Pearson Higher Nationals in

Engineering/Nuclear Engineering/Aeronautical Engineering

SCHEME OF WORK

UNIT: 1 Engineering Design

For use with the Higher National Certificate and Higher National Diploma in Engineering

First teaching from September 2017

Issue 2

Edexcel, BTEC and LCCI qualifications

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Higher National Certificate/Diploma in Engineering/Nuclear Engineering/Aeronautical Engineering

SCHEME OF WORK

Programme Title:	Higher Nationals in Engineering	**Level:**	4
Unit Title:	Engineering Design	**Tutor:**	
Unit Number:	1	**Academic Year:**	

Learning Outcomes (LO)	Assessment 1	Assessment 2	Assessment 3	Assessment 4
LO1 Prepare an engineering design specification in response to a stakeholder's design brief and requirements	☒	☐	☐	☐
LO2 Formulate possible technical solutions by using prepared examples of engineering design specifications	☒	☐	☐	☐
LO3 Prepare an engineering industry standard technical design report by using appropriate design calculations, drawings and concepts	☒	☐	☐	☐
LO4 Present, to an audience, a recommended technical design solution by using real examples of stakeholder briefs	☒	☐	☐	☐

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Sessions	Learning Outcome(s)	Session Activities
Session 1	LO1–LO4	**Topic: Introduction to the unit** • Define engineering design and its role in solving engineering problems. • Understand what engineering problems are, their different types & attributes and how to define them • Understand the different design methodologies and approaches used to solve various engineering problems (incl. typical 3 and 5 stage design processes) • Understand how engineering drawing is utilised to communicate and clarify the design details and specifications of the selected final concept • Define the common vocabulary used in engineering design and drawing. **Sample activities:** • Tutor activity: Teacher introduction to the unit and assessment • Tutor activity: Provide examples of various engineering problems and explain how to: – Define their main problems and resulting engineering design aims – Identify each problem's constraints, boundary conditions and properties and possible obstacles – List variables, technical parameters and assumptions. • Group activity: Identify the main problem for various provided engineering problems along with their boundary conditions, constraints, possible obstacles, variables, technical parameters and assumptions.

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Sessions	Learning Outcome(s)	Session Activities
Session 2	LO1–LO4	**Topic: Introduction to Idea Generation, Evaluation, Concept Selection & Sketching** • Define the idea generation and evaluation processes in concept selection (include divergence and convergence theory) • Understand the use of background research in defining product requirements • Define the product requirements document (PRD) and its formation. • Understand how idea generation, innovation and creativity tools are used to develop multiple possible design concepts • Understand how the evaluation process along with the PRD are used to select the best-suited concept • Create a concept sketch (emphasise the importance of including as much detail as possible). **Sample activities:** • Tutor activity: Demonstrate how to use background research along with the defined problem to define the product requirements and generate a PRD • Tutor activity: Interact with the students to generate ideas for solutions to a problem using – Brainstorming – Synectics – Morphological analysis – Invitational stems methods. • Group Activity: Evaluate the concepts generated in the tutor activities by comparing them against the PRD to identify the most suitable concept • Individual Activity: Sketch the selected concept.
Session 3	LO1 & LO2	**Topic: Introduction to drawing** • Understand the role of engineering drawings in engineering design • Understand the difference between engineering drawing and concept sketching • Understand the different types of projection, particularly third angle projection • Define Engineering Drawing instruments and software. **Sample activities:** • Tutor activity: Present a variety of engineering structures and products alongside their third angle, first angle and isometric drawings • Tutor activity: Draw an isometric & third angle view of an actual complex object • Individual activity: Draw an isometric view of a 3D object using drawing instruments.

