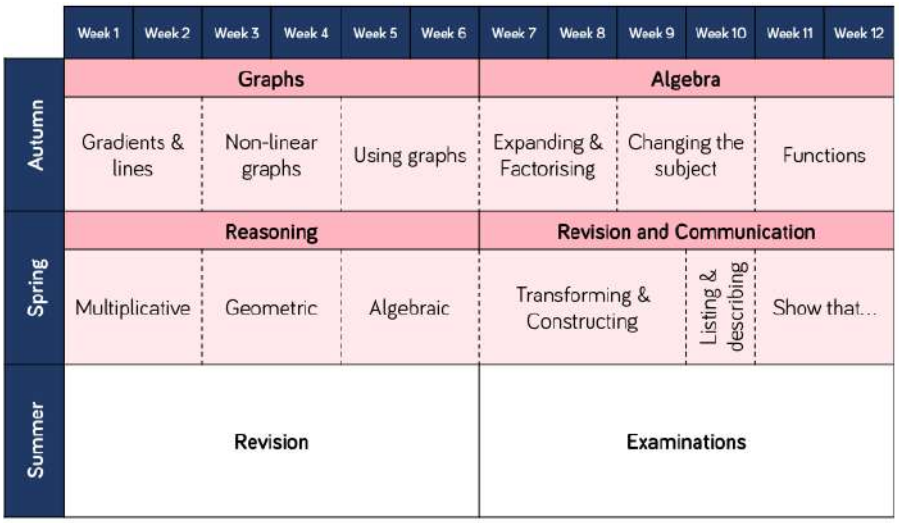
An example of this from Block 1 would be **all** students finding the studying the sides of similar shapes (an example of a task is here)but **only** Higher Tier students progressing to analyse the effect of enlargement on area and volume (an example of a task is here).

Similarly, in Block 2, **all** students will study the 'Core' material (to Grade 5) in finding the sides and angles of right-angle triangles using trigonometric ratios but only Higher tier of entry students will progress to the three-dimensional cases and then onto the Sine and Cosine rules (up to Grade 9). Again, both cohorts will study the material in a wide variety of contexts to help reinforce our focus on the Engineering Habits of Mind. Teachers use their professional judgement to decide which aspects of the Higher tier syllabus will be appropriate for their class within each unit at that moment.
This process of differentiation continues throughout KS4.

A major benefit of this approach is that at any point of the journey, all students will have studied the Core aspects of the GCSE specifications thus maintaining absolute flexibility for a student to change tiers without 'holes' in their prior experience. This avoids the historic problem of students changing their tier but not having experienced **any** trigonometry (for example).
The remainder of Year 10 follows a well-sequenced path of the Key National Curriculum subject areas namely, Number, Algebra, Ratio and proportion, Geometry and Measures, Probability and Statistics.
Rather than continue with a narrative style to examine the KS4 blocks in what might become laborious detail, three documents give the relevant information:

Our overview and exemplification of the Year 10 Scheme of Learning
In June, students will undertake three examination papers under exam conditions. Such data is invaluable and will (in part) inform us as to each student's appropriate Tier of Entry.

Year 11



As the journey progresses, we enter a critical year where the rationale and ethos of our curriculum continue to be embedded.
At both tiers, topics are sequenced carefully. Much of the content during the Autumn term is new material as we finish our coverage of the National Curriculum Objectives. In contrast, the Spring Term incorporates a large number of topics which are reviewed. All of the topics included in the Edexcel GCSE specifications will be completed by Easter. During the first half of the Summer Term, in the run-up to the GCSE examinations, teachers will work on past papers and with topics that have been identified as needing further attention.

As in the preceding years, new concepts will be presented in small steps and scaffolded where required. We continue to embed the "think like an engineer" pedagogy - these activities being wholly consistent and compatible with the skills required for examination success.

In Year 11 we place an even greater emphasis on the ability to learn independently and teachers engineer success by making each step achievable with ambitious end goals.

Students will continue to 'investigate' but the activity is incorporated within problems as a strategy. Entire lessons will no longer be given over to this skill due to the demands of covering and reviewing GCSE content.
Staff pay particular attention to dual coding, the process of combining verbal materials with visual materials. This is a key part of successful learning in maths, particularly within topics of statistics and geometry and measure and even more important now that exam questions that contain diagrams typically also contain a large amount of text.

