

**-SQA-SCOTTISH QUALIFICATIONS AUTHORITY**

**HIGHER NATIONAL UNIT SPECIFICATION**

**GENERAL INFORMATION**

**-Unit Number-**                **7481987**  
**-Superclass-**                **RB**  
**-Title-**                        **MATHEMATICS FOR ENGINEERING**

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**-DESCRIPTION-**

**GENERAL COMPETENCE FOR UNIT:** Using algebra and trigonometry to solve problems.

**OUTCOMES**

- 1     carry out operations involving complex numbers;
- 2     apply algebraic methods in problem solving;
- 3     apply trigonometric methods in problem solving;
- 4     differentiate and integrate functions.

**CREDIT VALUE:** 1 HN Credit

**ACCESS STATEMENT:** Access to this unit is at the discretion of the centre. However, it would be beneficial if the candidate had skills in mathematics as evidenced by possession of National Certificate Units 7180401 Analysis/Algebra 1 and 7181155 Calculus A, or Higher National Unit 7481997 Introductory Mathematics for Engineering, or an equivalent level of experience.

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For further information contact: Committee and Administration Unit, SQA, Hanover House, 24 Douglas Street, Glasgow G2 7NQ.

Additional copies of this unit may be purchased from SQA (Sales and Despatch section). At the time of publication, the cost is £1.50 (minimum order £5).

**HIGHER NATIONAL UNIT SPECIFICATION****STATEMENT OF STANDARDS****UNIT NUMBER:** 7481987**UNIT TITLE:** MATHEMATICS FOR ENGINEERING

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

**OUTCOME**

1. CARRY OUT OPERATIONS INVOLVING COMPLEX NUMBERS

**PERFORMANCE CRITERIA**

- (a) The performance of arithmetic operations on complex expressions is correct.
- (b) The conversion of complex numbers from cartesian to polar form and vice versa is correct.
- (c) The representation of complex numbers on an Argand diagram is correct.

**RANGE STATEMENT**

The range for this outcome is fully expressed within the performance criteria.

**EVIDENCE REQUIREMENTS**

PC (a) - Minimum of 4 correct solutions, one involving addition and subtraction in cartesian form, one involving multiplication in cartesian form, one involving division in cartesian form and one involving multiplication and division in polar form.

PC (b) - Minimum of 4 correct solutions one of which should be conversion from polar to cartesian form when the argument is in radians.

PC (c) - Minimum of 3 correct solutions.

**OUTCOME****2 APPLY ALGEBRAIC METHODS IN PROBLEM SOLVING****PERFORMANCE CRITERIA**

- (a) The solution of equations is correct.
- (b) Changing the subject of formulae is correct.

**RANGE STATEMENT**

Expressions: indicial; exponential; logarithmic.

**EVIDENCE REQUIREMENTS**

PCs (a) and (b) Minimum of 2 correct solutions for each performance criterion chosen from the range and between them, covering the full range.

**OUTCOME****3 APPLY TRIGONOMETRIC METHODS IN PROBLEM SOLVING****PERFORMANCE CRITERIA**

- (a) The solution of problems using compound angle formulae is correct.
- (b) The solution of problems using products-to-sums formulae is correct.

**RANGE STATEMENT**

The range for this outcome is fully expressed within the performance criteria.

**EVIDENCE REQUIREMENTS**

PCs (a) and (b) At least one correct solution for each performance criterion.

**OUTCOME****4 DIFFERENTIATE AND INTEGRATE FUNCTIONS****PERFORMANCE CRITERIA**

- (a) The differentiation of standard functions is correct.
- (b) The definite integration of standard functions is correct.

**RANGE STATEMENT**

Standard functions (a) differentiation of  $\ln(ax+b), \exp(ax+b)$

(b) integration of  $\frac{1}{ax+b}, \exp(ax+b)$

**EVIDENCE REQUIREMENTS**

Written evidence of at least 3 correct solutions for each performance criterion between PC (a) and PC (b), each classification in the range must be covered.

**MERIT**

A candidate who achieves all performance criteria for all outcomes will be awarded a pass. A pass with merit may be awarded to a candidate who demonstrates superior performance throughout the unit in each of the following aspects:

- consistently high level of accuracy;
- outstanding skills of analysis;
- consistently logical presentation of work.

