Title	**Demonstrate knowledge of practical mathematics for electronics technicians**		
Level	**3**	**Credits**	**8**

Purpose	This unit standard covers the practical mathematics required by electronics technicians in the laboratory and workplace. People credited with this unit standard are able to: – perform arithmetical calculations; – solve problems by rearranging given formulae; – solve algebraic equations; – perform calculations involving decibels; – perform calculations involving right angled triangles; – use complex numbers for simple alternating current applications; and – identify and sketch graphs of functions commonly found in electronics.

Classification	Electronic Engineering > Core Electronics

Available grade	Achieved

Guidance Information

1 This unit standard has been developed for learning and assessment off-job.

2 Definitions
Industry practice – those practices that competent practitioners within the industry recognise as current industry best practice.

3 The following are typical formulae for use in assessment of Outcome 2.

$$I_E = I_S(e^{qV/kT} - 1) \qquad I_C = \frac{V_{CC} - V_{BE}}{R_E + R_B/(\beta_{dc} + 1)} \qquad V_{CEQ} = V_{CC} - I_C R_C - V_E$$

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)^2 \qquad I_{S(\min)} = \frac{V_{S(\min)} - V_Z}{R_{S(\max)}} \qquad V_{R(out)} = \frac{R_Z}{R_S + R_Z} V_{R(in)}$$

$$V_C = \frac{V}{\left(1 - e^{-t/RC}\right)} \qquad B_n = B\sqrt{2^{1/n} - 1} \qquad \frac{v_{out}}{v_{in(CM)}} = \frac{R_C}{r'_e + 2R_E}$$

$$A = \frac{A_{mid}}{\sqrt{1 + (f / f_c)^2}} \qquad \tan\phi = \frac{X_C}{R} \qquad \frac{V_{OUT}}{V_{IN}} = \frac{R}{R - jX_C}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}\sqrt{\frac{Q^2}{1+Q^2}} \qquad f = \frac{1.44}{(R_A + 2R_B).C} \qquad \%\,\mathrm{Re}\,g = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100\%$$

$$f_R = \frac{1}{2\pi\sqrt{LC}} \quad Q = \frac{1}{R}\sqrt{\frac{L}{C}} \quad f_R = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$Z = R + j(X_L - X_C) \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad P = \sqrt{3}V_L I_L \cos\theta$$

$$\frac{V_p}{V_S} = \frac{N_p}{N_S} = \frac{I_S}{I_p} \quad V_{dc} = V_m - \frac{I_{dc}}{4fC} \quad V_{dc} = V_m - \frac{V_{r(p-p)}}{2}$$

$$V_{r(rms)} = \frac{V_{r(p-p)}}{2\sqrt{3}} \quad V_{r(rms)} = \frac{I_{dc}}{4\sqrt{3}fC} \quad V_{r(rms)} = \frac{V_{dc}}{4\sqrt{3}fCR_L}$$

$$R_t = R_O(1 + \alpha_0 t) \quad R_2 = R_1\frac{1+\alpha_0 T_2}{1+\alpha_0 T_1} \quad v_o = -\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right).R_f$$

$$c = \frac{k}{\log_e\left(\frac{d-r}{r}\right)} \quad V_{RMS} = \frac{V_{PK-PK}}{2\sqrt{2}} \quad v_o = \frac{Zi * E}{Zo + Zi}$$

$$dBm = 10\log_{10}\frac{P}{1\text{mW}} \quad dB = 20Log\frac{V_1}{V_2} \quad dBV = 20Log\frac{V_1}{1\text{V}}$$

$$\theta = \sin^{-1}\frac{A}{B} \quad \theta = \tan^{-1}\frac{X_C}{R} \quad \rho = \frac{P_t}{4\pi r^2}$$

$$\lambda = \frac{v}{f} \quad Z_o = \sqrt{\frac{L}{C}} \quad vf = \frac{1}{\sqrt{k}}$$

$$P_t = P_c(1 + \frac{m^2}{2}) \quad E_n = \sqrt{4kT\sigma fR} \quad \%BW = \frac{F_2 - F_1}{F_O} * 100\%$$

