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 2017

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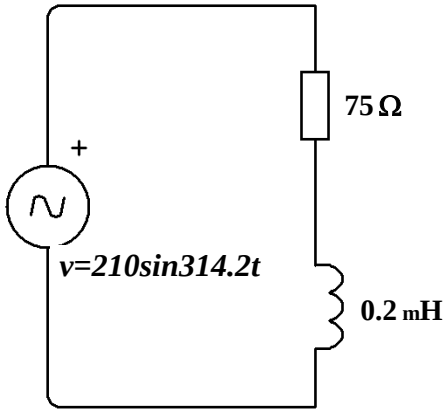
This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

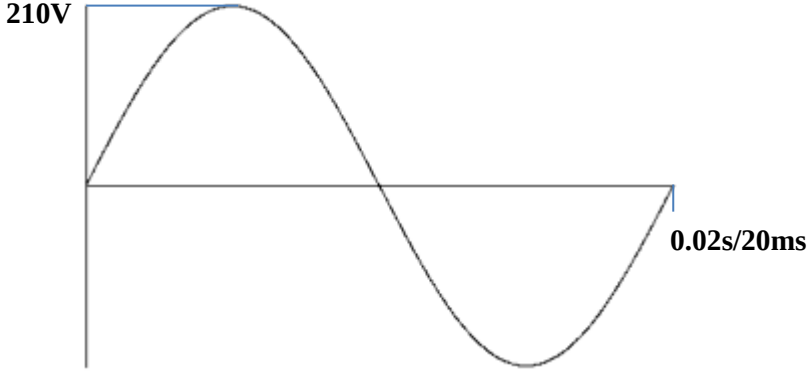
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

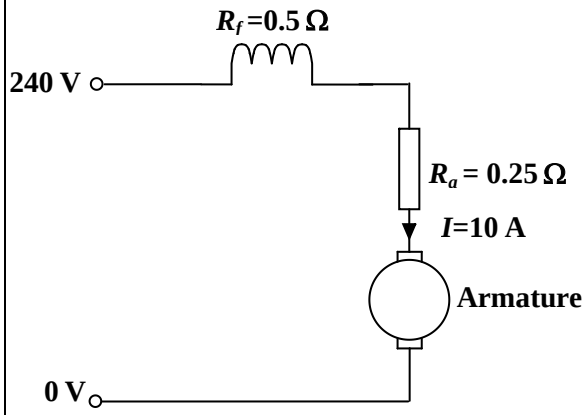
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

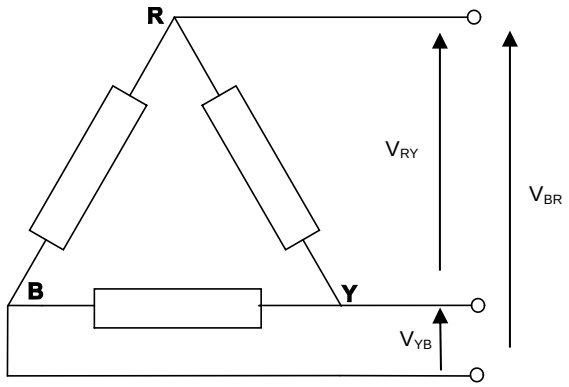
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Question			Answer	Marks	Guidance
1	(a)	(i)	I = 24/150 = 0.16 (A)	1 1	(For applying knowledge from Unit 2, LO3)
		(ii)	R = 150 + 25 = 175 (Ω) I = 24/175 = 0.137 (A) or 0.14 (A)	1 1	(For applying knowledge from Unit 2, LO3)
		(iii)	$P = I^2R = 0.137^2 \times 25$ P = 0.469 or 0.47 or 0.49 (W)	1 1	(For applying knowledge from Unit 2, LO3)
	(b)	(i)	Connect one probe to V/ΩmA and one probe to COM. Probe ends: one to point X, one to point Y (polarity not important).	1 1	Ignore reference to red/black or positive/negative.
		(ii)	Use $R_{total} = R_1 + R_2$ and $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$ R = 1 kΩ + 1.5 kΩ = 2.5 kΩ 1/R = 1/2.5 kΩ + 1/3.3 kΩ = 1422 (Ω) or 1.422 k(Ω)	 1 1 1	(For applying knowledge from Unit 2, LO3) Max 2 marks for incorrect parallel resistor combinations, such as R = 1 kΩ + 3.3 kΩ = 4.3 kΩ 1/R = 1/1.5 kΩ + 1/4.3 kΩ = 1112 (Ω) or 1.112 k(Ω)
		(iii)	Answer must be consistent with answer to (ii), e.g. if answer to (ii) is 1422 (Ω) or 1.422 k(Ω) then Ω / 2000	1	