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Sessions	Learning Outcome(s)	Session Activities
Session 4	LO3	**Topic: Introduction to the CAD software** • Define what CAD software is and its impact on engineering drawing/design • Understand the basic interface of the CAD software. **Sample activities:** • Tutor activity: Teacher introduction to the CAD software and present how it has revolutionised engineering drawing • Tutor activity: Create a simple 3D model using the extrude and sketch tools • Individual activity: – Run the software – Create a new drawing sheet – Become familiar with the variety of 2D and 3D tools and features.
Session 5	LO1 & LO2	**Topic: Creating a simple engineering drawing** • Be able to manipulate and edit sketch constraints • Be able to create an engineering drawing of a simple part • Be able to apply engineering drawing principles to a CAE drawing. **Sample activities:** • Tutor activity: Create an engineering drawing of a simple component • Individual activity: Create the same drawing as the tutor.
Session 6	LO1 & LO2	**Topic: Decision making tools and processes** • Create a visual representation of a design objective tree • Create a visual representation that includes both objectives and constraints • Create a visual representation of design functions • Be able to construct and makes decisions based on a decision matrix. **Sample activities:** • Tutor activity: For a design concept, create visual representations of: – a design objective tree – objectives and constraints • Tutor activity: Demonstrate how a decision matrix is formed • Tutor activity: List the different factors to include in the decision matrix and ask the students which factor should be included and why • Individual activity: Create a design objective tree for a component and list all objectives and constraints.

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Session 7	LO3 & LO4	**Topic: Lines and dimensions**
		• Uses of the different types of lines when drawing simple shapes.
		• Understand the important of engineering dimensioning
		• Dimensions
		• Understand correct and incorrect method of dimensioning
		• Interpret types of engineering symbology used in dimensioning.
		
		Sample activities:
		• Tutor activity: Demonstrate the appropriate use of:
		  ○ drawing, construction, centre, cutting plane and hidden lines,
		  ○ dimensioning and engineering symbols.
		• Tutor activity: Draw a third angle view of a part and include all required lines, dimensions and engineering symbols
		• Individual activity: Draw a third angle view of a part (different to tutors activity) and include all required lines, dimensions and engineering symbols.

Session 8	LO3 & LO4	**Topic: CAE Session** • Create a range of circles and rectangles • Create datum axes and planes • Create different extrudes • Create solid revolves. **Sample activity:** • Individual activity: Demonstrate examples of work above.
Session 9	LO2–LO4	**Topic: Ergonomics** • Define Ergonomics • Use Anthropometric tables • Give examples of how ergonomics influences everyday objects • Understand how to apply Ergonomics and Anthropometric in design. **Sample activities:** • Tutor activity: Present examples of different designs that have the same purpose. Identify the differences in ergonomics and show why one is superior to the other due to its ergonomic superiority. • Group activity: Examine examples of design work and list all examples of good ergonomics in design and appropriate consideration of anthropometric issues.

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Sessions	Learning Outcome(s)	Session Activities
Session 10	LO3 & LO4	**Topic: CAE Session** • Create holes on flat and curved surfaces by a variety of methods • Create holes of different profiles • Create full and partial rounds using a variety of methods • Create chamfers on existing geometry. **Sample activities:** • Tutor activity: Demonstrate the drawing activities above • Individual activity: Repeat and practice what the tutor demonstrated.
Session 11	LO3 & LO4	**Topic: Standardisation and regulatory compliance** • Understand the meaning of standard and compliance regulation as applied to engineering regulation and design in the UK • Understand the importance of standard and compliance in relation to product design. **Sample activities:** • Tutor activity: Present examples where designs, structures and components have failed due to poor and inadequate compliance with standards and regulations • Tutor activity: Give example of how different standards regulations are incorporated into real world designs and components • Group activities: For the design of a PVC pipe that transfers potable water, the group have to research and list the different standards that have been used.
Session 12	LO3 & LO4	**Topic: Sectioning** • Understand what is sectioning and its importance in engineering drawing • Determine which situations require the use of sectioning • Understand the different types of sectioning used in engineering drawing. **Sample activity:** • Tutor activity: Present a variety of sectioned drawings for different designed components and illustrate how they help in the manufacturing process and their use. • Individual activity: Create a sectioned drawing of a complex part that needs one.

