# Pre-requisite mathematics knowledge 

## for the Level 2 Entry Engineering Maths Summer School

As preparation for the Level 2 entry Maths Summer School (MSS) participants should revise and familiarise themselves with the following topics which will have appeared in their earlier mathematics learning. While many of these topics may be revisited during the first week of the Summer School, some level of familiarity will be assumed since these topics are first encountered much earlier in mathematics education.

This list is broken into two halves, the first half covers materials from the Engineering Maths $1 \& 2$ units, and are specific for students applying for Year 2 direct entry. The second half covers typical mathematics topics that appear across all of engineering.

Links have been provided to online resources to aid you with any topics of which you may like to refresh your knowledge. For the later general materials you will find many other resources online, for the specific Year 2 direct entry materials more tailored links are provided to assist you. The links are found in the footnotes and are accessible via the numbered superscripts in the main text.

## Year 2 Entry Engineering pre-requisites

## Exponentials and logarithms

- Definition of logarithms ${ }^{1}$
- Definition of exponentials ${ }^{2}$
- Appreciate the relationship between exponentials and logarithms ${ }^{3}$
- Use the three logarithm laws ${ }^{4}$
- Sketch and identify basic logarithm and exponential graphs ${ }^{5}$


## Vectors in 2D \& 3D ${ }^{6}$

- Definition of a vector
- Work with vectors in 2 D and 3 D including the topics of:
- magnitude ${ }^{7}$
- scalar product ${ }^{8}$
- angles between vectors
- Convert from Cartesian [Rectangular] form to Polar form and vice versa ${ }^{9}$

[^0]
## Complex numbers

- Basic algebra of complex numbers, like addition, subtraction, multiplication and division ${ }^{10}$
- Conversion between Cartesian (rectangular) format and polar format ${ }^{11} 12$
- Perform mutliplication and division of complex numbers in polar format ${ }^{13}$
- Represent complex numbers on an Argand diagram ${ }^{14}$


## Differentiation ${ }^{15}$

- Differentiation of standard functions, like $a x^{n}, \sin (a x+b), \ln (a x+b)$ and $e^{a x+b}$
- Use the chain rule for differentiation
- Use differentiation to find stationary/turning points of functions
- Calculate second derivatives to classify stationary/turning points ${ }^{16}$
- Use differentiation in real-world problems to determine rates of change, or optimize a variable.


## Integration

- Appreciation of integration as anti-differentiation ${ }^{17}$
- Integrate standard functions ${ }^{18}$, like $a x^{n}, \sin (a x+b), \frac{a}{a x+b}$ and $e^{a x+b}$
- Calculate definite integrals with given limits ${ }^{19}$
- Appreciate usage of integration to find areas under graphs, to solve real-world problems ${ }^{20}$


## General engineering maths pre-requisites

## Numerical skills

- Calculating percentages ${ }^{21}$
- Reversing percentage calculations, e.g. calculating original quantities after percentage reductions
- Orders of operations: i.e. BODMAS or BIDMAS or PEDMAS (depending on when you learnt it)


## Algebra skills

- Working with brackets
- Expanding brackets ${ }^{22}$, e.g. $(x+1)\left(a x^{2}+b x+c\right)$
- Factorising into brackets, spotting common factors
- Using algebraic formulae, like Pythagoras' theorem
- Simplifying by grouping 'like' terms

[^1]
## Fractions

- Reducing fractions to lowest forms ${ }^{23}$
- Multiplication, division, addition and subtraction of fractions
- Relationship between fractions and negative powers (see Powers)


## Linear equations

- Identifying linear equations
- Re-arranging to make a variable the subject
- Solving linear equations


## More general equations

- Rules for re-arranging equations: changing sides, dividing through, squaring and square-rooting
- Substitution methods
- Making a variable the subject
- Simultaneous linear equations ${ }^{24}$
- Formulating simultaneous equations from text questions
- Solving simultaneous equations


## Powers

- Simplifying powers and rationalising denominators of fractions ${ }^{25}$
- The standard power laws
- Multiplication and division using positive, negative and fractional indices
- Expanding brackets with powers, e.g. $(a b)^{n}=a^{n} b^{n}$
- Powers of powers, e.g. $\left(a^{m}\right)^{n}=a^{m n}$
- Fractional powers as roots, $a^{m / n}=\sqrt[n]{a^{m}}$


