

UNIT 439, APPLIED MATHEMATICS FOR CIVIL ENGINEERING 60GLH

Lesson 1: Introduction and Basic Principles

Suggested Teaching Time: 4 hours

Learning Outcome: Be able to use algebraic methods to analyse and solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
<ul style="list-style-type: none"> Introduction to Unit Algebra 	<ul style="list-style-type: none"> Basic terminology used in the unit. Algebraic functions including graphs, inverse, odd, even and linear functions Gradient of a linear function Points of intersection 	<p>Work sheets and illustrative examples</p> <ul style="list-style-type: none"> Algebraic functions: http://mathworld.wolfram.com/AlgebraicFunction.html Algebra: http://mathworld.wolfram.com/topics/Algebra.html Gradients and linear functions: http://www.mathcentre.ac.uk/topics/graphs/linear/ Points of intersection: http://www.mathopenref.com/coordintersection.html

Lesson 2: More on Basic principles

Suggested Teaching Time: 4 hours

Learning Outcome: Be able to use algebraic methods to analyse and solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
Algebraic functions and symbols	<ul style="list-style-type: none"> Algebraic common engineering functions (polynomial, rational, modulus, unit step, unit impulse) Use of symbols; indices (positive and negative); laws of indices; algebraic formulae (transposition, factorisation, evaluation of algebraic fractions) 	<p>Work sheets and illustrative examples</p> <ul style="list-style-type: none"> Engineering functions: http://www3.ul.ie/~mlc/support/Loughborough%20website/chap2/2_8.pdf Engineering maths: http://www.efunda.com/math/math_home/math.cfm Algebra: http://mathworld.wolfram.com/topics/Algebra.html

Lesson 3: Algebraic Equations

Suggested Teaching Time: 6 hours

Learning Outcome: Be able to use algebraic methods to analyse and solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
Algebraic equations and functions	<ul style="list-style-type: none"> Linear equations; quadratic equations; polynomial equations; simultaneous equations Solving inequalities; partial fractions Laws of logarithms; solving exponential and logarithmic equations 	<p>Work sheets and illustrative examples.</p> <ul style="list-style-type: none"> Equations: http://www.bbc.co.uk/schools/gcsebitesize/maths/algebra/quadequationshirev4.shtml Equations: http://mathbits.com/MathBits/TISection/Algebra1/LinQuad.htm Partial fractions: http://www.mathsisfun.com/algebra/partial-fractions.html

Lesson 4: Trigonometry

Suggested Teaching Time: 6 hours

Learning Outcome: Be able to solve civil engineering problems using trigonometry

Topic	Suggested Teaching	Suggested Resources
Basic trigonometric functions	<ul style="list-style-type: none"> • Angles; sine; cosine; tangent; secant; cosecant; cotangent of an angle • Inverse functions; \sin^{-1}; \cos^{-1}; \tan^{-1} • Trigonometric functions and their graphs; amplitude; frequency; phase and period of a sine or cosine function 	<p>Work sheets, illustrative graphs and examples</p> <ul style="list-style-type: none"> • Trigonometry: http://www.mathcentre.ac.uk/resources/uploaded/mc-ty-trigegn-2009-1.pdf • Geometry: http://mathworld.wolfram.com/topics/Geometry.html • Trigonometric functions: http://www.efunda.com/math/trig_functions/trig_functions.cfm

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Lesson 5: Trigonometry

Suggested Teaching Time: 6 hours

Learning Outcome: Be able to solve civil engineering problems using trigonometry

Topic	Suggested Teaching	Suggested Resources
Trigonometric identities	<ul style="list-style-type: none"> Compound and double angle formulae for sine and cosine Sums to product and product to sums formulae Solve trigonometric equations; application to resolution and resultant of forces 	<p>Work sheets, illustrative examples and exercises</p> <ul style="list-style-type: none"> Solving trigonometric equations: http://www.purplemath.com/modules/solvtrig.htm Compound and double angle formulas: http://www.mathsrevision.net/advanced-level-maths-revision/pure-maths/trigonometry/compound-angle-formulae Compound and double angle formulas: http://www.mathcentre.ac.uk/resources/uploaded/mc-ty-doubleangle-2009-1.pdf

Lesson 6: Vectors

Suggested Teaching Time: 4 hours

Learning Outcome: Be able to solve civil engineering problems using trigonometry

Topic	Suggested Teaching	Suggested Resources
Vector Analyses	<ul style="list-style-type: none"> • Scalar and vector quantities • Scalar and vector product of two vectors • Angle between two vectors • Static forces, frameworks 	Work sheets, illustrative examples and exercises <ul style="list-style-type: none"> • Vectors: http://mathworld.wolfram.com/topics/VectorAlgebra.html

Lesson 7: Differential Equations

Suggested Teaching Time: 4 hours

Learning Outcome: Be able to use differential and integral calculus to solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
<ul style="list-style-type: none"> • Derivation of Functions • Differential calculus 	<ul style="list-style-type: none"> • Algebraic, trigonometric, logarithmic functions • Product rule; quotient rule; chain rule • Implicit and logarithmic differentiation • Maximum and minimum values of a function • Points of inflection 	<p>Work sheets, illustrative examples and exercises</p> <ul style="list-style-type: none"> • Trigonometry: http://www.mathcentre.ac.uk/resources/uploaded/mc-ty-trigeqn-2009-1.pdf • Logarithmic functions: http://www.mathsisfun.com/sets/function-logarithmic.html • Logarithmic differentiation: https://www.youtube.com/watch?v=Q27MGf1V70 • Max and min functions: http://www.themathpage.com/acalc/max.htm • Points of inflection: http://www.mathsisfun.com/calculus/inflection-points.html