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Sessions	Learning Outcome(s)	Session Activities
Session 13	LO3 & LO4	**Topic: CAE Session** • Create drawings with standard orientations • Create section and detailed views • Create assembly views. **Sample activities:** • Tutor activity: Demonstrate how each of the different types of drawing views coupled with details are used in the manufacture and completion of the final product • Individual activity: Draw with standard orientations the different components of a ballpoint pen. Create section and detailed views. Draw the assembly views as well.
Session 14	LO3 & LO4	**Topic: Sweeps, Blends and Screw threads** • Create open sweeps • Create closed sweeps • Edit sweep definitions • Create blends by creating and selecting sketches • Identify different types of thread • Correctly represent a screw thread on a drawing • Understand different types of threaded fasteners. **Sample activities:** • Tutor activity: Demonstrate all varieties of sweeps and complete practical examples and exercises. • Individual activity: Repeat the exercises presented by the tutor and solve new exercises • Tutor activity: Present the advantages, disadvantages and applications of threads and fasteners • Group activity: Review a variety of drawings of threaded items (include some that use the wrong thread details). Identify the mistakes and corrections that should be made.

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Sessions	Learning Outcome(s)	Session Activities
Session 15	LO3 & LO4	**Topic: Engineering materials** • Understand the necessity for material selection • Understand the typical properties for groups of materials • Understand the different testing methods used to test engineering properties of materials • Give examples of material choice for a particular design requirement. **Sample activities:** • Tutor activity: List a number of designed components and discuss with the students what materials could be used for the item and why • Individual activity: Select materials that could replace the current materials used for conventional daily used products. List the benefits and disadvantages of the changes.
Session 16	LO3 & LO4	**Topic: Limits and fits** • Understand the different types of tolerances • Understand the different types of fit • Understand how fits are decided • Understand the importance of tolerance, limit and fit in product design and assembly through a case study. **Sample activities:** • Tutor activity: Demonstrate the different types of fits and tolerances used in the design of engineering products. Discuss how they are selected and what calculations, assumptions and factors are used in the selection process. • Individual activity: Complete practical calculation exercise on tolerances.

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Sessions	Learning Outcome(s)	Session Activities
Session 17	LO3 & LO4	**Topic: Manufacturing processes** • Understand what is machining and the basic workings of a lathe, mill and drill machines • Define maximum expected accuracy of a mill and a lathe machine • Understand cutting speed and cutting feed • Understand the basics of injection moulding. **Sample activities:** • Tutor activity: Practical use of machine tools to demonstrate the processes above. • Tutor activity: Demonstrate how cutting tools and their speed & feed impact the final dimensions of the components and surface finishes. • Tutor activity: Explain how components that require high tolerances and surface finishes require more time, sophisticated tooling and different types of lubrication. • Tutor activity: List a variety of components manufactured using the injection moulding technique. Explain when it is feasible to use (emphasis on quantity, cost and quality). • Individual activity: Select the different machining processes required for a variety of components listed by the tutor.
Session 18	LO3 & LO4	**Topic: CAE Session** • Assemble components in fixed positions • Assemble components using a variety of constraints. **Sample activities:** • Individual activity: For a variety of product assemblies the students list the different constraints that apply.
Session 19	LO3 & LO4	**Topic: Surface finish** • Understand the causes of different surface finish • Understand the difference between waviness and roughness • Describe how surface finish is measured • Understand surface finish specification. **Sample activities:** • Tutor activity: Present examples were different surface finishes are used and how their roughness and waviness affect the interaction between components • Group activity: List at least 15 components and designs that require different roughness and waviness.

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Sessions	Learning Outcome(s)	Session Activities
Session 20	LO3 & LO4	**Topic: Design, testing and validation** • Understand the importance of validating your design • Understand what is design validation and verification • Have a basic understanding of other CAE simulation tools used in product validation • Understand the process involved in developing/creating a model for simulation. **Sample activities:** • Tutor activity: Present a variety of different products and explain how they were tested. Highlight the products that required rigorous testing and list the reasons why. • Tutor activity: Discuss with the students the trade-off between testing time and cost • Group activity: For a real engineered product that is currently in the market: – Identify what methods could have been used to test and validate it – Try to find out what is techniques are feasible to conduct the test and identify which method would save time and money.

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SCHEME OF WORK

UNIT: 2 Engineering Maths

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SCHEME OF WORK

Programme Title:	Higher Nationals in Engineering/Nuclear Engineering/Aeronautical Engineering	**Level:**	4
Unit Title:	Engineering Maths	**Tutor:**	
Unit Number:	2	**Academic Year:**	

Learning Outcomes (LO)	Assessment 1	Assessment 2	Assessment 3	Assessment 4
LO1 Identify the relevance of mathematical methods to a variety of conceptualised engineering examples	☒	☐	☐	☐
LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages	☐	☒	☐	☐
LO3 Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering application	☐	☐	☒	☐
LO4 Examine how differential and integral calculus can be used to solve engineering problems	☐	☐	☐	☒

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Sessions	Learning Outcome(s)	Session Activities

Session 1	LO1	**Topic: Introduction**
		• Introduction to the unit's content and an overview of assessment within the unit
		• Reinforcing pre-requisite knowledge.
		
