Cambridge Technicals
Engineering

Unit 4: Principles of electrical and electronic engineering

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

Mark Scheme for June 2019

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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.

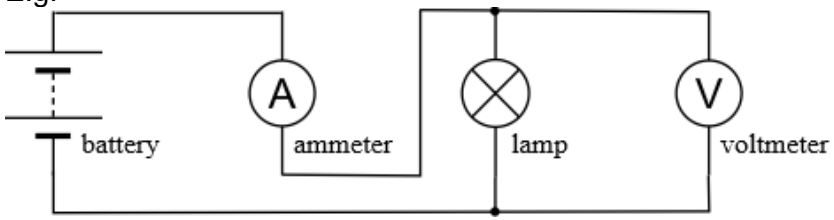
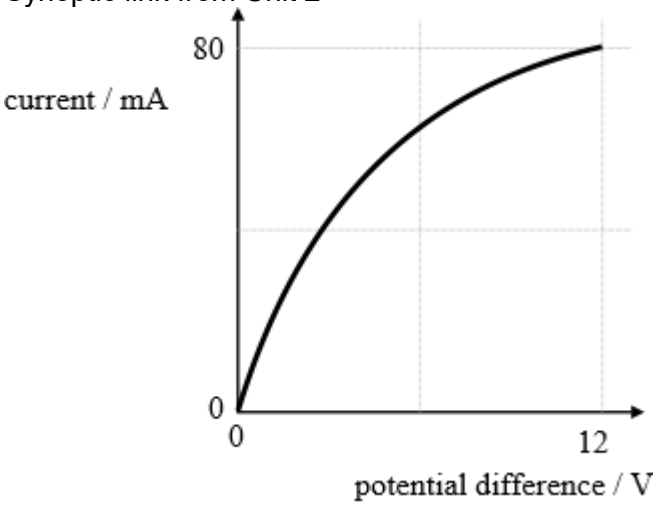
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

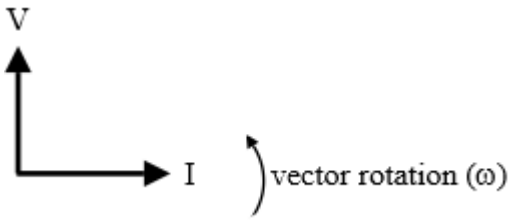
Annotations

Annotation	***Meaning***
tick	Correct response
cross	Incorrect response
Omission mark (carat)	Incomplete response
ECF	Error carried forward
BOD	Benefit of doubt
NBOD	No benefit of doubt
RE	Rounding error

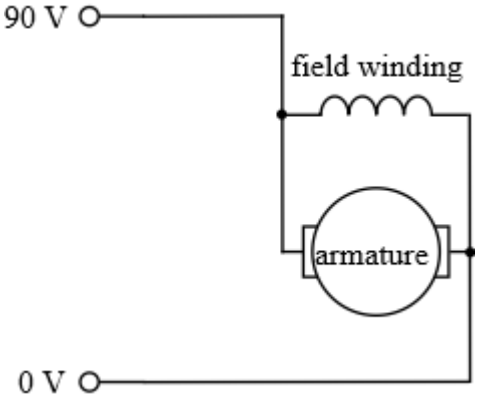
Subject-specific marking instructions

In all numerical calculation questions a correct response will gain all marks unless specified otherwise.
Rounding of answers should be to the same number of significant figures as the data in the question, or, otherwise, an answer will be correct provided it rounds to the correct answer.
Symbols used in circuit diagrams must identify relevant components uniquely and unambiguously.

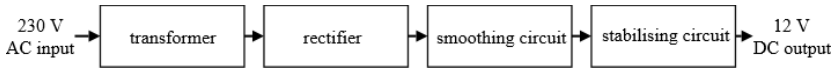
Question			Answer	Marks	Guidance
1	(a)	(i)	battery supplies current to lamp ammeter measures current through lamp [and voltmeter] voltmeter measures p.d. across lamp [and ammeter] E.g.  	1 1 1	Ignore wrongly placed meters for this mark
1	(a)	(ii)	12 / 0.080 = **150** (Ω)	1	Correct answer only.
1	(a)	(iii)	Line passes through (0,0) & (12, 80) within 1 mm Line curved correctly (>40 mA @ 6 V)	1 1	Synoptic link from Unit 2 

