OCR
Oxford Cambridge and RSA

Cambridge Technicals
Engineering

Unit 4: Principles of electrical and electronic engineering

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

Mark Scheme for January 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.

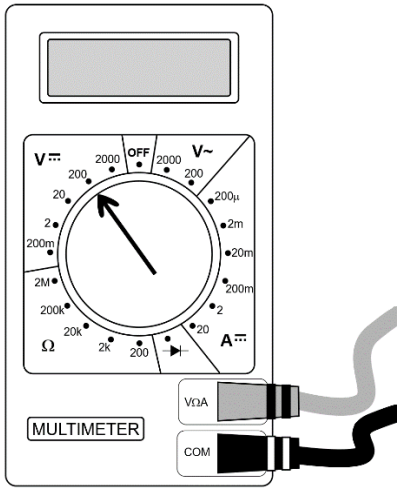
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

Annotations

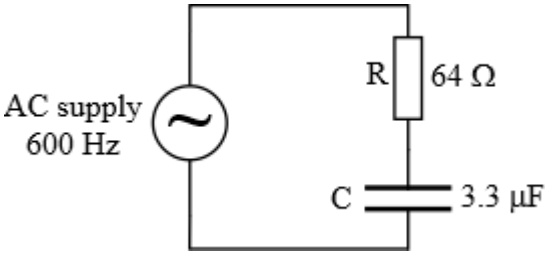
Annotation	Meaning
tick	Correct response
cross	Incorrect response
Omission mark (carat)	Incomplete response
ECF	Error carried forward
BOD	Benefit of doubt
NBOD	No benefit of doubt
Wtte	Words to that effect

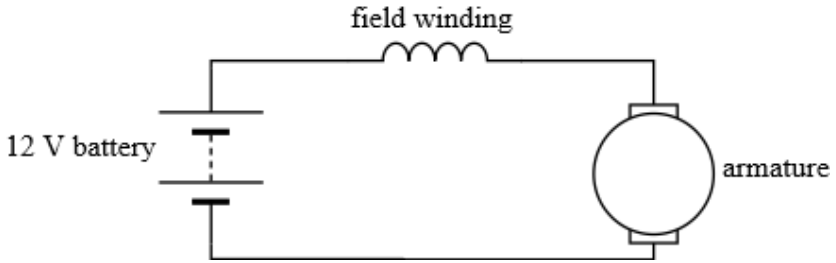
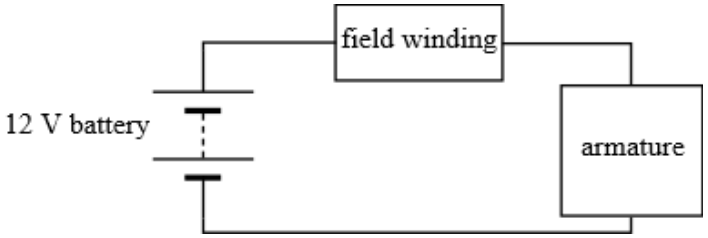
Subject-specific marking instructions

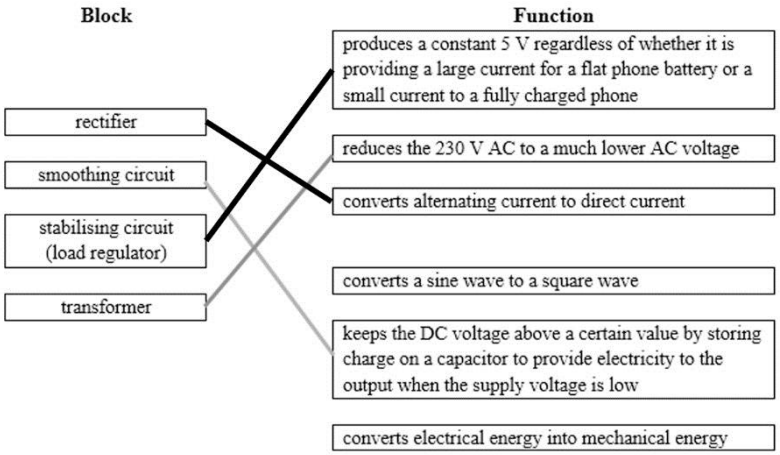
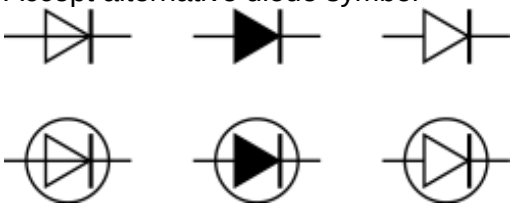
In all numerical calculation questions a correct response will gain all marks unless specified otherwise.
Rounding of answers should be to the same number of significant figures as the data in the question, or, otherwise, an answer will be correct provided it rounds to the correct answer.
Symbols used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

