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 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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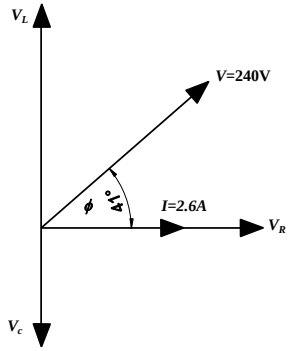
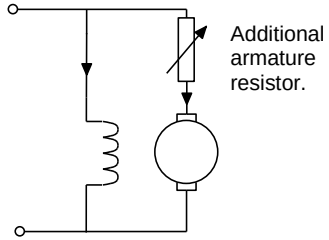
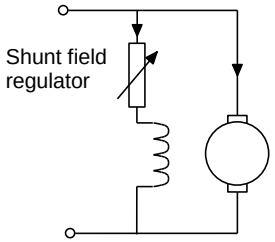
Subject-specific marking instructions

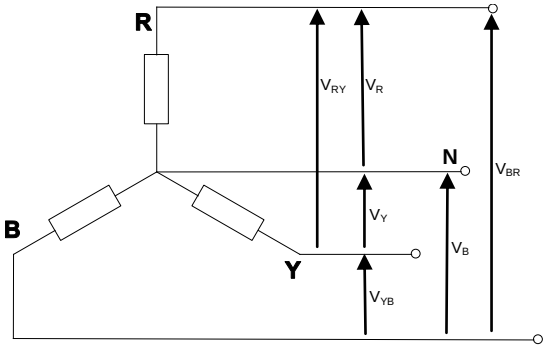
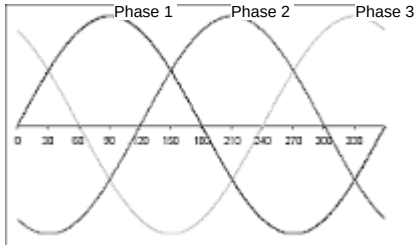
In all numerical calculation questions a correct response will gain all marks unless specified otherwise.

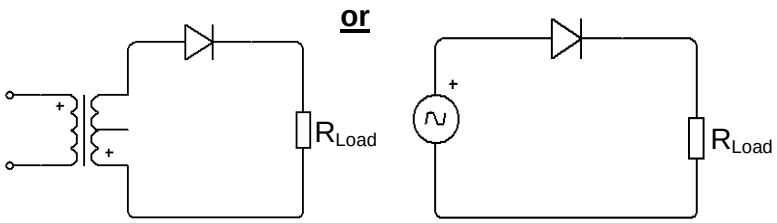
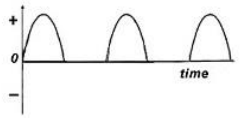
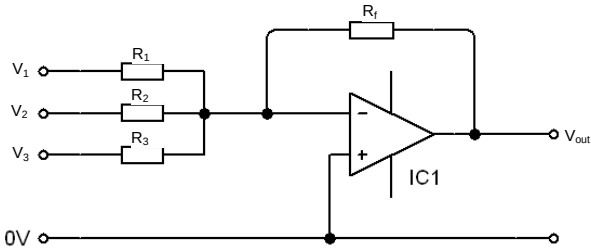
Question			Answer	Marks	Guidance
1	(a)		Use $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$ and $R_{total} = R_1 + R_2$ R =4.7kΩ + 3.3kΩ = 8 kΩ 1/R = 1/8kΩ + 1/2.2kΩ, R = 1.73kΩ R_{total} = 10kΩ + 1.73kΩ + 15kΩ R_{total} = 26.7kΩ	 1 1 1 1	 (For applying knowledge from Unit 2, LO3) (For applying 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) = $1x10^{-3}$ x 4.7 $x10^3$ = 4.7V Using Kirchoff's Voltage law: $V_{Supply} = V_1 + V_2$, $V_2 = 12V - 4.7V$ V_2 =7.3V	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, $P=I^2R$ R_t = 3Ω + 3Ω = 6Ω I = 24V/6Ω = 4A $P=4^2.3$ = 48(W) Or Use $R_t=R_1+R_2$, I=V/R, P=VI V across R_{Load} = V/2 =12V (1) I = 24V/6Ω = 4A (1) P=12.4 =48(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)	$X_C = \frac{1}{2\pi fc}$ $X_C = \frac{1}{2 \times \pi \times 50 \times 33x10^{-6}}$		
			X_C = 96.5(Ω)	1	Award 1 mark for correct numerical result 96.46 /96.154 / 96 / 96.5 / 96.2 with or without unit.
			$X_L = 2\pi fL$ $X_L = 2 \times \pi \times 50 \times 0.5$ X_L= 157(Ω)	1	Award 1 mark for correct numerical result 157.1 / 157 / 160 with or without unit.
			$Z = \sqrt{R^2 + (X_L - X_c)^2}$ $Z = \sqrt{70^2 + (157 - 96.5)^2}$ Z = 92.5(Ω)	1	Award 1 mark for correct numerical result 92.6 / 92.5 / 94 / 93 with or without unit.
			Cos ϕ = R/Z Cos ϕ = 70/92.5 Phase angle (ϕ) = 40.8˚	1	Allow ECF. Correct answer 40.9 ˚ / 40.8 ˚ / 41 ˚ (For applying knowledge from Unit 2, LO3) Unit must be included, degrees or radians equivalent.
		(ii)	I= V/Z = 240V/92.5Ω = 2.6A	1	Allow ECF. Correct answer 240/Z to at least 2 significant figures Unit must be included.