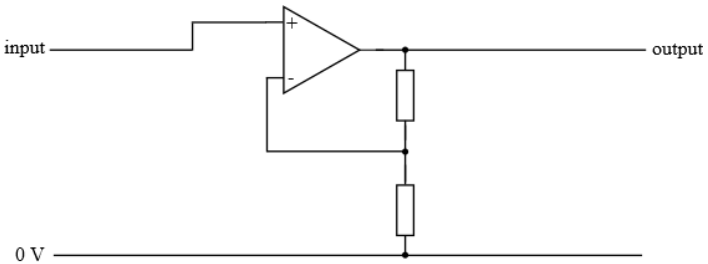
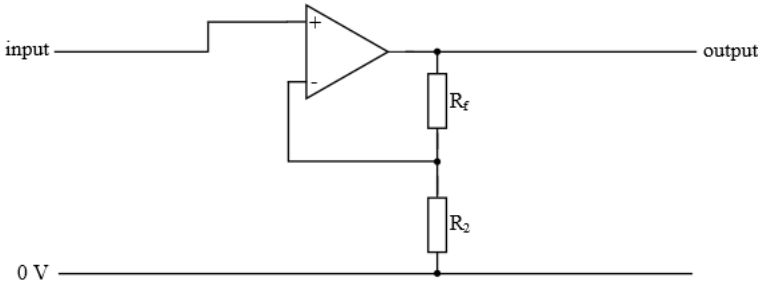
Question			Answer	Marks	Guidance
1	(b)	(i)	**7.3** (mA)	1	Correct answer only.
1	(b)	(ii)	7.3 – 2 = **5.3** (mA)	1	Correct answer only.
1	(b)	(iii)	V = IR = 0.0073 x 470 = **3.4** (V)	1	3.431 V to at least 2 s.f. ECF 1(b)(i)
1	(b)	(iv)	R=V/I = 11/0.0073= **1500** (Ω)	1	1507 / 1510 (Ω) to at least 2 s.f. ECF 1(b)(i)
1	(b)	(v)	V across 1.8 kΩ resistor = IR = 0.002 x 1800 = 3.6 V 220 Ω + R_3 = V/I = 3.6/5.3* = 680 Ω R_3 = 680 – 220 = **460** (Ω) (accept ±10)	2	Allow ECF for their I_3 from 1(b)(ii) Award I mark for method, One mark for correct answer Allow any alternative method e.g.: V across 220 Ω = 0.0053 x 220 = 1.2 V V across R_3 = 18 – 11 – 3.4 – 1.2 = 2.4 V R_3 = 2.4/0.0053 = 452.8 Ω
2	(a)		convert mechanical energy into electrical energy/to produce an ac supply	1 1	
2	(b)	(i)	T = 4 ms = 0.004 s f = 1/T = 1/0.004 = **250** (Hz)	1	Correct answer only.
2	(b)	(ii)	**90** (°)	1	
2	(b)	(iii)	Arrow labelled V at right angles to I V leads I	1 1	 ignore length of V Right angle by eye or explicit

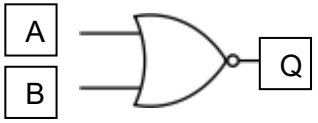
Question			Answer	Marks	Guidance
2	(b)	(iv)			Synoptic link from Unit 2
			Use of 220 μH converted to 0.00022 H	1	
			Calculation using $X_L = 2\pi fL =$ 0**.350** (Ω) ecf from b(i) and L	1	0.346 (Ω) to at least 2 s.f. for [2]
			Correct unit **Ω**	1	

Question			Answer	Marks	Guidance
3	(a)		Property of a motor that is different for shunt-wound and series-wound motors linked to the operation of the workshop pillar drill E.g.: • Shunt-wound motor runs at fairly constant/self-regulating speed/torque (1) control of drill rotational speed needed for drilling (1). • Series wound motor would get uncontrollably fast when no mechanical load is present (1) no mechanical load present when drill is started before contact made with material to be drilled. (1)	1 1	
3	(b)		Power supply provides current to armature Field winding in parallel with armature	1 1	