		Sample activities:
		• Tutor activity: Teacher introduction to the unit and assessment
		• Tutor activity: demonstrate how to solve:
		  ○ Algebra – transposing equations
		  ○ Linear and quadratic equations
		  ○ Solutions of polynomials
		  ○ Simultaneous equations
		• Individual activity: students to complete exercises on:
		  ○ Algebra – transposing equations
		  ○ Linear and quadratic equations
		  ○ Solutions of polynomials
		  ○ Simultaneous equations
		• Paired activity: Peer assessment and feedback on the above activities
		• Group activity: Students to work through practical/real world applications.

Session 2	LO1	**Topic: Dimensional analysis**
		• Introducing the basic dimensions that are present within the physical world and the extension of the basic dimensions to embrace all physical quantities.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Units and dimensions
		  ○ Dimensionless quantities and coefficients
		  ○ Dimensional consistency in formulae
		  ○ Finding a formula using analysis
		• Individual activity: students to complete exercises on:
		  ○ Rate conversion
		  ○ Same rates with different units
		  ○ Dimensionless quantities and coefficients
		  ○ Dimensional consistency in formulae
		  ○ Finding a formula using analysis
		• Paired activity: Peer assessment and feedback on the above activities
		• Group activity: Students to work through some fun practical/real world problems such as seconds in a day, hours in a year, group road trips, costs of pizza for a party, etc.

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Sessions	Learning Outcome(s)	Session Activities

Session 3	LO1	**Topic: Arithmetic and geometric progressions**
		• Beginning with an explanation of the types of sequences, the topic will then focus upon arithmetic and geometric sequences and series.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Convergent and divergent sequences
		  ○ Oscillating and periodic sequences
		  ○ Arithmetic progressions
		  ○ Geometric progressions
		• Individual activity: students to complete exercises on:
		  ○ Convergent and divergent sequences
		  ○ Oscillating and periodic sequences
		  ○ Arithmetic progressions
		  ○ Geometric progressions
		• Paired activity: Peer assessment and feedback on above activities
		• Group activity: Students to prepare a presentation about exponential or logarithmic functions in real life using a data set.

Session 4	LO1	**Topic: Exponential and logarithmic functions**
		• Exploring the occurrences of exponentials and logarithms to arrive at the useful concept of the base e. The inverse property between these functions needs to be stressed.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Definition of exponential and logarithm functions
		  ○ Converting from exponential to logarithmic form, and vice versa
		  ○ Base e with both functions
		  ○ The laws of logarithms
		  ○ Using inverse properties to solve equations
		• Individual activity: students to complete exercises on:
		  ○ Definition of exponential and logarithm functions
		  ○ Converting from exponential to logarithmic form, and vice versa
		  ○ Base e with both functions
		  ○ The laws of logarithms
		  ○ Using inverse properties to solve equations
		• Paired activity: Peer assessment and feedback on above activities
		• Paired research activity: students in pairs to investigate the Fibonacci sequence and some pairs to presenting their findings
		• Group activity: Students to examine and explore how sequences and series can be used to solve engineering problems.

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Session 5	LO1	**Topic: Circular functions**
		• Revisiting trigonometry and radian measure in order to identify any problems with the use of trig equations when solving equations.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Review of sin θ, cos θ and tan θ, and the reciprocal trigonometric functions
		  ○ Circular measure
		  ○ The identities tan θ = sin θ/cos θ and sin2θ + cos2θ = 1
		  ○ Solving trig equations in given intervals
		• Individual activity: students to complete exercises on:
		  ○ sin θ, cos θ and tan θ, and the reciprocal trigonometric functions
		  ○ The identities tan θ = sin θ/cos θ and sin2θ + cos2θ = 1
		  ○ Solving trig equations in given intervals
		• Paired activity: Peer assessment and feedback on above activities
		• Paired activity: Interactive exploration of trig functions producing sine and cosine graphs.