This will all be delivered in conjunction with exam technique development. For example, how to break larger mark questions down into manageable parts, learning how long to spend on questions and how to maximise their marks on any given question. Across both tiers, there will be a greater emphasis on exam questions.

Knowledge organisers play an important role in helping to recall facts.
Students work closely with their Study Aid and with formulae which they are expected to know.

A greater emphasis is also paid to the weightings due under GCSE assessment and these are detailed below:

Topic Area	Foundation Tier (%)	Higher Tier (%)
Number	25	15
Algebra	20	30
Ratio	25	20
Geometry	15	20
Probability and statistics (combined)	15	15

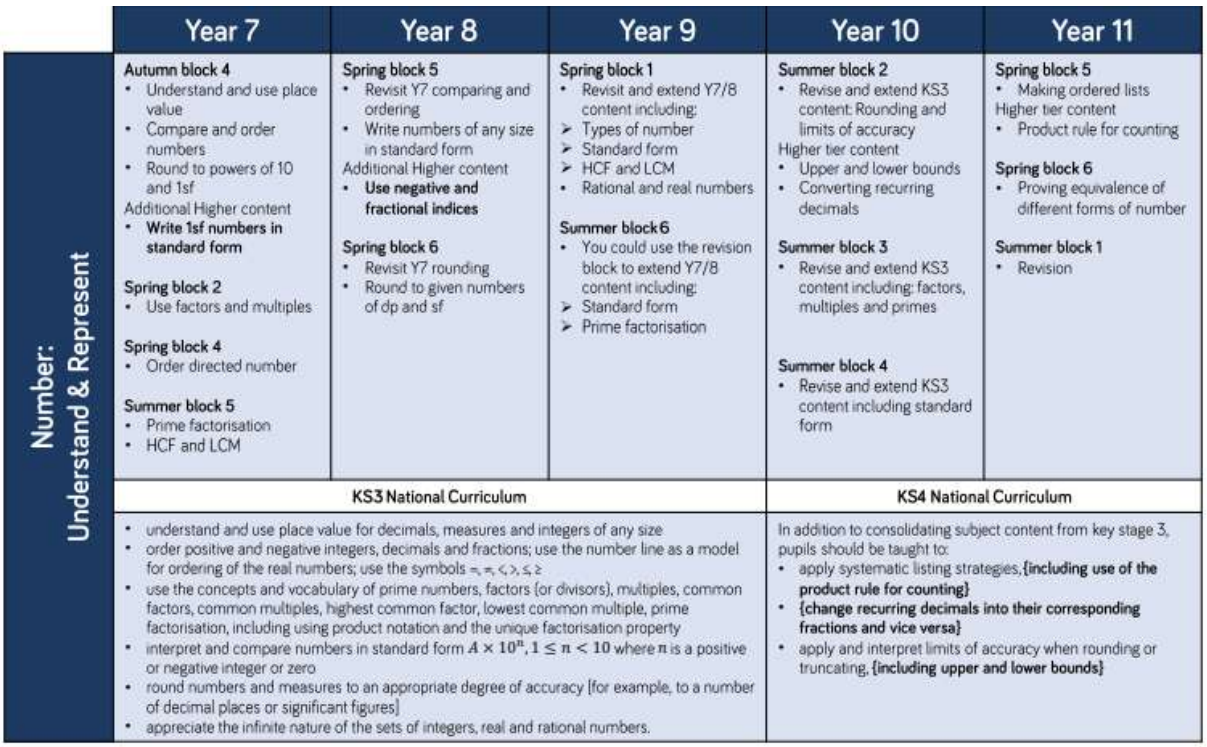
Intervention classes, which have been running since September, occur with increasing frequency. In addition to data gained from the end-of-block assessments we now have data from mock examinations enabling us to tailor classes to meet students' individual needs.
However, two groups (11C and 11D)will **not** be following this pathway. The mapping of prior attainment vs the new **White Rose** Year 11 Scheme of Learning, if corrected with a simple topic list, would have led to an incoherence in sequencing. These groups instead follow an alternative route , again ensuring that all aspects of the appropriate levels of National Curriculum have coverage.