Question			Answer	Marks	Guidance
3	(c)	(i)	Evidence of calculating resistors in parallel $\frac{1}{R} = \frac{1}{2.55} + \frac{1}{333} = 0.395$ $R = \frac{1}{0.395} = 2.53$ Resistance of motor = **2.53** (Ω)	1 1	Synoptic link from Unit 2 $R = \frac{2.55 \times 333}{2.55 + 333} = 2.53$ **Not** 2.5 nor 2.55
3	(c)	(ii)	$I_f = \frac{V}{R_f} = \frac{90}{333} = 0.270$ (A)	1	Correct answer only.
3	(c)	(iii)	Correct rearrangement of equation $E = V - I_aR_a$ Correct values used in calculation 90 V, 0.606 A, 2.55 Ω E = 90 – (0.606 x 2.55) = **88.5** (V)	1 1	Synoptic link from Unit 1
4	(a)	(i)	Any valid advantage e.g.: • Uses less copper than single-phase for transmitting current. • More efficient for driving motors. • Smaller motors for the same power. • Continuous power delivery so no pulsating at 100 Hz.	1	

Question			Answer	Marks	Guidance
4	(a)	(ii)	**120** (°)	1	Correct answer only.
4	(a)	(iii)	Any valid advantage e.g.: • Simple wiring of supply so cheaper/easier installation. • Equipment simpler to construct so cheaper appliances. • Low power, low voltage equipment easier to produce from single phase.	1	
4	(a)	(iv)	Up to a maximum of 3 of: • When too much current flows • A contact opens (wtte) • Stopping further current flowing • Preventing damage to wiring/appliances	3	Accept alternative suitable answers.
4	(b)		1 mark for each correct box in correct sequence 	4	

Question			Answer	Marks	Guidance
5	(a)		An operational amplifier (op-amp) is a DC coupled voltage amplifier with a **high** open loop gain. Op-amps have a **high** input impedance. Op-amps have a **low** output impedance.	1 1 1	
5	(b)		Feedback resistor from output of op-amp to inverting input Output of op-amp to output Input to non-inverting input of op-amp (ignore any resistor in series or parallel) Resistor from inverting input to 0 V	1 1 1 1	
5	(c)		Ratio of R_F:R_2 = 3:1 [1]	1	
5	(d)		Values next to correct resistors ecf from 5c (must have first and final marks from 5b) 	1	**Both** must be correct for 1 mark.
5	(e)		10/4 = **2.5** (V)	1	Correct answer only.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td></td><td> 
</td><td>1</td><td>Correct symbol and A, B and Q correctly labelled for 1 mark.</td></tr>
<tr><td>6</td><td>(b)</td><td></td><td>All combinations of A and B

Q correct (must have all combinations for this mark)

<table>
<tr><th>A</th><th>B</th><th>Q</th></tr>
<tr><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td></tr>
</table></td><td>1

1</td><td></td></tr>
<tr><td>6</td><td>(c)</td><td></td><td>$\mathbf{Q = \overline{A + B}}$</td><td>1</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(d)</td><td></td><td>1 mark for each correct column.

<table>
<tr><th>G</th><th>H</th><th>J</th><th>K</th></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td></tr>
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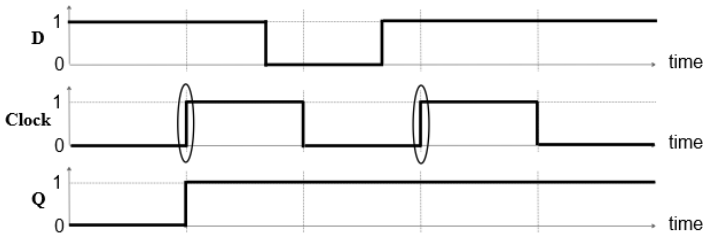
<tr><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td></tr>
</table></td><td>4</td><td>Ecf for H, J and K</td></tr>
<tr><td>6</td><td>(e)</td><td></td><td>At least one of the rising edges of the clock identified.
The second rising edge of the clock identified and no others.

 
</td><td>1
1</td><td>Disregard any incorrect rings for this mark
No incorrect rings anywhere on the diagram for this mark</td></tr>
</table>

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