Session 6	LO1	**Topic: Hyperbolic functions**
		• Hyperbolic functions will be introduced by linking to the previous two topics, and the similarity with the circular functions needs to be clear.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Definitions of the hyperbolic functions
		  ○ Standard hyperbolic identities
		  ○ Osborn's rule
		  ○ Solving hyperbolic equations
		• Individual activity: students to complete exercises on:
		  ○ Solving hyperbolic equations
		• Paired activity: Peer assessment and feedback on above activities
		• Paired research activity: students in pairs to investigate the Fibonacci sequence and some pairs to presenting their findings
		• Group activity: Investigate:
		  ○ applications of hyperbolic functions in real life
		  ○ the difference between a Catenary and Parabola.

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Sessions	Learning Outcome(s)	Session Activities

Session 7	LO2	**Topic: Summary statistics**
		• This will be a familiar topic to the majority of students, so the emphasis will be placed on notation, terminology and the interpretation of the results.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ The purpose of summary statistics
		  ○ Measures of central tendency
		  ○ Mean of grouped data
		  ○ Variance and standard deviation of grouped data
		  ○ Graphical presentation of grouped data
		• Individual activity: students to complete exercises on:
		  ○ Short exercises on summary statistics
		  ○ Interpreting summary statistics
		• Paired activity: Peer assessment and feedback on above activities
		• Paired activity: Summary statistics in excel/spss/matlab.
		
		Topic: Correlation
		• By examining scatter diagrams and identifying the correlation formed graphically, the topic will progress to calculating the correlation coefficient and interpreting the results that are found.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Scatter diagrams representing data
		  ○ The difference between correlation and causation
		  ○ Discussion regarding nonsense correlation and the interpretation of results
		  ○ Pearson's correlation coefficient
		• Individual activity: students to complete exercises on:
		  ○ Scatter diagrams and the interpretation of results
		  ○ Pearson's correlation coefficient
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Statistics and interpreting data in excel/spss/matlab
		• Group activity: presentation on applied statistics in engineering with a focus on research and development.

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Session 8	LO2	**Topic: Linear regression** • Continuing from the previous topic, this lesson will focus on the trend line through scattered data, determining the equation of the line, and using it to approximate unknown quantities. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o The equation of a straight line o Line of 'best fit' on scatter diagrams o The equation of the least squares regression line o Using the regression line to make approximations • Individual activity: students to complete exercises on: o The equation of a straight line o Line of 'best fit' on scatter diagrams o The equation of the least squares regression line o Using the regression line to make approximations • Paired activity: Peer assessment and feedback on above activities • Individual activity Linear regression and interpretation in excel/spss/matlab • Group activity: Research activity evaluating the impact of computer use in correlation and regression tasks.
Session 9	LO2	**Topic: Binomial distribution** • Recognising binomial situations and deriving the probability function is important here before using the distribution to calculate probabilities Once students are comfortable with the calculations, probability tables can be used instead. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o Probability distribution and notation o Discrete random variables o Bernoulli trials and applications o Finding probabilities using binomial distribution tables • Individual activity: students to complete exercises on: o Probability distribution and notation o Discrete random variables o Bernoulli trials and applications o Finding probabilities using binomial distribution tables • Paired activity: Peer assessment and feedback on above activities • Individual activity: Binomial distribution activities in excel/spss/matlab.

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Sessions	Learning Outcome(s)	Session Activities
Session 10	LO2	**Topic: Normal distribution** • Understanding the conditions for a normal distribution, the standardised normal curve and calculating probabilities using the probability tables will be the main focus • The normal approximation to the binomial distribution will also be identified. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o Continuous random variables o The standard normal distribution o Confidence intervals o Finding probabilities using normal distribution tables o Normal approximation to a binomial distribution • Individual activity: students to complete exercises on: o Continuous random variables o The standard normal distribution o Confidence intervals o Finding probabilities using normal distribution tables o Normal approximation to a binomial distribution • Paired activity: Peer assessment and feedback on above activities • Individual activity: Normal distribution activities in excel/spss/matlab.