National Curriculum progression

Class teachers need to know exactly what is meant to be covered, what has already been covered and where the topic will be extended and revisited in the future. To further support those delivering our curriculum the six national curriculum subject content areas are divided into strands:

NC Subject Content Area	Strands
Number	• Number: Understand and represent number • Number: Calculations • Number: Understand fractions and decimals • Number: Percentages
Algebra	• Algebra: Understand Notation and Substitute • Algebra: Equivalence and Proof • Algebra: Solve Equations and Inequalities • Algebra: Linear Graphs • Algebra: Non-linear Graphs • Algebra: Sequences
Ratio, proportion and rates of change	• Ratio, Proportion, Rates of Change: Multiplicative Relationships • Ratio, Proportion, Rates of Change: Ratio & Rates
Geometry and measures	• Geometry and Measures: Perimeter, Area and Volume • Geometry and Measures: Construct and Transform Geometric Figures • Geometry and Measures: Shape properties • Geometry and Measures: Angles • Geometry and Measures: Pythagoras and Trigonometry • Geometry : Geometrical Proof
Probability	• Probability
Statistics	• Statistics: Represent and Interpret Data • Statistics: Statistical Measures • Statistics: Bivariate Data

Each of the strands is exemplified (an example is below) to give an overview of the progression within this phase.



Number: Understand & Represent	Year 7	Year 8	Year 9	Year 10	Year 11
	Autumn block 4 • Understand and use place value • Compare and order numbers • Round to powers of 10 and 1sf Additional Higher content • **Write 1sf numbers in standard form** **Spring block 2** • Use factors and multiples **Spring block 4** • Order directed number **Summer block 5** • Prime factorisation • HCF and LCM	**Spring block 5** • Revisit Y7 comparing and ordering • Write numbers of any size in standard form Additional Higher content • **Use negative and fractional indices** **Spring block 6** • Revisit Y7 rounding • Round to given numbers of dp and sf	**Spring block 1** • Revisit and extend Y7/8 content including: ➢ Types of number ➢ Standard form ➢ HCF and LCM • Rational and real numbers **Summer block 6** • You could use the revision block to extend Y7/8 content including: ➢ Standard form ➢ Prime factorisation	**Summer block 2** • Revise and extend KS3 content: Rounding and limits of accuracy Higher tier content • Upper and lower bounds • Converting recurring decimals **Summer block 3** • Revise and extend KS3 content including: factors, multiples and primes **Summer block 4** • Revise and extend KS3 content including standard form	**Spring block 5** • Making ordered lists Higher tier content • Product rule for counting **Spring block 6** • Proving equivalence of different forms of number **Summer block 1** • Revision
	KS3 National Curriculum			**KS4 National Curriculum**	
	• understand and use place value for decimals, measures and integers of any size • order positive and negative integers, decimals and fractions; use the number line as a model for ordering of the real numbers; use the symbols $=, \neq, <, >, \leq, \geq$ • use the concepts and vocabulary of prime numbers, factors (or divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation property • interpret and compare numbers in standard form $A \times 10^n, 1 \leq n < 10$ where n is a positive or negative integer or zero • round numbers and measures to an appropriate degree of accuracy [for example, to a number of decimal places or significant figures] • appreciate the infinite nature of the sets of integers, real and rational numbers.			In addition to consolidating subject content from key stage 3, pupils should be taught to: • apply systematic listing strategies, **{including use of the product rule for counting}** • **{change recurring decimals into their corresponding fractions and vice versa}** • apply and interpret limits of accuracy when rounding or truncating, **{including upper and lower bounds}**	

Key Stage 5 Curriculum

Our students' journey continues with a number of different pathways within the framework of BTEC Level 3. The department contributes both directly to the teaching of Units within the BTEC qualifications and indirectly, through the teaching of A level and Core Mathematics. Students choose which course they undertake but their decision is informed by their previous experiences and performance at KS4.
The prerequisite required grade for joining the A Level course is a grade 6 at GCSE and for the Core course a Grade 4. Those who didn't achieve a grade 4 at GCSE are offered a 'resit course', with their first opportunity to achieve that grade 4 in the November of Year 12.
Throughout students' VI Form experience, irrespective of the pathway they choose to follow, the "Think Like An Engineer" ethos is at the heart of our curriculum.

Year 12
A Level Maths

The fully resourced Year 12 A Level Scheme of Work can be found here.

Half Term 1

At the start of the A Level course students will begin by reviewing and extending their understanding of the GCSE topics, particularly in number and algebra. These are vital topics that students need to be confident with to access the rest of their mathematical studies.