Evidence which satisfies the criteria for merit may be generated by either:

- solving the problem to a level beyond that defined as pass

or

- where this is not possible, including in the assessment a further section which would allow the candidate to demonstrate skills which satisfy the criteria for merit.

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**ASSESSMENT**

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all the performance criteria for each outcome within the range specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the SQA assessment model and an integrative approach to assessment is encouraged. (See references at the end of the support notes).

Accurate records should be made of the assessment instruments used showing how evidence is generated for each outcome and giving marking schemes and/or checklists, etc. Records of candidates' achievements should also be kept. These records will be required for external verification.

**SPECIAL NEEDS**

Proposals to modify outcomes, range statements or agreed assessment arrangements should be discussed in the first place with the external verifier.

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**HIGHER NATIONAL UNIT SPECIFICATION****SUPPORT NOTES****UNIT NUMBER:** 7481987**UNIT TITLE:** MATHEMATICS FOR ENGINEERING**SUPPORT NOTES:** This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.**NOTIONAL DESIGN LENGTH:** SQA allocates a notional design length to a unit on the basis of the time estimated for achievement of the stated standards by a candidate whose starting point is as described in the access statement. The notional design length for this unit is 40 hours. The use of notional design length for programme design and timetabling is advisory only.**PURPOSE** This unit enables candidates to use algebra and trigonometry to solve problems within their chosen engineering discipline.**CONTENT/CONTEXT** Corresponding to outcomes:

- 1 Addition, subtraction, multiplication, division of complex numbers in cartesian form. The conversion of complex numbers from cartesian to polar form and vice-versa. Operations of multiplication and division using polar form. Complex number representation on an Argand diagram.
- 2 Indicial, exponential and logarithmic expressions as used in problems involving voltage and current transient circuits; sound amplification; rates of reaction; tension in belts; damped oscillations.

Rearrange equations which involve logs and/or exponentials to explicit form from simple implicit form.

- 3 Conversion of expression such as  $a \sin wt \pm b \cos wt$  and  $a \sin wt \pm b \sin(wt \pm \infty)$ .

into the form

 $R \sin(wt \pm \alpha)$  or  $R \cos(wt \pm \alpha)$ eg  $3 \sin wt + 4 \cos wt$ ,  $5 \cos wt - 12 \sin wt$ ,  $4 \sin wt + 9 \sin(wt + \frac{\pi}{4})$ ,

$$8 \sin(wt + \frac{\pi}{3}) + 15 \cos(wt + \frac{\pi}{6})$$

Changing products of sines and cosines into sums or differences of sines and cosines eg  $\sin 4x \cos x$ ,  $\cos 3\theta \sin 2\theta$ ,  $\cos 6t \cos 4t$ ,  $\sin 5\phi \sin 3\phi$ .

Using compound angle formulae to solve problems including maximum and minimum values, frequency and phase angles when adding currents or voltages.

Using product-to-sum formulae to solve problems involving power.

**ASSESSMENT PROCEDURES:** Centres may use the Instruments of Assessment which are considered by tutors/trainers to be most appropriate. Examples of Instruments of Assessment which could be used are illustrated by the exemplars.

## EXEMPLARS

Outcome 1

PC(a)

Simplify each of the following to a single complex number:

(i)  $z_1 - 2z_2 + 4z_3$  where  $z_1 = 3 - j4$ ,  $z_2 = 1 + j3$  and  $z_3 = 5 - j6$

(ii)  $z_1 z_2$  where  $z_1 = 7 - j2$  and  $z_2 = 2 + j$

(iii)  $\frac{z_1}{z_2}$  where  $z_1 = -3 + j$  and  $z_2 = 1 - j2$

(iv)  $\frac{60 \angle 120^\circ}{8 \angle 35^\circ} \cdot 5 \angle -15^\circ$

PC(b)

1. Convert to polar form:

(i)  $5 + j8$  leaving the argument in radians

(ii)  $3 - j5$  leaving the argument in degrees

2. Convert to cartesian form

(i)  $3.5 \angle 66^\circ$

(ii)  $5 \angle -\frac{\pi}{5}$

PC(c) Show the following on an Argand diagram

(i)  $z_1 = -5 + j8$

(ii)  $z_2 = 6 \angle -110^\circ$

(iii)  $z_3 = 4 \angle \frac{\pi}{3}$

Outcome 2

PC(a) - 2 questions correct

1 The voltage drop  $V$  volts, across an inductor  $L$  henrys is given by

$$V = V_{\max} e^{-\frac{Rt}{L}} \text{ where } V_{\max} \text{ is the maximum voltage.}$$

Calculate the time taken for the voltage to drop to half of its maximum value,

given  $L = 12.5 \times 10^{-3} \text{H}$  and  $R = 180 \Omega$ .