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Sessions	Learning Outcome(s)	Session Activities

Session 11	LO2	**Topic: Hypothesis testing for significance**
		• The process of hypothesis testing and the associated vocabulary and notation is important to begin with
		• Hypothesis test examples will then be conducted using both the binomial and normal distributions so students can become familiar with the associated methods.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ The null and alternate hypothesis
		  ○ Critical regions and significance levels
		  ○ Testing procedure and the associated vocabulary
		  ○ Drawing the correct conclusion
		• Individual activity: students to complete exercises on:
		  ○ The null and alternate hypothesis
		  ○ Critical regions and significance levels
		  ○ One and two-tailed predictions
		  ○ Rejecting or failing to reject the null hypothesis and drawing the correct conclusion
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Binomial and normal distribution and hypothesis testing in excel/spss/matlab
		• Group activity: Tutor to assign examples to pairs/groups to carry out hypothesis testing following the structure of hypothesis testing.

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Sessions	Learning Outcome(s)	Session Activities

Session 12	LO3	**Topic: Sine waves and applications**
		• Exploring properties of the sine function and calculating quantities analytically from the equation of a sine wave.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ The general sinusoidal function
		  ○ Definitions of amplitude, frequency and periodic time
		  ○ Graphs of sine waves and periodic motion
		  ○ Applications, such as natural vibrations and alternating current
		• Individual activity: students to complete exercises on:
		  ○ The general sinusoidal function
		  ○ Definitions of amplitude, frequency and periodic time
		  ○ Graphs of sine waves and periodic motion
		  ○ Applications, such as natural vibrations and alternating current
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Explore sine waves in excel/matlab/Simulink
		• Group activity: Students to explore drawing their own waveforms and recreating those waveforms based on their acquired knowledge of frequency, amplitude and harmonics.

Session 13	LO3	**Topic: Sine waves with graphical software**
		• Using appropriate software to model a sinusoidal function and determining relevant information as found from the graph.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Plotting a sine wave with point data
		  ○ Using software to draw graphs
		  ○ Exploring maximum and minimum points, and transformations of graphs
		  ○ Using graphical form to determine amplitude and frequency
		• Individual activity: students to complete exercises on:
		  ○ Plotting a sine wave with point data
		  ○ Using software to draw graphs
		  ○ Maximum and minimum points, and transformations of graphs
		  ○ Using graphical form to determine amplitude and frequency
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Explore sine waves in excel/matlab/simulink/sinlab
		• Group activity: Students to use mobile or desktop apps to explore time and frequency plots for different types of waveforms in order to see and hear how multiple sinusoids comprise any type of sound waves.

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Sessions	Learning Outcome(s)	Session Activities

Session 14	LO3	**Topic: Trigonometric identities**
		• Further trigonometric identities are explained and used by separating and combing waves and simplifying equations.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Recall Pythagoras' theorem
		  ○ Compound angle formulae
		  ○ The expansion of the general sinusoidal function
		• Individual activity: students to complete exercises on:
		  ○ Proving identities
		  ○ The expansion of the general sinusoidal function
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Solving problems in excel/matlab/simulink
		• Group activity: Students to explore and construct their own trig identities.

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Sessions	Learning Outcome(s)	Session Activities

Session 15	LO3	**Topic: Vector notation and properties**
		• Introducing vector methods and basic properties.
		• For more familiar students the focus of the topic could be applications and problem-solving.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Vector and scalar quantities in engineering
		  ○ Addition of vectors
		  ○ Components of a vector
		  ○ Resultant vectors
		• Individual activity: students to complete exercises on:
		  ○ Add and subtract vectors
		  ○ Magnitude of a vector
		  ○ Multiplying a vector by a scalar
		  ○ Multiplying a vector by a vector
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Explore vectors in matlab/simulink
		• Group activity: Students to explore the use vectors to understand directions, distances and times associated with movement and speed and present how vector analysis is used in mechanical, aerospace, and civil engineering.
		
		Topic: Further vector analysis
		• Exploring how to model a problem with vectors
		• Introducing additional theory and expanding into three dimensions.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Converting information to vector diagrams
		  ○ Scalar product and calculating the angle between vectors
		  ○ 3D vectors.
		• Individual activity: students to complete exercises on:
		  ○ Add and subtract vectors in 3 or more dimensions
		  ○ Magnitude and direction of a vector
		  ○ Scalar product and calculating the angle between vectors
		• Paired activity: Peer assessment and feedback on above activities
		• Individual activity: Explore vectors in excel/matlab/simulink/autograph.