## Simple graphs

- Equations of straight lines ${ }^{26}$
- Graphs of quadratics ${ }^{27}$
- Recognising maxima and minima of graphs


## Quadratics

- Working with quadratics
- Completing the square
- Factorising quadratics
- Using the 'quadratic formula'
- Identifying graphs of quadratics (see also Simple graphs)

[^2]
## Trigonometry ${ }^{28}$

- Basic graphs of sine and cosine
- Amplitude
- Translations vertically and horizontally
- The $\sin ^{2}(x)+\cos ^{2}(x)=1$ identity
- The $\tan (x)=\frac{\sin (x)}{\cos (x)}$ identity
- Using sine, cosine and tangent in right-angled triangles, i.e. SOH-CAH-TOA


## Trigonometric equations \& hyperbolics functions

- Solve problems of the form $A \sin (m x+a)=b$ and similar
- The reciprocal trignometric functions (cosec, sec, cot) $)^{29}$
- Working with the compound angle formulae ${ }^{30}$, e.g. $\sin (A+B)$
- Using trigonometric identities ${ }^{31}$, like $\cos (2 A)=2 \cos ^{2}(A)-1$
- (Nice to know, but optional) Hyperbolic functions ${ }^{32}$ :
- Evaluate sinh, cosh and tanh functions
- Use hyperbolic identities


## Links to revision resources

If you would like to look up some revision notes on any of the above topics then you should find a very wide range of resources, especially videos online. For the latter general engineering mathematics there are many very high quality resources.

Furthermore, since many of these topics will be revisited in the first week of the Maths Summer School (MSS) you will find a lot of the topics have at least summary notes available here, in the MSS Week 1 algebra notes. This is the default advice for initial revision.

Some topics above do not explicitly appear in the Week 1 notes, for those you will find some useful links provided via the superscripts/footnotes embedded in this document.

As a final bonus, here are a few of the most popular websites which specifically offer maths learning resources (though YouTube is also excellent):

- https://www.mathcentre.ac.uk/students/topics (UK academic consortium outputs)
- http://www.mathtutor.ac.uk (UK academic consortium outputs)
- https://www.khanacademy.org/math (in-house developed materials)
- https://www.examsolutions.net/maths (links to mostly YouTube videos)

[^3]
[^0]:    ${ }^{1}$ Logarithms
    ${ }^{2}$ The exponential constant $e$
    ${ }^{3}$ Taking logs
    ${ }^{4}$ The logarithm laws
    ${ }^{5}$ Graphs of logs and exponentials
    ${ }^{6}$ Introduction to vectors
    ${ }^{7}$ Forces as vectors
    ${ }^{8}$ The scalar product
    ${ }^{9}$ Polar coordinates

[^1]:    ${ }^{10}$ Complex number algebra
    ${ }^{11}$ Polar format for complex numbers
    12 also see topic inside Vectors
    ${ }^{13}$ Multiplication and division of complex numbers in polar format
    ${ }^{14}$ Argand diagrams
    ${ }^{15}$ Differentiation (many topics)
    ${ }^{16}$ Maxima and minima
    ${ }^{17}$ Integration as anti-differentiation
    ${ }^{18}$ Integration using a table of anti-derivatives
    ${ }^{19}$ Calculating definite integrals
    ${ }^{20}$ Finding areas with integration
    ${ }^{21}$ Percentages at Mathcentre
    ${ }^{22}$ Expanding brackets - Grid Method or Expanding brackets - Traditional method

[^2]:    ${ }^{23}$ Reducing fractions
    ${ }^{24}$ Simultaneous linear equations (all methods) and Simultaneous linear equations - elimination method
    ${ }^{25}$ Rationalise fractions with surds - see Section 5
    ${ }^{26}$ Straight line equations
    ${ }^{27}$ Quadratic sketching - Khan Academy - one method (see other nearby videos too)

[^3]:    ${ }^{28}$ Trigonometry topics
    ${ }^{29}$ Reciprocal trigonometric functions (in 5 lessons)
    ${ }^{30}$ Addition formulae
    ${ }^{31}$ Double angle formula (you don't need the tan formulae)
    ${ }^{32}$ Hyperbolic functions and identities