2  $D = 20 \log_{10} \left( \frac{V_o}{V_i} \right)$ ,  $D$  in db and  $V_o$  and  $V_i$  in volts. Calculate  $V_i$  to ensure

than 45db if  $V_o$  is that  $D$  is not greater than 35V.

3 The variable quantities  $p$  and  $q$  are known to be related thus:  $p = 38.2q^n$

Calculate  $n$ , given that  $p = 15$  when  $q = 24$ .

PC(b) - 2 questions correct

1 Rearrange the formula

$$I = \frac{E}{R} (1 - e^{-kt}) \text{ to give a formula for } t.$$

2 Obtain a formula for  $\theta$  given

$$\frac{T_1}{T_2} = e^{u\theta}$$

3 Rearrange the equation

$$\frac{1}{2} \ln(y + 2) = x^2 + c \text{ to obtain a formula for } y.$$

## Outcome 3

Satisfactory achievement of the outcome will be demonstrated by the candidate producing correct responses for questions 1 and 2. Question 3 may be used to demonstrate the candidate's superior skills of analysis.

1 Alternating currents are given by

$$i_1 = 8 \sin 2\pi t \text{ and } i_2 = 12 \sin \left( 2\pi t + \frac{\pi}{3} \right)$$

Find the maximum value of the resultant current  $i_1 + i_2$ , its frequency and its phase angle.

2 In an alternating current circuit a voltage

$$v = 10 \cos 100\pi t \text{ and a current } i = 5 \cos \left( 100\pi t - \frac{\pi}{4} \right)$$

Find the expression for the instantaneous power  $p$  in the circuit at time  $t$  given that  $p = vi$ , expressing the answer as a sum or difference of sines and cosines.

3 The voltages

$$v_1 = 5 \sin \left( 10\pi t + \frac{\pi}{2} \right) \text{ volts \& } v_2 = 8 \cos \left( 10\pi t - \frac{\pi}{3} \right) \text{ volts}$$

are fed into a summing analogue circuit.

Find when the output voltage is first equal to 10 volts.

## Outcome 4

## Calculus

PC(a) At least 3 correct solutions required

Differentiate each function w.r.t. its independent variable.

(i)  $f(x) = \ln(3x - 4)$

(ii)  $y(x) = \exp(1 - 2x)$

(iii)  $v(x) = \ln \left( 1 - \frac{3}{5}x \right)$

(iv)  $I(t) = \frac{E}{R} \left( 1 - e^{-kt} \right)$

PC(b) At least 3 correct solutions required:

(i) Evaluate  $\int_1^2 \frac{5}{3x+2} dx$

(ii) Evaluate  $\int_0^3 \frac{e^{2x} + e^{-3x}}{e^x} dx$

(iii) Evaluate  $\int_0^1 (1 - e^{0.3t}) dt$

(iv) Evaluate  $\int_{-2}^{-1} \frac{3}{1-2x} dx$

**PROGRESSION:** For information on how this unit relates to National Certificate mathematics provision and to other units in the Higher National mathematics framework, please refer to the following grids:

- Higher National mathematics grid for electrical/mechanical engineering
- Higher National mathematics grid for construction/civil engineering.

## REFERENCES

- 1 Guide to unit writing.
- 2 For a fuller discussion on assessment issues, please refer to SQA's Guide to Assessment.
- 3 Information for centres on SQA's operating procedures is contained in SQA's Guide to Procedures.
- 4 For details of other SQA publications, please consult SQA's publication list.
- 5 For an up-to-date list of suitable computer packages, please contact SQA's Product Development Department.