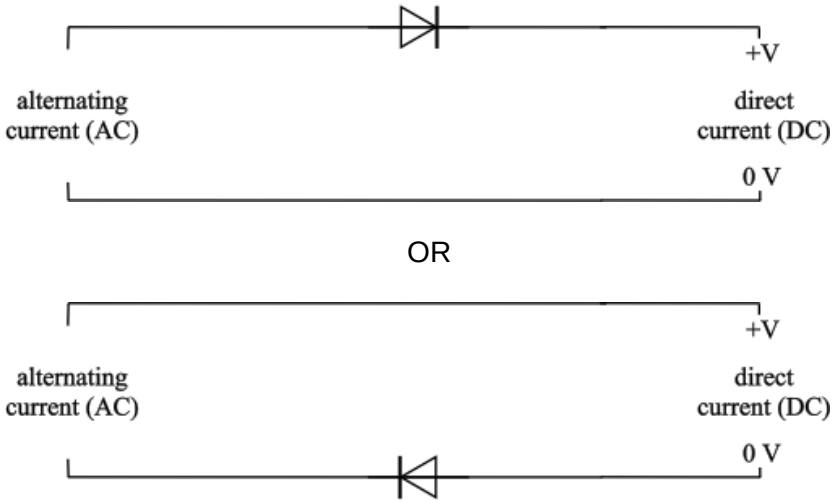
Question			Answer	Marks	Guidance
1	**(a)**	**(i)**	20 Ω + 40 Ω = 60 Ω	1	Unit given in question
1	**(a)**	**(ii)**	$I = \frac{V}{R} = \frac{9}{60} = 0.15\,A$ Correct numerical answer (0.15) Correct units A	 1 1	*For applying knowledge from Unit 2 LO3* Accept A, mA or μA etc. 150 mA for [2]
1	**(a)**	**(iii)**	$V = IR = 0.15 \times 40 = 6\,V$ ecf from (ii)	1	Unit given in question
1	**(a)**	**(iv)**	P = IV = 0.15 x 6 = 0.9 W ecf from (ii) and (iii)	1	Unit given in question
1	**(b)**	**(i)**	 200 V DC	1	
1	**(b)**	**(ii)**	maximum number of decimal places (1) e.g.: Setting on 200 provides <u>maximum number of decimal places</u> (wtte) for accuracy of measurement without going over range.	1	Mark for understanding 'maximum number of decimal places'

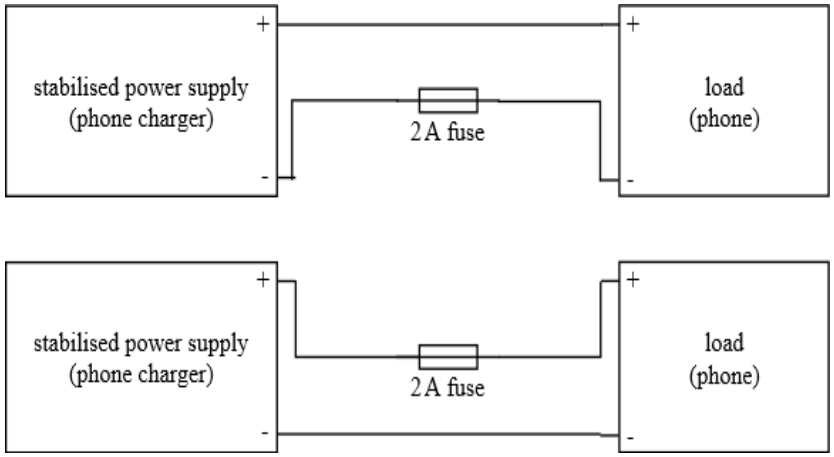
Question			Answer	Marks	Guidance
1	(c)	(i)	6 – 1.8 = 4.2 V	1	
1	(c)	(ii)	0.8 mA	1	
1	(c	(iii)	0.8 – 0.6 = 0.2 mA	1	
1	(c)	(iv)	$R_1 = \frac{V_1}{I_1} = \frac{1.8}{0.0008} = 2250\,\Omega$	1	2.25 kΩ Accept answer to 2sf: 2300Ω Accept e.c.f. from 1(c)(ii) for I_1
1	(c)	(v)	$R_t = \frac{V}{I_2} = \frac{4.2}{0.0002} = 21000\,\Omega$ $R_t = R_2 + 18000$ $\therefore R_2 = 21000 - 18000 = 3000\,\Omega$	 1	Full marks for any method that gives 3000 Ω or 3 kΩ Accept e.c.f. from 1(c)(iii) for I_2 and/or for V from 1(c)(i)
2	(a)	(i)	6 V	1	
2	(a)	(ii)	2 ms	1	
2	(a)	(iii)	12 V	1	**Not** ± 6 V
2	(a)	(iv)	$T = 2\text{ ms} = 2 \times 10^{-3}\text{s}$ $f = \frac{1}{T} = \frac{1}{2 \times 10^{-3}} = 500\text{ Hz}$	1 1 1	*For applying knowledge from Unit 2 LO3* Conversion of ms to s or use of kHz in answer Use of f=1/T to get answer ecf from conversion and 1(a)(ii) Correct units in answer (Hz or kHz)

