Cambridge Technicals
Engineering

Unit 1: Mathematics for engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05822 - 05825 & 05873

Mark Scheme for January 2024

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Browse enough scripts for you to feel confident that you understand the scheme.

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MARKING

1 Mark strictly to the mark scheme.

2 Marks awarded must relate directly to the marking criteria.

3 The schedule of dates is very important. It is essential that you meet the traditional 50% Batch 1 and 100% Batch 2 deadlines. If you experience problems, you must contact the PE without delay.

4 If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or by email.

5 **Crossed Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed-out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed-out response where legible.

6 **Contradictory Responses**
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

7 Always annotate the extra answer space pages which will appear in the window for question 1(a). Note that when you look at the next script the window will be at the bottom, showing the response for 1(a) and you will have to scroll back up for these pages.
If there is anything written on these pages then identify the question and link it to that question, even if there is nothing of value on the page. Then when you mark the question it will be there for you to annotate.

8 There is a NR (No Response) option. Award NR (No Response)
- if there is nothing written at all in the answer space
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question

Note: Award 0 marks for an attempt that earns no credit (including copying out the question)

9 Assistant Examiners should email a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. Your report should contain notes on particular strength displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10 Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Missing something
FT	Follow through
BOD	Benefit of doubt
ISW	Ignore subsequent working
M0	Method mark awarded 0
M1	Method mark awarded 1
A0	Accuracy mark awarded 0
A1	Accuracy mark awarded 1
B0	Independent mark awarded 0
B1	Independent mark awarded 1
SC	Special Case
	The work or page has been seen

11 Mark scheme abbreviations

Other abbreviations in mark scheme	Meaning
oe	Or equivalent
Soi	Seen or implied
www	Without wrong working
ecf	Error carried forward

12 Subject-specific marking instructions

Annotations should be used whenever appropriate during your marking.

An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

DM
A method mark which is dependent on a previous method mark.
A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

Question			Answer	Marks	Guidance
1	(a)		$= 4x + 14 - 3x - 6$ $= x$ $+ 8$	B1 B1	
				[2]	
	(b)		$2(2x + 5y)$	B1	
				[1]	
	(c)		$2x - 1 = 5 \Rightarrow 2x = 6$ $\Rightarrow x = 3$	M1 A1	Collect terms
				[2]	
	(d)		$x^2 + x - 6 = 0$ $\Rightarrow (x - 2)(x + 3)\ (= 0)$ $\Rightarrow x = 2$ and $x = -3$	M1 A1 A1	Attempt to factorise (i.e. $(x \pm 2)(x \pm 3)$ or $(x \pm 1)(x \pm 6)$ or use correct formula 2 correct brackets or correct substitution SC if M0 one correct root only B1
				[3]	
	(e)		$x - 2 \overline{)\ x^3 + 2x^2 - 4x + 3}$ $\quad x^2 + 4x + 4$ $x^3 - 2x^2$ $4x^2 - 4x$ $4x^2 - 8x$ $4x + 3$ $4x - 8$ 11	M1 A1 A1	Long division seen; 2nd line plus x^2 in quotient or grid multiplication used Quotient Remainder. Allow $\frac{11}{x-2}$ SC Remainder theorem used giving f(2) =11 B1
				[3]	

Question			Answer	Marks	Guidance
2	(a)		5A + 3B = 670 4A + 5B = 640	B1	Two equations in A and B correct (unless, for e.g. x is defined as A)
			e.g. elimination	M1	Attempt to solve *their* equations by elimination or substitution
			Get coefficients in A the same: $5A+3B=670 \Rightarrow 20A+12B=2680$ $4A+5B=640 \Rightarrow 20A+25B=3200$	A1	2 equations with one coefficient the same *or* one equation in one variable
			Subtract: $13B=520 \Rightarrow B=40$	A1	B
			$\Rightarrow A=110$	A1	A Correct answers www full marks
				[5]	
	(b)		$\frac{1}{R}=\frac{1}{A}+\frac{1}{B}$ $=\frac{B+A}{AB}$	M1	Attempt to turn into a single fraction (soi by common denominator)
			$\Rightarrow R=\frac{AB}{A+B}$	A1	SC $R=\frac{1}{\frac{1}{A}+\frac{1}{B}}$ or $R=\frac{1}{\frac{A+B}{AB}}$ B1
				[2]	

Question			Answer	Marks	Guidance
3	(a)		94 – 96 Gives 4, 5 or 6	M1 A1	Read against 305 to find value on cum freq axis soi by answer
				[2]	
	(b)		S.D. = 4.71	M1 A1 A1	Sight of correct formula being used, indicated by sums of squares of differences Correct substitutions Awrt to 4.71 but Allow 4.7 SC Correct answer with no working B3 Allow for full marks the answer awrt4.97 using divisor (n - 1), allow 5.0 but not 5 SC If variance given (22.2 or 24.7) B1
				[3]	
	(c)	(i)	P(A does not fail on any day) = $\frac{3}{4}$ P(B does not fail on any day) = $\frac{4}{5}$ P(Machine working at end of day) = $\frac{4}{5}\times\frac{3}{4}$ $=\frac{3}{5}$ **oe**	B1 M1 A1	Both 1 – Multiply *their* probabilities
				[3]	
		(ii)	$=1-\frac{3}{5}$ $=\frac{2}{5}$ **oe**	B1	FT 1 – *their* answer to (b)(i) OR probabilities that lead to correct answer
				[1]	

