# 4 Essential mathematics for engineering and manufacturing

| Criteria | Range | Resource identified |
|---|---|---|
| 4.1 Applied mathematical theory in engineering applications | Standard arithmetic – ordering | https://www.bbc.co.uk/bitesize/topics/znmtsbk/articles/zj29dxs <br><br> http://www.ultimatemaths.com/order-of-operation-bidmas.htm |
| | Standard arithmetic – integers, decimals | https://www.bbc.co.uk/bitesize/guides/zpf3k2p/revision/1 <br> https://www.khanacademy.org/math/arithmetic-home/arith-review-decimals |
| | Standard arithmetic – standard forms | https://www.bbc.co.uk/bitesize/guides/zxsv97h/revision/1 <br> https://revisionmaths.com/gcse-maths-revision/number/standard-form |
| | Standard arithmetic – fractions | https://www.mathplanet.com/education/pre-algebra/more-about-the-four-rules-of-arithmetic/calculating-with-decimals-and-fractions |
| | Standard arithmetic – percentages | https://www.bbc.co.uk/bitesize/guides/z9rjxfr/revision/1 <br> https://revisionmaths.com/gcse-maths-revision/number/percentages <br> https://www.khanacademy.org/math/cc-sixth-grade-math/cc-6th-ratios-prop-topic/cc-6th-percent-problems/v/finding-percentages-example <br> https://www.youtube.com/watch?v=Zx9_ja_2H38 |
| | Standard arithmetic – ratios | https://revisionmaths.com/gcse-maths-revision/number/ratios <br> https://www.mathsisfun.com/numbers/ratio.html <br> https://themathpage.com/Arith/ratio-and-proportion_1.htm#:~:text=Ratio%20is%20the%20spoken%20language,%2D%2D%20of%206%20to%2012 |

| | Algebra – factorising and manipulating equations | https://www.bbc.co.uk/bitesize/guides/zcqmsrd/revision/1 |
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| | | http://www.mathcentre.ac.uk/resources/workbooks/mathcentre/web-formulae2-tom.pdf |
| | | http://www.mathcentre.ac.uk/resources/uploaded/3a3printableversion.pdf |
| | | https://www.khanacademy.org/math/algebra2/x2ec2f6f830c9fb89:modeling/x2ec2f6f830c9fb89:manipulating-formulas/v/rearrange-formulas-to-isolate-specific-variables |
| | | http://www.studyphysics.ca/newnotes/20/unit01_kinematicsdynamics/chp02_intro/lesson06.htm |
| | | https://www.youtube.com/watch?v=A-zkVOrbJHM |
| | Algebra – solving quadratics | https://www.bbc.co.uk/bitesize/guides/z3hb97h/revision/1 |
| | | https://www.mathsisfun.com/algebra/quadratic-equation.html |
| | | https://www.youtube.com/watch?v=3ayhvAI3IeY |
| | Algebra – using indices | https://www.bbc.co.uk/bitesize/guides/zpmyrwx/revision/1 |
| | | https://thirdspacelearning.com/gcse-maths/algebra/laws-of-indices/ |
| | | https://www.engineeringtoolbox.com/laws-indices-d_1800.html |
| | | http://www.ultimatemaths.com/powers-and-the-laws-of-indices.htm |
| | | https://www.learninghub.ac.nz/laws-of-indices/ |
| | Algebra – using logarithms | https://www.bbc.co.uk/bitesize/guides/zn3ty9q/revision/1 |
| | | https://www.rapidtables.com/math/algebra/Logarithm.html |
| | | https://mathinsight.org/logarithm_basics |
| | | https://www.chilimath.com/lessons/advanced-algebra/logarithm-rules/ |
| | Algebra – determining numbers in a sequence | https://www.bbc.co.uk/bitesize/guides/zy82ng8/revision/1 https://www.mathsisfun.com/numberpatterns.html |
| | | https://www.khanacademy.org/math/ap-calculus-bc/bc-series-new/bc-10-13/v/power-series-radius-interval-convergence |
| | Algebra – standard matrices and determinants | https://www.mathsisfun.com/algebra/matrix-determinant.html |
| | | https://www.intmath.com/matrices-determinants/matrix-determinant-intro.php |