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Sessions	Learning Outcome(s)	Session Activities
Session 16	LO4	**Topic: Differentiation** • Starting with the explanation of calculating gradients of non-linear algebraic functions, differential calculus will be introduced and the basic concepts used to find gradients at a specific point. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o Calculating gradients of lines o Exploring the gradient curves o Wallis' Rule for differentiation o Applications of differentiation. • Individual activity: students to complete exercises on: o Gradients of lines o Gradient of curves • Paired activity: Peer assessment and feedback on above activities • Individual activity: Explore differentiation in matlab/Simulink.
Session 17	LO4	**Topic: Differentiation of functions** • Expanding the topic of differentiation to include derivatives of more complex functions. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o Differentiating trigonometric and hyperbolic functions o Differentiating logarithm and exponential functions. • Individual activity: students to complete exercises on: o Differentiating trigonometric and hyperbolic functions o Differentiating logarithm and exponential functions. o Applications: Derivatives of Trigonometric Functions o Applications: Derivatives of Logarithmic and Exponential Functions • Paired activity: Peer assessment and feedback on above activities • Paired activity: Explore differentiation in matlab/simulink .

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Sessions	Learning Outcome(s)	Session Activities
Session 18	LO4	**Topic: Stationary points** • Exploring higher derivatives to determine maxima and minima points of a changing function and the range of practical uses of this. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o Increasing and decreasing functions o Minima, maxima and points of inflection o Second derivative to determine stationary points o Practical applications of minima and maxima • Individual activity: students to complete exercises on: o Increasing and decreasing functions o Minima, maxima and points of inflection o Second derivative to determine stationary points o Practical applications of minima and maxima • Paired activity: Peer assessment and feedback on above activities • Group activity: Produce posters by sketching curves illustrating solving real life problems **Topic: Rates of change** • Cementing differential calculus as a rate of change of a quantity with respect to another, with a focus on changing with time. **Sample activities:** • Tutor activity: Tutor intro and demonstration on: o Differentiation representing changing quantities o Rates of change with respect to time o Related rates of change o Engineering quantities represented as rates of change. • Individual activity: students to complete exercises on: o Differentiation representing changing quantities o Rates of change with respect to time o Related rates of change o Engineering quantities represented as rates of change. • Paired activity: Peer assessment and feedback on above activities • Group activity: Produce posters by sketching curves illustrating solving real life problems

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Sessions	Learning Outcome(s)	Session Activities

Session 19	LO4	**Topic: Definite and indefinite integration**
		• Introduction to integral calculus, beginning with the explanation of this as an inverse to differential calculus. Basic methods of indefinite will be introduced, then definite integration will be explained thoroughly.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Integration as the inverse to differentiation
		  ○ Indefinite integration and notation
		  ○ Definite integration with limits.
		• Individual activity: students to complete exercises on:
		  ○ Antiderivatives
		  ○ Integration as a summation
		  ○ Indefinite integrals
		  ○ Finding areas by integration
		• Paired activity: Peer assessment and feedback on above activities
		• Group activity: Produce posters by sketching curves illustrating solving real life problems

Session 20	LO4	**Topic: Solving problems using calculus**
		• Algebraic including partial fractions and trigonometric (sine, cosine and tangent) functions
		• Solving engineering problems involving calculus.
		
		Sample activities:
		• Tutor activity: Tutor intro and demonstration on:
		  ○ Integrals involving trig functions trigonometric and hyperbolic functions
		  ○ Applications of Integrals
		  ○ Integrating partial fractions
		• Individual activity: students to complete exercises on:
		  ○ Integrating trigonometric functions
		  ○ Integrating algebraic functions and integrating by parts
		  ○ Solving engineering problems with calculus
		  ▪ including: Including: stress and strain, torsion, motion, dynamic systems, oscillating systems, force systems, heat energy and thermodynamic systems, fluid flow, AC theory, electrical signals, information systems, transmission systems, electrical machines, electronics
		• Paired activity: Peer assessment and feedback on above activities
		• Paired activity: Explore calculus in matlab/Simulink involving engineering problems