Question			Answer	Marks	Guidance
4	(a)	(i)	$\cos BAC = \frac{5}{13}$ $\Rightarrow BAC = 67.4^0 \ (=1.18^c)$	M1 A1	Correct ratio and use of correct method to find angle awrt 67.4 SC. 22.6^0 seen B1
				[2]	
		(ii)	$\frac{BD}{13} = \sin 40$ $\Rightarrow BD = 13\sin 40$ $= 8.36$ **oe** m	M1 A1 B1	Correct ratio to find BD in triangle ABD Alternatively: Awrt 8.36 Consistent with their final answer
			Alternative method Cosine rule: BC = 9.717 Sin rule: Angle DCB = 59.3 BD = 9.717sin59.3 = 8.36 m	M1 A1 B1	Use of cosine rule then sin rule to find BC and angle DCB then correct ratio in triangle BCD: BD = BCsin BCD
				[3]	
	(b)		$\text{Cos}ABC = \frac{50^2 + 80^2 - 70^2}{2 \times 50 \times 80}$ $= 0.5$ $\Rightarrow ABC = 60^0$	M1 A1 A1 A1	Correct cos formula used for any angle (38.2, 81.8) Correct substitutions to find angle B Correct answer www
				[4]	

Question			Answer	Marks	Guidance
5	(a)		$2^x = 3$ $\Rightarrow x \log 2 = \log 3$ $\Rightarrow x = \frac{\log 3}{\log 2} = 1.585$	**M1** **A1** **M1** **A1**	Take logs (any base not 2) Divide Must be $x =$ SC use of base 2 to give correct value B4 SC $\text{Log}_2 3$ seen but not calculated or calculated incorrectly B3 n.b. Embedded correct answer can only earn 3 marks
			Alternative method by trial and improvement At least two trials, one above and one below Attempt to reduce upper value or lower value Answer in range [1.5,1.6] $x = 1.585$	 **M1** **M1** **A1** **A1**	
				[4]	
	(b)		$3\log a + \log b$ $= \log a^3 + \log b$ $= \log a^3 b$	**B1** **B1**	Log law to deal with power Log law to deal with adding e.g. log3ab is B0 B1, 3logab is B0 B0
				[2]	
	(c)		$\frac{y-4}{6-4} = \frac{x-3}{7-3}$ $\Rightarrow 2y - 8 = x - 3$ $\Rightarrow 2y = x + 5$ **oe**	**M1** **A1**	Or any correct method to produce $y = mx + c$ and substitute one point Must be 3 terms only
				[2]	

	(d)		$5x-2y=c$ $\Rightarrow 5x-2y=16$	**M1** **A1** **M1** **A1**	Find form of equation by reversing coefficients and changing one sign Substitute (4, 2) Must be 3 terms only
			Alternative method Grdient of line = $-\frac{2}{5}$ Gradient of perpendicular line = $\frac{5}{2}$ $\Rightarrow y=\frac{5}{2}x+c$ Through $(4,2) \Rightarrow 2=\frac{5}{2}\times 4+c \Rightarrow c=-8$ $\Rightarrow y=\frac{5}{2}x-8$ **oe**	**B1** **M1** **M1** **A1**	 Use of $m_1m_2=-1$ Substitute (4, 2) Must be 3 terms only
				[4]	
	(e)	**(i)**	(Passes through (0, 1) so $c=$) 1	**B1**	
				[1]	
	(e)	**(ii)**	–0.8, Allow 0.5 or 0.6, Allow 2.2 or 2.3	 **B1** **B1**	 One correct or all correct to more than 1 dp All correct
				[2]	

Question			Answer	Marks	Guidance
6	(a)		**AG**	**M1**	Diffn
			$y = \frac{1}{13}\left(2x^3 - 21x^2 + 60x\right)$ $\Rightarrow \frac{dy}{dx} = \frac{1}{13}\left(6x^2 - 42x + 60\right)$	**A1**	Must be correct and complete including $\frac{dy}{dx} =$
			$\Rightarrow 6x^2 - 42x + 60 = 0$	**M1**	Put *their* grad fn = 0
			$\Rightarrow x^2 - 7x + 10 = 0$ **oe**	**A1**	Factorisation or correct formula with correct substitutions
			$\Rightarrow (x-5)(x-2) = 0$ **oe** $\Rightarrow x = 2, 5$	**A1**	www
			Alternative method for last 3 marks Substitute $x = 2, 5$ $=0$ at $x = 2$ $=0$ at $x = 5$	**M1** **A1** **A1**	
				[5]	
	(b)	**(i)**	$y = \frac{1}{13}\left(2\times5^3 - 21\times5^2 + 60\times5\right)$ $= \frac{1}{13}\times 25$	**M1**	Substitute $x = 5$ **soi**
			$= 1.92$ **oe**	**A1**	Fraction or awrt 1.92Allow 1.9
				[2]	
	(b)	**(ii)**	$y = \frac{1}{13}\left(2\times2^3 - 21\times2^2 + 60\times2\right)$ $= \frac{1}{13}\times 52$	**M1**	Substitute $x = 2$
			$= 4$	**A1**	4 with no working is 0
				[2]	

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