



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 2017

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Subject-specific marking instructions

In all numerical calculation questions a correct response will gain all marks unless specified otherwise.

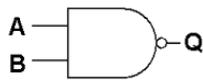
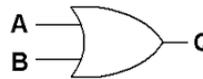
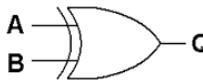
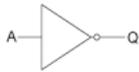
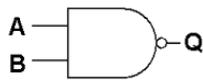
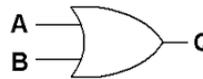
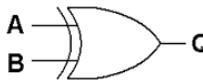
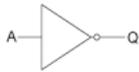
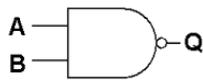
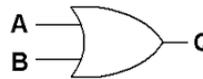
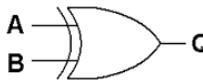
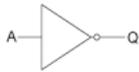
Question		Answer	Marks	Guidance
1	(a)	Use $\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{and} \quad R_{\text{total}} = R_1 + R_2$ $R = 4.7\text{k}\Omega + 3.3\text{k}\Omega = 8\text{ k}\Omega$ $1/R = 1/8\text{k}\Omega + 1/2.2\text{k}\Omega, R = 1.73\text{k}\Omega$ $R_{\text{total}} = 10\text{k}\Omega + 1.73\text{k}\Omega + 15\text{k}\Omega$ $R_{\text{total}} = 26.7\text{k}\Omega$	1 1 1 1	(For applying knowledge from Unit 2, LO3) (For applying knowledge from Unit 2, LO3) Allow ECF Award 1 mark for correct numerical result with unit, with or without rounding.
	(b)	Using $V=IR$ Voltage drop across $R_1 (V_1) = 1 \times 10^{-3} \times 4.7 \times 10^3 = 4.7\text{V}$ Using Kirchoff's Voltage law: $V_{\text{Supply}} = V_1 + V_2, V_2 = 12\text{V} - 4.7\text{V}$ $V_2 = 7.3\text{V}$	1 1 1 1	(For applying knowledge from Unit 2, LO3) Award 1 mark for correct numerical result with unit. Award 1 mark for correct numerical result with unit.
	(c) (i)	3Ω	1	Award 1 mark for correct numerical result with unit.
	(ii)	Use $R_t = R_1 + R_2, I = V/R, P = I^2 R$ $R_t = 3\Omega + 3\Omega = 6\Omega$ $I = 24\text{V}/6\Omega = 4\text{A}$ $P = 4^2 \cdot 3 = 48\text{(W)}$ Or Use $R_t = R_1 + R_2, I = V/R, P = VI$ V across $R_{\text{Load}} = V/2 = 12\text{V}$ (1) $I = 24\text{V}/6\Omega = 4\text{A}$ (1) $P = 12 \cdot 4 = 48\text{(W)}$ (1)	1 1 1	(For applying knowledge from Unit 2, LO3) Allow ECF if 3Ω (For applying knowledge from Unit 2, LO3) Award 1 mark for correct numerical result with or without unit. Award a maximum of 1 mark for $24^2/6$ or $24^2/3$

Question			Answer	Marks	Guidance
2	(a)	(i)	$X_C = \frac{1}{2\pi f c}$ $X_C = \frac{1}{2 \times \pi \times 50 \times 33 \times 10^{-6}}$ $X_C = 96.5(\Omega)$ $X_L = 2\pi f L$ $X_L = 2 \times \pi \times 50 \times 0.5$ $X_L = 157(\Omega)$ $Z = \sqrt{R^2 + (X_L - X_C)^2}$ $Z = \sqrt{70^2 + (157 - 96.5)^2}$ $Z = 92.5(\Omega)$ $\cos \phi = R/Z$ $\cos \phi = 70/92.5$ $\text{Phase angle } (\phi) = 40.8^\circ$	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Award 1 mark for correct numerical result 96.46 / 96.154 / 96 / 96.5 / 96.2 with or without unit.</p> <p>Award 1 mark for correct numerical result 157.1 / 157 / 160 with or without unit.</p> <p>Award 1 mark for correct numerical result 92.6 / 92.5 / 94 / 93 with or without unit.</p> <p>Allow ECF. Correct answer 40.9 ° / 40.8 ° / 41 ° (For applying knowledge from Unit 2, LO3) Unit must be included, degrees or radians equivalent.</p>
		(ii)	$I = V/Z = 240V/92.5\Omega = 2.6A$	1	<p>Allow ECF. Correct answer 240/Z to at least 2 significant figures Unit must be included.</p>