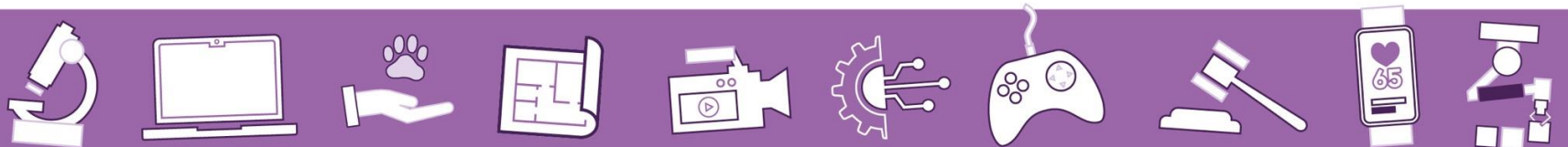| | | |
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| Geometry – calculation of areas | https://revisionmaths.com/gcse-maths/geometry-and-measures/area<br><br>https://www.mathsisfun.com/area.html | |
| Geometry – calculation of volumes | https://www.bbc.co.uk/bitesize/guides/zcnb8mn/revision/2<br><br>http://www.math.com/tables/geometry/volumes.htm or http://math2.org/math/geometry/areasvols.htm | |
| Calculus – Graphs and charts relevant to engineering and manufacturing contexts | https://www.bbc.co.uk/bitesize/guides/z9387p3/revision/3<br>https://philschatz.com/algebra-trigonometry-book/contents/m49362.html<br><br><br>https://philschatz.com/algebra-trigonometry-book/contents/m49364.html | |
| Calculus – differentiation | https://www.bbc.co.uk/bitesize/guides/zyj77ty/revision/1<br>https://www.engineeringtoolbox.com/differentials-integrals-d_1799.html<br>https://www.stem.org.uk/resources/elibrary/resource/30356/differentiation | |
| Calculus – integration | https://www.bbc.co.uk/bitesize/guides/zgxttfr/revision/1<br>https://www.engineeringtoolbox.com/differentials-integrals-d_1799.html<br>https://www.stem.org.uk/resources/elibrary/resource/30361/integration | |
| Trigonometry – Pythagoras' theorem | https://www.bbc.co.uk/bitesize/guides/z3hv97h/revision/1<br>https://www.stem.org.uk/resources/community/collection/424222/pythagoras-theorem-engineering<br>https://www.engineeringtoolbox.com/pythagorean-theorem-d_1713.html | |
| Trigonometry – triangle measurement | https://www.mathwarehouse.com/geometry/triangles/<br><br>http://www.montereyinstitute.org/courses/DevelopmentalMath/COURSE_TEXT2_RESOURCE/U07_L1_T3_text_final.html<br><br>https://owlcation.com/stem/Everything-About-Triangles-and-More-Isosceles-Equilateral-Scalene-Pythagoras-Sine-and-Cosine | |

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| Trigonometry – circular measure | https://www.engineeringtoolbox.com/radian-d_942.html<br>https://www.mathwarehouse.com/trigonometry/radians/convert-degee-to-radians.php<br>https://www.purplemath.com/modules/radians.htm<br>https://www.youtube.com/watch?v=MzJoEqrefBs | |
| Trigonometry – trigonometric functions | https://www.teachengineering.org/lessons/view/uno_handheld_lesson01<br><br>https://x-engineer.org/undergraduate-engineering/mathematics/trigonometry/introduction-to-trigonometry/ | |
| Trigonometry – graphs of trigonometric functions | https://www.mathsisfun.com/algebra/trig-sin-cos-tan-graphs.html<br>https://www.bbc.co.uk/bitesize/guides/zwbwgdm/revision/1<br>https://www.youtube.com/watch?v=oaJz9qpEAjI<br>https://www.youtube.com/watch?v=JD5Nfh23joI | |
| Trigonometry – sine and cosine rules | https://www.mathcentre.ac.uk/resources/Engineering%20maths%20first%20aid%20kit/latexsource%20and%20diagrams/4_6.pdf<br><br>https://x-engineer.org/undergraduate-engineering/mathematics/trigonometry/law-of-sines-and-cosines/<br><br>https://www.bbc.co.uk/bitesize/guides/z84297h/revision/1 | |
| Trigonometry – common trigonometric identities and values | https://www.mathsisfun.com/algebra/trigonometric-identities.html<br>https://www.purplemath.com/modules/idents.htm<br>https://www.embibe.com/exams/trigonometry-formulas/<br>https://sites.google.com/a/scienceleadership.org/trig_identities/home/real-world-applications | |
| Trigonometry – applications of vectors and coordinates, scalars | https://courses.lumenlearning.com/boundless-physics/chapter/vectors/<br>http://mechanicsmap.psu.edu/websites/A1_vector_math/vectors/vectors.html<br>http://mechanicsmap.psu.edu/websites/A1_vector_math/vectoraddition/vectoraddition.html<br>https://www.mathsisfun.com/algebra/vectors-dot-product.html<br>https://www.youtube.com/watch?v=OIX3iwoXglg | |

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| | Statistical analysis – Analysis of data in engineering contexts | https://www.bbc.co.uk/bitesize/guides/znhsgk7/revision/1 https://revisionmaths.com/gcse-maths-revision/statistics-handling-data/standard-deviation http://www.freestudy.co.uk/analytical/outcome4t1.pdf<br><br>https://www.toppr.com/guides/maths/statistics/range-and-mean-deviation-for-grouped-data/ | |
| | Statistical analysis – calculation of probabilities in engineering contexts | https://www.bbc.co.uk/bitesize/guides/z3p3k2p/revision/2<br><br>https://www.mathplanet.com/education/pre-algebra/probability-and-statistic/probability-of-events<br><br>https://www.khanacademy.org/math/statistics-probability/probability-library/basic-theoretical-probability/a/probability-the-basics | |
| | Statistical analysis – estimation | https://www.bbc.co.uk/bitesize/guides/z8fj6yc/revision/1<br>https://www.mathsisfun.com/numbers/estimation.html<br>https://www.youtube.com/watch?v=JTQ2Wh5E2js<br>https://www.youtube.com/watch?v=fVAMKbBGzTY | |
| 4.2 Number systems used in engineering and manufacturing | Numbering systems – Decimal, binary, hexadecimal | https://www.engineeringtoolbox.com/binary-decimal-hexadecimal-ascii-converter-d_1914.html  and https://www.engineeringtoolbox.com/binary-octal-hexadecimal-numbers-d_1802.html<br><br>https://medium.com/coderscorner/number-systems-decimal-binary-octal-and-hexadecimal-5e567e55ab28<br><br>https://x-engineer.org/undergraduate-engineering/mathematics/arithmetics/numbers-representation-systems-decimal-binary-octal-and-hexadecimal/ | |