Lesson 8: Integration

Suggested Teaching Time: 6 hours

Learning Outcome: Be able to use differential and integral calculus to solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
Integrals	<ul style="list-style-type: none"> Integration as the reverse of differentiation Indefinite integrals; table of integrals for common functions (constant, ax^n ($n \neq -1$), $1/x$, $\sin(ax \pm b)$, $\cos(ax \pm b)$, $e(ax \pm b)$) Definite integrals; integration methods: integration by parts, by substitution, by using partial fractions Integration of trigonometric functions and differential equations 	<p>Work sheets, illustrative examples and exercises</p> <ul style="list-style-type: none"> Integrations: <ul style="list-style-type: none"> http://www.bbc.co.uk/bitesize/higher/maths/calculus/integration/revision/1/ Integration of functions and equations: <ul style="list-style-type: none"> http://www.mathtutor.ac.uk/integration

Lesson 9: Integral Calculus

Suggested Teaching Time: 6 hours

Learning Outcome: Be able to use differential and integral calculus to solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
Integral calculus	<ul style="list-style-type: none"> • Applications of integration to areas • Volumes of revolution • Centres of mass • Moments of inertia • Mean value and root-mean-square (rms) values 	<p>Work sheets, illustrative examples and exercises</p> <ul style="list-style-type: none"> • Moments of inertia: https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf <p>Centre of Mass: http://www.bbc.co.uk/schools/gcsebitesize/science/triple_aqa/using_physics_make_things_work/centre_of_mass/revision/1/ </p> <ul style="list-style-type: none"> • Volume of revolution: http://www.mathsrevision.net/advanced-level-maths-revision/pure-maths/calculus/volumes-revolution

Lesson 10: Statistics

Suggested Teaching Time: 4 Hours

Learning Outcome: Be able to use statistical concepts to describe data

Topic	Suggested Teaching	Suggested Resources
Data	<ul style="list-style-type: none"> • Data presentation • Bar charts, tally charts, line diagrams, histograms • Cumulative frequency diagrams • Scatter plots 	<p>Work sheets, illustrative examples, plots and exercises</p> <ul style="list-style-type: none"> • Curves: http://mathworld.wolfram.com/topics/Curves.html • Frequency diagrams: http://www.bbc.co.uk/bitesize/ks3/maths/handling_data/representing_data/revisio n/6/ • Bar charts: http://www.bbc.co.uk/bitesize/ks3/maths/handling_data/representing_data/revisio n/2/ • Scatter plots: http://www.mathsisfun.com/data/scatter-xy-plots.html

Lesson 11: Statistics

Suggested Teaching Time: 4 Hours

Learning Outcome: Be able to use statistical concepts to describe data

Topic	Suggested Teaching	Suggested Resources
Statistics	<ul style="list-style-type: none"> • Concept of central tendency to include mean • Median and mode • Dispersion to include standard deviation, variance • Interquartile range of grouped data • Normal distribution 	<p>Work sheets, illustrative examples, plots and exercises</p> <ul style="list-style-type: none"> • Statistical functions: http://www.ltconline.net/green/courses/201/descstat/mean.htm • Basic statistics: https://controls.engin.umich.edu/wiki/index.php/Basic_statistics:_mean,_median,_average,_standard_deviation,_z-scores,_and_p-value • Normal distribution: http://www.mathsisfun.com/data/standard-normal-distribution.html

Lesson 12: Probability

Suggested Teaching Time: 6 Hours

Learning Outcome: Be able to apply probability techniques to solve civil engineering problems

Topic	Suggested Teaching	Suggested Resources
Probability	<ul style="list-style-type: none"> • Empirical probability • Mutually exclusive and non-exclusive events • Conditional probability • Discrete probability distribution • Permutations and combinations • General binomial distribution • Normal distribution 	<p>Work sheets, illustrative examples and exercises</p> <ul style="list-style-type: none"> • Probability: http://www.mathsisfun.com/data/probability.html • Binomial distribution: http://www.mathsrevision.net/advanced-level-maths-revision/statistics/binomial-distribution • Probability distribution: http://stattrek.com/probability/probability-distribution.aspx

Books:

Stroud, K. A. and Booth, D. J. *Engineering Mathematics* 2007
6th Edition
Macmillan, ISBN 978-1403942463

Bird, John
Engineering Mathematics 2010 6th Edition
Newnes, ISBN 978-0080965628

Croft, A. and Davison, R.
Mathematics for Engineers: A Modern Interactive Approach
2010, 3rd Edition
Prentice Hall, ISBN 978-1408263235

Singh, K.
Engineering Mathematics through Applications 2003
1st Edition
Palgrave, ISBN 0-333-92224-7

Internet:

<http://www.mathcentre.ac.uk/links>
<http://mathworld.wolfram.com/>
<http://www.statstutor.ac.uk/>