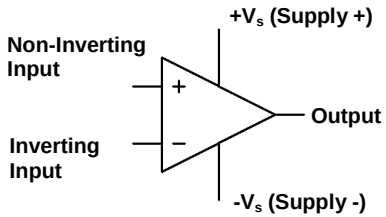
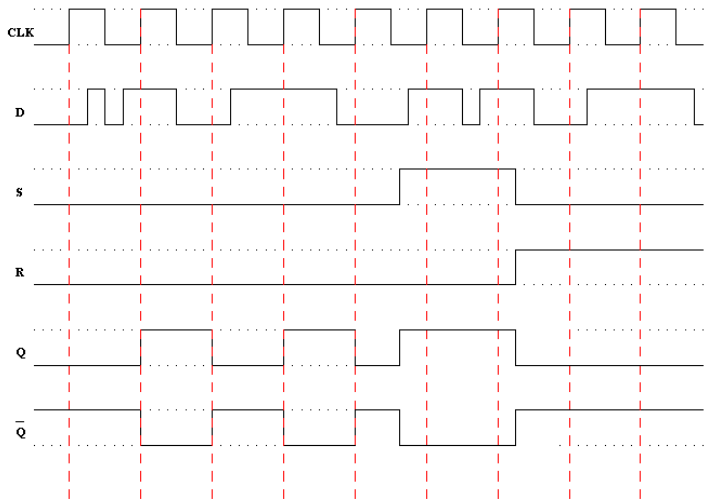
Question			Answer	Marks	Guidance
2	(a)			3	Award 1 mark for each correct symbol with value connected in series. Allow 2 marks if inductor symbol with both inductance and resistance indicated. Allow 210V 50 Hz ac supply.

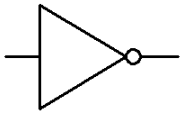
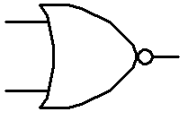
Question			Answer	Marks	Guidance
	(b)			1 1	Award 1 mark for sine wave as shown (For applying knowledge from Unit 1, LO4) Award 1 mark for correct value of peak voltage on sketch.
			$2\pi f = 314.2$ $f = 314.2/2\pi = 50\ Hz$ $t = 1/f = 1/50 = 0.02\ s$	1 1	Award 1 mark for calculation of periodic time. Award 1 mark for correct value of periodic time on sketch.

Question			Answer	Marks	Guidance
	(c)		$2\pi f = 314.2$ $X_L = 2\pi fL = 0.2 \times 10^{-3} \times 314.2 = 0.06284(\Omega)$	1	
			$Z = \sqrt{R^2 + X_L^2}$ $Z = \sqrt{75^2 + 0.06284^2}$ $Z = 75\ (\Omega)$	1	Allow ECF. There must be evidence of calculation of impedance.
			$I = V/Z = 210(V)/75\ (\Omega)$ $I = 2.8$ **A**	1	Allow ECF. (For applying knowledge from Unit 2, LO3)
	(d)		$V_L = IX_L = 2.8 \times 0.06284$ $= 0.176$ **V**	1 1	Allow ECF for current from part (c)
3	**(a)**			3 1 1	1 mark for each of armature, armature resistance and field resistance connected in series. 1 mark for values of voltage and current (with arrow). 1 mark for resistor values correctly labelled. Allow marks if: • both resistor and inductor symbol used to represent field coil and/or • armature symbol includes armature resistance.