Students will also connect their previous knowledge of quadratics and transformations with which they will then apply to practical problems. Throughout this work students will be encouraged to make connections

between topics in Maths they may not have at GCSE, using multiple representations where appropriate. There will be a strong emphasis in using algebraic, geometrical, graphical and numerical representations both traditionally and using technology.

Half Term 2

In the second half term students will continue to form connections between multiple representations of mathematics, in particular when studying The Binomial Series and Trigonometry. To be effective at solving problems, students need to be confident in switching between algebraic and geometric representations continuously. To support them with these students will use dynamic geometry to enable them to explore the relationships. The study of circles here will enable students to develop a greater conceptual understanding of geometrical inter-relationships.

Students will also encounter advanced Statistics. Data collection will be studied more formally than at GCSE and measures of spread such as Standard Deviation will give students a deeper appreciation of how variance within data sets can be analysed.

Half Term 3

In the Spring Term students will study Trigonometric Identities and equations and extend their knowledge of Vectors well beyond GCSE level. The latter provides a fundamental base knowledge for their study of Mechanics later in the year and will support their work in their other BTEC Engineering Units. Students will explore more complex forms of data representation than they have hitherto encountered and will be introduced to the correlation techniques which extend far beyond their GCSE knowledge.

Half Term 4

During the fourth half term students will be introduced to the study of calculus. Students will be formally introduced to the areas of differentiation and integration from a Pure mathematics perspective before using their fluency to reason and solve practical problems. Again, these tools will support their work with Mechanics and in particular, variable acceleration, which they will meet later in the Year. In Statistics, students will Turn their attention to probabilistic methods and in particular to formal statistical distributions. Again, focusing on practical elements to apply the theoretical aspects of the material.

Half Term 5

This term involves a mixture of Pure, Mathematics, Statistics and Mechanics as students have become more adept at using abstract mathematics to solve real-world problems. Students study Exponential functions and Logarithms, understanding the importance of technology in the field and complete their study of Statistics by applying the previously learnt material to make and test hypotheses. They will study critical values, understand concepts surrounding different types of tests, and draw conclusions. They will appreciate the precision and rigour involved in rejecting a Null Hypothesis. Mechanics will be introduced gently by examining the importance of modelling.

Half Term 6

During this term, the culmination of their Year 12 A Level experience, students will focus solely on Mechanics. They will apply their knowledge of Pure Mathematics which they have gained throughout the year to address problems involving Kinematics, Forces and motion. This has multiple purposes. It completes the Year 12 specifications for AS Level, it prepares students for Year 13 study within the A level framework and it offers support for other areas of study within the BTEC field. The teaching of other Engineering units will be facilitated through students already having a firm grasp of Mechanics and its applications.

Students will be assessed after each Unit of the course to identify areas for support. A full examination series will be undertaken at the end of year comprising papers in Pure mathematics, Statistics and Mechanics. This will inform progress and determine which areas of study need to be addressed for further study in Year 13. Support materials are available in this respect.

Core Maths (12 and 13)

A detailed overview of the course and its contents is here.

This course is available to those students who have achieved a Grade 4 or above at GCSE but for whom A Level Maths may not be considered appropriate for the reasons outlined earlier.

Core Maths is an umbrella term for a specific type of level 3 maths qualification that was introduced by the Government as an incentive to encourage more students to take their mathematical studies further than GCSE. The qualification is equal in size to an AS level qualification and is graded A-E. It has the same number of UCAS tariff points as an AS level qualification.

It can be studied in a single year or over a two-year period and can be taken alongside A levels or other qualifications, including vocational courses. The students sit two exam papers

Core Maths is relatively new, but entries are growing rapidly, with over 9000 entries in 2019.

At UTC we study AQA's version of Core Maths – Level 3 Certificate in Mathematical Studies, and it is studied over a two-year period. At the end of the two years the students sit two exam papers. There are considerable cross curricular links between this qualification and the Level 3 BTEC in Manufacturing Engineering, which is highly beneficial to the students in supporting their Engineering studies.

This Level 3 Certificate Mathematical Studies qualification will consolidate students' mathematical understanding, build their confidence and competence in applying mathematical techniques to solve a range of problems and introduce them to new techniques and concepts that will prepare them for further study and future employment within a broad range of academic, professional and technical fields.

Mathematical Studies aims to prepare students for the mathematical demands of higher education and work where there is a distinct mathematical or statistical element, but where the mathematical demands do not stretch to a requirement for A-level Mathematics.