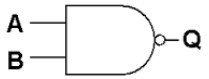
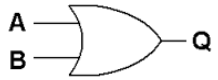
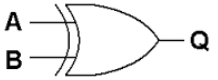
Question			Answer	Marks	Guidance
		(iii)		1 1 1	Award one mark for correct positioning of $\boldsymbol{V_L}$, $\boldsymbol{V_C}$ and $\boldsymbol{V_R}$. Award 1 mark for correct positioning of $\boldsymbol{V}$ with correct phase angle and value. Units must be included. Allow ECF. Award 1 mark for correct positioning of $\boldsymbol{I}$ with value. Units must be included. Allow ECF.
	(b)	(i)	2πf = 628.3 f=628.3/2π = 100Hz	1 1	Award 2 marks for correct numerical result with unit.
		(ii)	f=1/t t=1/100 = 0.01seconds	1 1	Award 2 marks for correct numerical result with unit.

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

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

Question			Answer	Marks	Guidance
	(d)		 **or** • Diode is forward biased/conducting for first half (positive) of the AC input waveform. A half waveform (positive) of current will therefore flow through the load. • Diode is reverse biased/not conducting for the second half (negative) of the AC input waveform. No output signal for this half if the waveform as no current flow.	1 1 1	Award 1 mark for correct circuit diagram, must include reference to AC supply N.B. ignore '+' signs. Allow up to 2 marks for correct explanation even if circuit diagram is incorrect. Must mention operation of diode. May also use diagrams in explanation i.e. 
5	(a)			3	Award 1 mark for each correct bullet (as shown below). Maximum 3 marks. • Correct symbol for operational amplifier (+/- supply not required). • Three input resistors connected to inverting input. • Feedback resistor connected between output and inverting input. • Non-inverting input connected to 0V/Gnd.
	(b)		$V_0 = -R_f(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3})$	1	Or other arrangements of same formula.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td></td><td>V_o = -50 x (0.2/10 + 0.5/10 + 0.25/10)
= -4.75V</td><td>2</td><td>Award 1 mark for correct substitution
Award 1 mark for correct numerical result with unit.
Sign must be correct.

ECF: Award 1 mark if incorrect formula used but calculation correct, unit must be given.</td></tr>
<tr><td>6</td><td>(a)</td><td></td><td>
<table>
<tr><th>Boolean Expression</th><th>Logic Gate Symbol</th></tr>
<tr><td>$Q = \overline{A.B}$</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>
</table>
</td><td>1

1

1

1</td><td>A, B and Q not required on Logic Gate symbols.</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>
<table>
<tr><th>X</th><th>Y</th><th>Z</th><th>Q</th></tr>
<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>
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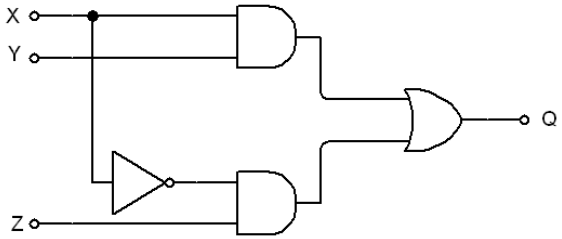
<tr><td>1</td><td>1</td><td>1</td><td>1</td></tr>
</table>
</td><td>4</td><td>Award 1 mark for every 2 correct rows in the table.</td></tr>
<tr><td></td><td>(b)</td><td>(ii)</td><td> 
</td><td>4</td><td>Award 1 mark for each correct Logic Gate, with correct connections and correct input labels.

Output label not required.</td></tr>
</table>

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