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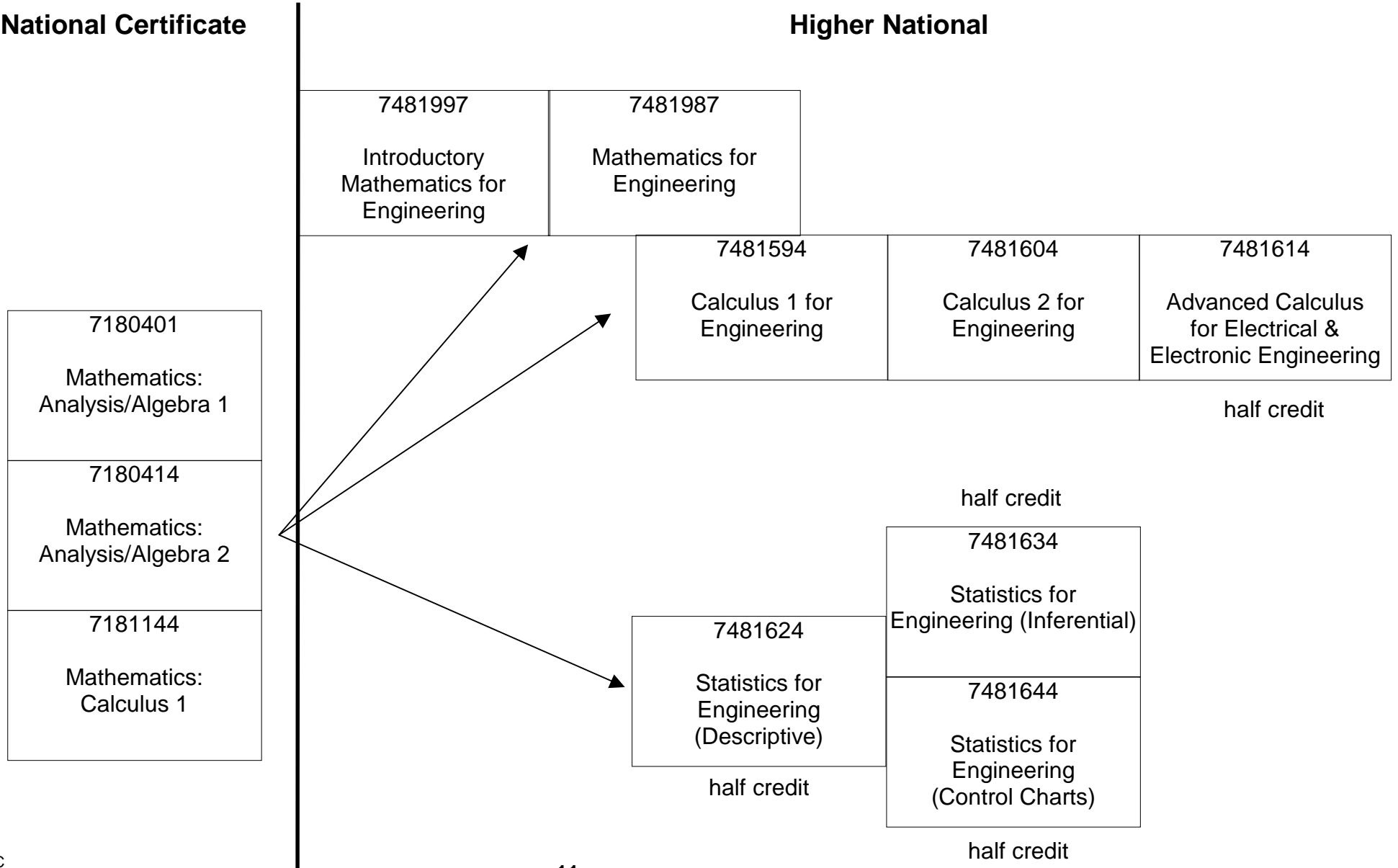
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# HIGHER NATIONAL MATHEMATICS GRID FOR ELECTRICAL/MECHANICAL ENGINEERING

## National Certificate

## Higher National



# HIGHER NATIONAL MATHEMATICS GRID FOR CONSTRUCTION/CIVIL ENGINEERING

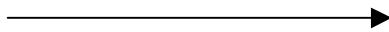
## National Certificate

## Higher National

7180401 Mathematics: Analysis/Algebra 1	7180414 Mathematics: Analysis/Algebra 2	7481654 Mathematics for Heating & Ventilating Engineering
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7181155 Mathematics: Calculus A  half credit	one and a half credits
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7180331 Core Maths 4
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7481744 Mathematics for Construction Engineering	7481754 Mathematics for Civil Engineering 1	7481764 Mathematics for Civil Engineering 2
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7481594 Calculus 1 for Engineering	half credit
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