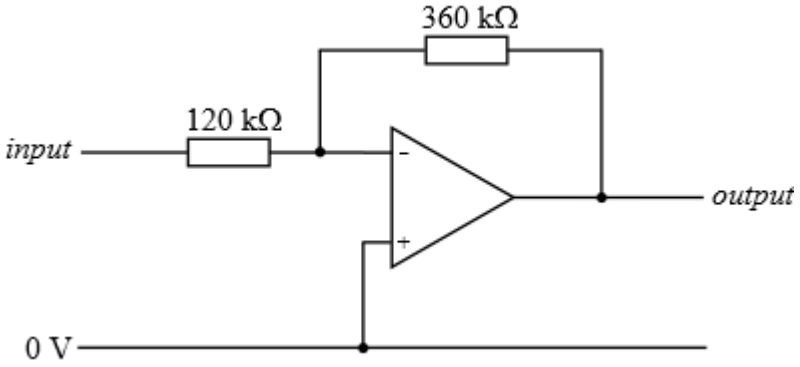
Question			Answer	Marks	Guidance
2	(b)	(i)	Correct symbols used for R and C. Series circuit of three elements with correct values	1 1	Accept US resistor symbol  Accept any symbols for this mark 
2	(b)	(ii)	$f = 600\,Hz$ $C = 3.3\,\mu F = 3.3\times10^{-6}\,F$ $X_C = \frac{1}{2\pi\times600\times3.3\times10^{-6}} = 80\,\Omega$	 1 1 1	*For applying knowledge from Unit 2 LO3* Conversion to F Successful calculation using correct values ecf from conversion to F Correct units
2	(b)	(iii)	$Z = \sqrt{R^2 + X_C^2} = \sqrt{64^2 + 80^2} = 102\,\Omega$ ecf from 2bii	1	Ignore units Accept answer to 2sf: 100Ω Accept answers 102.7 Ω or 103 Ω from using the precise answer to 2(b)ii of 80.38 Ω.

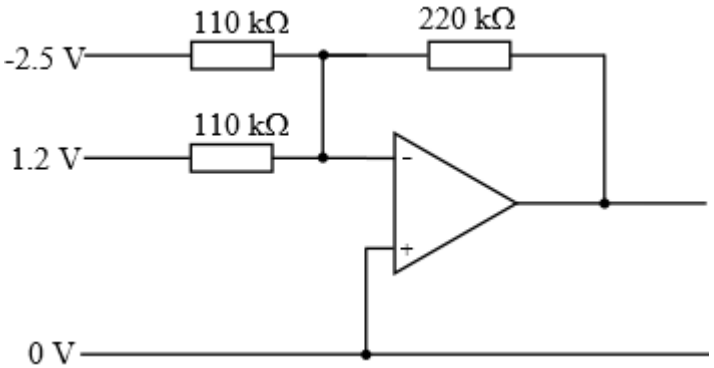
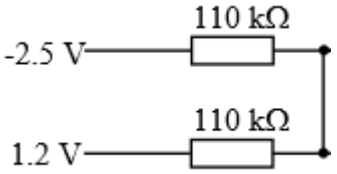
Question			Answer	Marks	Guidance
3	(a)		A series wound DC motor is used to start a car engine. When a voltage is first applied to the motor it is not turning and so the EMF generated by the motor is **zero** and the torque provided by the motor is **high**. After a short time the motor has reached high speed and so the EMF generated by the motor is **high** and the torque provided by the motor is **low**.	1 1 1 1	1 mark for each correct word: zero high high low
3	(b)			1	Accept any labelled symbols for field winding and armature in series with the battery. 
3	(c)	(i)	$R_t = 0.20\ \Omega$	1	
3	(c)	(ii)	Selection of correct formula $V = E + I_aR_t$ seen or implied $E = V – I_aR_t = 12 – (20 \times 0.2) = 8$(V) Mark for correct units = V	1 1 1	Allow ecf for R_t from 3(c)(i) Award mark for 8 regardless of units *For applying knowledge from Unit 2 LO3*