Question			Answer	Marks	Guidance
	(b)		$V = E + I(R_f+R_a)$ $V = E + 10(0.5 + 0.25)$ $E = 240 – 7.5 = 232.5$ **V**	1 1 1	Award 1 mark for identification of correct formula. For substitution and rearrangement Award 1 mark for correct numerical result **with** unit. Allow use of $E=V+IR_t$ <u>this series only</u> (as quoted incorrectly in version 2 of the formula booklet): $E= V+IT_t$ 1 mark id of formula $E= 240 + 10(0.5 + 0.25)$ 1 mark for substitution $E+ 240 + 7.5 = 247.5$ **V** 1 mark **with** correct unit
	(c)		Any suitable application e.g. trains, delivery vehicles, cranes and hoist. Series wound motors have high torque **at start up** therefore good for motors which are used for traction/require high initial torque.	1 1	Accept any reasonable alternative examples
4	**(a)**			1 1 1	Resistors or AC power sources drawn in delta arrangement. Three wires drawn. Line voltages correctly labelled V_{BR}, V_{RY}, $V_{YB.}$

Question			Answer	Marks	Guidance
	(b)		Accept any one from: • colour sequence; current UK colour sequence brown, black and grey. • 3-phase 4 wire star connected system. • 120˚ degrees phase shift (between incoming phases) or 0˚, 120˚, 240˚.	1	Allow benefit of doubt if red, yellow, blue seen
	(c)		For a given amount of power transmission, three-phase networks require conductors with a smaller cross–sectional area, therefore cheaper as fewer resources needed. Two voltages are available on a three phase network.	1 1	Also accept other suitable advantages

Question			Answer	Marks	Guidance
5	(a)			3	1 mark for every 2 correct points. i.e. correct labels and correctly drawn symbol. Allow $-V_S = 0$. Maximum 3 marks.
	(b)	(i)	Gain = -120 kΩ /10 kΩ = -12	1	Correct numerical value and sign, no units.
		(ii)	Gain = V_{out}/V_{in} $V_{out} = V_{in}$ x Gain V_{out} = 0.2 x -12 = **-**2.4 **V**	1 1	Award 1 mark for correct numerical result With correct unit, and sign. Allow ecf Gain from b(i)
		(iii)	Gain = V_{out}/V_{in} $V_{out} = V_{in}$ x Gain, V_{out} = -1.5 x -12 V_{out} = **+**18 **V**	1 1	Award 1 mark for correct numerical result With correct unit, and sign. Allow ecf Gain from b(i)
6	(a)			4 1	Award 1 mark if Q correct for 2 rising edges. Maximum 4 marks. Allow ECF Award 1 mark if $\overline{Q}$ inverse of Q.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th>Circuit Symbol</th><th>Logic Gate Name</th></tr>
<tr><td>  </td><td>NOT</td></tr>
<tr><td>  </td><td>NOR</td></tr>
</table>
</td><td>2</td><td>Award 1 mark/ correct logic gate name.</td></tr>
<tr><td></td><td>(c)</td><td></td><td>
<table>
<tr><th>A</th><th>B</th><th>C</th><th>A.B</th><th>A.C</th><th>A.B + A.C</th><th>Q</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
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</table>
</td><td>1

4</td><td>Award 1 mark for correct input combination (columns A, B and C correct) in order of binary count).

Award 1 mark for every 2 correct rows, maximum 4 marks. Max 2 marks if $Q=A.B + A.C$ i.e. not inverted.

Columns A, B, C and Q only ones required.</td></tr>
</table>

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

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Head office
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