$$f_P = \frac{1}{2\pi\sqrt{\frac{LCC_O}{(C + C_O)}}} \quad f_S = \frac{1}{2\pi\sqrt{LC}} \quad f = \frac{1}{2\pi RC}$$

$$Q_O = \frac{F_O}{F_2 - F_1} \quad Q_C = \frac{X_L}{R_{ac} + R_{dc}} \quad Q = \frac{X_{L_S}}{R_S}$$

$$f_c = \frac{v}{2}\sqrt{(\frac{m}{a})^2 + (\frac{n}{b})^2} \quad m = \frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}} \quad \frac{p_t}{p_c} = 1 + \frac{m^2}{2}$$

$$P_{SB} = \frac{P_C m^2}{2}$$

4 Range

a Assessment is to be *closed book*, with all relevant formulae provided. Use of non-programmable calculators is permitted during assessment

b All measurements are to be expressed in Système Internationale (SI) units and multipliers.

c All activities and evidence presented for all outcomes and performance criteria in this unit standard must be in accordance with legislation, policies, procedures, ethical codes, Standards, applicable site and enterprise practice, and industry practice; and, where appropriate, manufacturers' instructions, specifications, and data sheets.

Outcomes and performance criteria

Outcome 1

Perform arithmetical calculations used in the electronic engineering industry.

Performance criteria

1.1 Fractions are converted to decimals and percentages, and vice-versa.

1.2 Calculator is used to solve problems from given data.

Range add, subtract, multiply, divide, square, cube, square-root.

1.3 Areas and volumes are calculated for simple two and three-dimensional shapes using given data.

Range area – square, oblong rectangle, triangle, circle;
volume – box, cylinder.

Outcome 2

Solve electronic engineering problems by rearranging given formulae.

Range for formulae see guidance information 3. Assessment of five formulae is required involving exponential functions including – powers and roots, common and natural logarithms, trigonometric quantities.

Performance criteria

2.1 Formulae are rearranged to make one unknown quantity the subject.

2.2 The unknown quantity is calculated, given values for the other quantities.

2.3 Calculations demonstrate use of scientific and engineering notations, including conversion between multipliers from pico to giga.

Outcome 3

Solve algebraic equations.

Performance criteria

3.1 Linear equations are solved.

3.2 Quadratic equations are solved by factorisation and use of formula.

3.3 Simultaneous linear equations are solved.

Range sets of two and three simultaneous equations as applied to Kirchhoff's laws.

Outcome 4

Perform calculations involving decibels.

Performance criteria

4.1 Decibels are calculated from given power and voltage ratios.

4.2 Power and voltage ratios are calculated from given decibels.

Outcome 5

Perform calculations involving right angled triangles.

Performance criteria

5.1 Right angle triangle problems are solved such as found in vector and phasor applications.

Range Pythagoras theorem, sine, cosine, tangent.

5.2 Convert degrees to radians and vice versa.

Outcome 6

Use complex numbers for simple alternating current applications encountered in the electronics industry.

Performance criteria

6.1 Vectors are expressed in rectangular $(a+jb)$ and polar form (r, θ).

6.2 Conversions between rectangular and polar forms are made.

6.3 Vector additions and resolutions are made graphically and by calculation.

6.4 Vectors are multiplied and divided using the polar form.

Outcome 7

Identify and sketch graphs of functions commonly found in electronics.

Performance criteria

7.1 Given sketches of curves are identified.

Range curves – sine, cosine, tangent, linear, quadratic, logarithmic, exponential.

7.2 Given formulae, curves are sketched and key points are identified.

Range sketches indicating general shape and direction, intercepts on x and y axes, asymptotes, minimum and maximum points.

This unit standard is expiring. Assessment against the standard must take place by the last date for assessment set out below.

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	24 November 2003	31 December 2012
Review	2	21 July 2011	31 December 2024
Review	3	25 May 2023	31 December 2024

Consent and Moderation Requirements (CMR) reference	0003

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.