Question			Answer	Marks	Guidance
4	(a)		1 mark for each correct link  	2	No marks for any block with links to more than one function.
4	(b)		Correct diode symbol  used anywhere in diagram	1	Accept alternative diode symbol 
			Diode achieves rectification	1	Award this mark even if polarity of output is incorrect
			Rectifier produces correct polarity half-wave rectified dc with one diode	1	Must obtain rectification mark for this mark For a correct full-wave rectifier circuit that produces the

Question			Answer	Marks	Guidance
			Correct answers for 3 marks:  OR 		required polarity award 2 marks. Accept other correct alternative solutions. Ignore load resistor <u>across</u> output or transformer across input
4	**(c)**		Direct current: only flows in one direction (owtte) Alternating current: changes direction periodically/moves one way then the other/keeps changing direction (owtte)	1 1	 Do not accept 'flows in both directions'. Answer must express the idea that the change in direction of current flow changes with time.

Question			Answer	Marks	Guidance
4	(d)	(i)	Either of the below 	1	
4	(d)	(ii)	When too much <u>current</u> flows the thin fuse wire melts <u>disconnecting</u> the supply from the load so preventing and damage to the supply or the load.	1 1 1	Must mention current for this mark. Look for comment about a large current (2 A <u>or more</u>) Look for comment about fuse failing/blowing under adverse conditions Look for comment about disconnecting or preventing further flow of current

Question			Answer	Marks	Guidance
5	(a)	(i)	**inverting amplifier**	1	
5	(a)	(ii)		1	Must have both correctly labelled for one mark Allow labelling of output anywhere on output line Accept V_{in} and V_{out}
5	(a)	(iii)	$\text{Voltage Gain} = -\frac{R_f}{R_{in}} = -\frac{360000}{120000} = -3$ magnitude sign	 1 1	Ignore any units 1 mark for +3 1 mark for a negative number
5	(a)	(iv)	$V_{out} = G \times V_{in} = -3 \times 1.5 = -4.5\,V$	1	Unit given in question ecf Voltage Gain from 5aiii

Question			Answer	Marks	Guidance
5	(b)	(i)	 Op-amp with feedback resistor of 220 kΩ from output to inverting input and non-inverting input to 0 V Two input resistors of 110 kΩ each with inputs labelled -2.5 V and 1.2 V	1 1	Accept any two correctly labelled resistors joined to a common point 
5	(b)	(ii)	$V_{out} = -\frac{R_f}{R_{in}}(V_1 + V_2) = -\frac{220000}{110000} \times (-2.5 + 1.2) = 2.6\,V$	1	Correct answer Unit given in question
6	(a)		AND gate	1	

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<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(b)</td><td></td><td>
<table>
<tr><th>A</th><th>D</th><th>E</th></tr>
<tr><td>0</td><td>0</td><td>0</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>1</td></tr>
</table>
all combinations of A and D (any order)
E correct</td><td>2</td><td></td></tr>
<tr><td>6</td><td>(c)</td><td></td><td>$E = A \cdot D$</td><td>1</td><td></td></tr>
<tr><td>6</td><td>(d)</td><td></td><td>
<table>
<tr><th>D</th><th>E</th><th>F</th><th>G</th></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td></tr>
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1
1</td><td>1 mark for each correct column
allow ecf from D to E
allow ecf from D to F
allow ecf from E and F to G</td></tr>
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