Question		Answer	Marks	Guidance
	(iii)	<p>A phasor diagram with a horizontal axis representing the reference voltage V_R and current I. The current vector $I = 2.6\text{A}$ is shown as a horizontal arrow pointing to the right. The voltage vector $V = 240\text{V}$ is shown as an arrow pointing into the first quadrant, making an angle ϕ with the V_R axis. The voltage vector V_L is shown as a vertical arrow pointing upwards, and V_C is shown as a vertical arrow pointing downwards. The V_L and V_C vectors are collinear with the V_R axis.</p>	1 1 1	<p>Award one mark for correct positioning of V_L, V_C and V_R.</p> <p>Award 1 mark for correct positioning of V with correct phase angle and value. Units must be included. Allow ECF.</p> <p>Award 1 mark for correct positioning of I with value. Units must be included. Allow ECF.</p>
(b)	(i)	$2\pi f = 628.3$ $f = 628.3/2\pi = 100\text{Hz}$	1 1	Award 2 marks for correct numerical result with unit.
	(ii)	$f = 1/t$ $t = 1/100 = 0.01\text{seconds}$	1 1	Award 2 marks for correct numerical result with unit.

Question	Answer	Marks	Guidance
<p>3</p>	<div> <p>Additional armature resistor.</p> </div> <p>Speed can be controlled by varying the current flow through the armature.</p> <p>Increasing the resistance of the armature circuit will decrease the current flow in the armature and decrease the speed of the motor.</p> <div> <p>Shunt field regulator</p> </div> <p>Speed can be controlled by varying the value of flux using a variable resistor in series with the field winding (shunt field regulator).</p> <p>As resistance of shunt field regulator increases the value of field current decreases, value of flux decreases and the speed increases.</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Diagram or allow adequate description</p> <p>Purpose of the change</p> <p>Explanation of the outcome</p> <p>Diagram or allow adequate description</p> <p>Purpose of the change</p> <p>1</p> <p>Also award 1 mark here if explained using formula $n \propto 1/\Phi$ where n = motor speed, Φ = flux Explanation of the outcome</p> <p>Allow suitable alternative answers</p>

Question		Answer	Marks	Guidance
4	(a)		<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Resistors drawn in star formation.</p> <p>Neutral Line</p> <p>Line voltages correctly labelled V_{BR}, V_{RY}, V_{YB}</p> <p>Phase voltages correctly labelled V_R, V_Y, V_B</p> <p>Accept suitable alternative labelling that differentiates 3 distinct line voltages and 3 distinct phase voltages.</p>
	(b)		<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>- Three sine waves.</p> <p>- Phase difference of 120° between any two</p> <p>- Three waveforms are 120° out of phase.</p> <p>Award 1 mark for correct labelling of phases 1,2 and 3</p>
	(c)	415V	1	<p>Award 1 mark for correct numerical result with unit.</p> <p>Accept 400V (European standard)</p>

Question		Answer	Marks	Guidance										
	(c)	$V_o = -50 \times (0.2/10 + 0.5/10 + 0.25/10)$ $= -4.75V$	2	<p>Award 1 mark for correct substitution Award 1 mark for correct numerical result with unit. Sign must be correct.</p> <p>ECF: Award 1 mark if incorrect formula used but calculation correct, unit must be given.</p>										
6	(a)	<table border="1"> <thead> <tr> <th>Boolean Expression</th> <th>Logic Gate Symbol</th> </tr> </thead> <tbody> <tr> <td>$Q = \overline{A \cdot B}$</td> <td>  </td> </tr> <tr> <td>$Q = A + B$</td> <td>  </td> </tr> <tr> <td>$Q = A \oplus B$</td> <td>  </td> </tr> <tr> <td>$Q = \overline{A}$</td> <td>  </td> </tr> </tbody> </table>	Boolean Expression	Logic Gate Symbol	$Q = \overline{A \cdot B}$		$Q = A + B$		$Q = A \oplus B$		$Q = \overline{A}$		1 1 1 1	A, B and Q not required on Logic Gate symbols.
Boolean Expression	Logic Gate Symbol													
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Question		Answer	Marks	Guidance																																				
(b)	(i)	<table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> <th>Q</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	X	Y	Z	Q	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1	1	1	0	0	0	1	0	1	0	1	1	0	1	1	1	1	1	4	Award 1 mark for every 2 correct rows in the table.
X	Y	Z	Q																																					
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(b)	(ii)		4	Award 1 mark for each correct Logic Gate, with correct connections and correct input labels. Output label not required.																																				

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