A course of study leading to this qualification should enable students to:

• study a mathematics curriculum that is integrated with other areas of their study, work or interest leading to the application of mathematics in these areas

• develop mathematical modelling, evaluating and reasoning skills

• solve problems some of which will not be well defined and may not have a unique solution

• solve substantial and real life problems encountered by adults

• use ICT as an exploratory tool for developing mathematical understanding and when solving problems

• develop skills in the communication, selection, use and interpretation of their mathematics

• enjoy mathematics and develop confidence in using mathematics.

Of the three optional Units we have chosen Critical Path Analysis as we believe it complements well the Project Planning faculties required of an Engineer. It is also unlike any form of mathematics which students will thus far have encountered and thus adds breadth to their experience.

Students will be assessed regularly to identify areas for support. A full examination series will be undertaken at the end of year involving the material under study in year 12. This will inform progress and determine which areas of study need to be addressed by the student over the summer break. Support materials are available to assist students.

Engineering Units/ Year 12/13 GCSE resits

A specialist in the maths department contributes to the teaching of Units 1 and 7 of the BTEC Level 3 Engineering Diploma.

The department also offers a GCSE resit course and examinations are available in November and June.

Year 13

A Level

Students will expand their repertoire of advanced mathematical techniques and apply these to solve a wide range of mathematical problems. This will enable them to recognise when mathematics can be used to analyse and solve a problem **in context**, through selecting the appropriate mathematical technique.

Students will furthermore develop an understanding of the elegance and precision of mathematics through communicating their mathematical ideas logically and constructing proofs. They will be exposed to reading and comprehending articles concerning applications of mathematics and communicate their understanding.

Term 1

The final year of the journey begins with students building on their knowledge of trigonometric functions. This directly supports the work undertaken in other elements of their BTEC field of study. This involves extensive analysis of inverse and reciprocal trig functions as well as using identities to support proofs and solve equations in practical settings. Algebraic manipulation is reviewed at this stage and more complex forms of functions are explored.
This gives way to the heart of the Year 13 experience - a deeper study of techniques in calculus. These skills directly support the Engineering Units.

Term 2

Now, the calculus techniques are even more complex. The students' repertoire of functions to differentiate and integrate is extended to include trig functions and exponentials and techniques include the product, Chain and Quotient rules as well as Integration by substitution and by parts.

Students move on to study Numerical methods, again supporting their Engineering Units, before meeting parametric equations, in preparation for their use in Mechanics later in the year.
A mock exam is taken at the end of the term to assess progress and to support in addressing issues.

Term 3

As we enter the final calendar year of the student experience, students revisit Trigonometry and equivalent forms. Radians, a form often preferred by engineers, are studied in greater depth and after analysing partial fractions students engage with Differential Equations which play such a prominent role in Advanced Engineering.
A second Mock exam will be undertaken.

Term 4

Students turn their attention to Applied mathematics and in particular, Mechanics. This involves a mixture of fresh material and some work which has already been met in other areas of BTEC study However, that is reviewed from a purely mathematical perspective. Kinematics is extended to two dimensions and thus vectors play a prominent role. The study of dynamics is extended to involve friction, creating solutions which are a closer reflection to those in the real world and we explore concepts surrounding Moments.

Term 5

The final term of the course in terms of new material. Here we return to advanced statistical analysis. Students model with probability before turning their attention to the Normal Distribution - arguably the most important distribution in statistics due to its huge number of applications. Students apply more complex hypothesis tests with this distribution before building on their Year 12 study of correlation by using

coefficients.
With the A level content completed, students will fully turn their focus to the A level examinations.

Engineering Units/ Year 12/13 GCSE resits

As in year 12, a specialist in the maths department contributes to the teaching of Units in the BTEC Level 3 Engineering Diploma.

Again, if required, the department will offer a GCSE resit course and as in Year 12, examinations are available in November and June.

Summary

In summary, we view the implementation of our curriculum as a process, not a single event. We have allowed enough time for teachers to analyse the curriculum in depth and to receive training in the rationale. Every member of the team is a learner.

Our team continues to make valuable contributions not only in the development of resources but in terms of shared experiences.

Teaching for mastery is a challenge to master and we are striving to improve, aiming to solve problems creatively, thinking systematically and remaining adaptable.

In short, to support students in ‘Thinking Like an Engineer’, we need to practice the Engineering Habits of Mind ourselves.