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 2018

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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.

Annotations

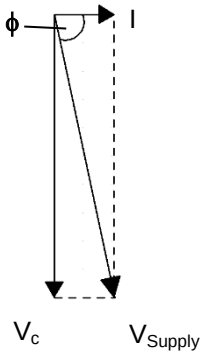
Annotation	***Meaning***
tick	Correct response
cross	Incorrect response
Omission mark (carat)	Incomplete response
ECF	Error carried forward
BOD	Benefit of doubt
NBOD	No benefit of doubt
RE	Rounding error

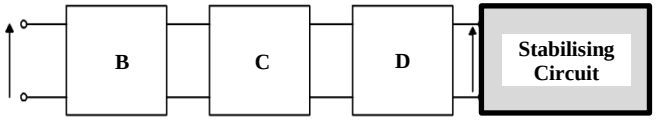
Subject-specific marking instructions

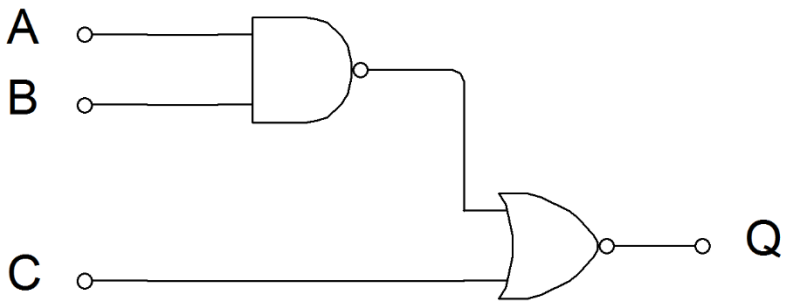
In all numerical calculation questions a correct response will gain all marks unless specified otherwise.

Question			Answer	Marks	Guidance
1	(a)		• High/infinite gain voltage amplifier • Differential input • Amplifies the difference between the non-inverting and inverting inputs. • Produces an output voltage many times larger than the voltage difference between its inputs. • Has a single ended output. • Has a dual supply which allows the output voltage to swing above and below 0V. • Can be used to amplify both A.C. and D.C. • DC-coupled voltage amplifer • High/infinite input impedance • Low/zero output impedance	3	Any 3 points Do not award a simple description of the diagram, e.g. ”has two inputs and one output”
	(b)	(i)	$\boldsymbol{Voltage\ Gain\ (A_v) = 1 + \frac{R2}{R1}}$ $\boldsymbol{20 = 1 + \frac{R_2}{10K\Omega}}$ (20-1) x 10000 = R2 R2 = 190 kΩ	 1 1 1	 1 mark for substitution 1 mark for rearrangement - For applying knowledge from Unit 1 LO1
		(ii)	$Voltage\ Gain\ (A_v) = \frac{V_{out}}{V_{in}}$ V_{out}= Voltage Gain x Vi_n = 20 x 10mV = 0.2**V** **or** 200**mV**	 1 +1 1	**Units required in answer** Recalling formula (see or implied) & rearrangement and substitution. Correct unit must be stated or maximum 2 marks.

Question			Answer	Marks	Guidance
2	(a)		$X_C = \frac{1}{2\pi fc}$ $X_C = \frac{1}{2 \text{ x } \pi \text{ x } 50 \text{ x } 3.3\mu}$ $X_C =$ 965 Ω	1 1	Allow 960 Ω (rounded to 2 sig. figs.)
	(b)	(i)	$Z = \sqrt{R^2 + {X_c}^2}$ $Z = \sqrt{964.575 ...^2 + 200^2}$ * Z= 985 or 986 **Ω** *If rounded answer from (i) 965 used = 985.51 so accept rounding to 986	1 1+1	**Units required in answer** Use of formula seen or implied. Allow ecf from (i) for X_c^2 1 mark for correct answer, 1 mark for unit. Allow 980 Ω if X_C = 960 Ω in 2(a).
		(ii)	Cos ϕ = R/Z Cos ϕ = 200/985 or 200/986 or 200/980 Phase angle (ϕ) = 78.3º /78.2º or 1.4 **rad**	1 1+1	**Units required in answer** Allow ecf from (i) for Z 1 mark for correct answer, 1 mark for unit.

Question			Answer	Marks	Guidance
		(iii)		3 1	1 mark each for the correct position of V_{Supply}, V_C and ϕ 1 mark for correct alignment (see dotted lines).
3	**(a)**		At any node/junction in a circuit the sum of the currents flowing into the node are equal to the sum of the currents flowing out.	2	1 mark for recognising it is the current law. 2 marks for correct definition.
	(b)	**(i)**	I=V/R R= 10kΩ + 2.2kΩ = 12.2kΩ I= 6/12.2kΩ I= 0.492 mA	 1 1 1	For applying knowledge from Unit 2 LO3
		(ii)	I_1= 6V/33 kΩ = .000182 (A) 0.182m**(**A) or 182μ**(**A) $I=I_1 + I_2 + I_3$ (Kirchhoff's current law) I=0.182mA + 1mA +0.492mA I= 1.67**mA**	1 1 2	**Units required in answer** For applying knowledge from Unit 2 LO3 Allow ecf for 0.492mA for I_3 from (i) Allow ecf for 0.182mA for I_1 1 mark for correct answer. And 1 mark for correct unit. 1 mark for unit - For applying knowledge from Unit 2 LO1

Question			Answer	Marks	Guidance
4	(a)	(i)	B Transformer C Rectifier D Smoothing Circuit E (unregulated/unstabilised) DC output	1 1 1 1	Part marks for BCD may be earned where elements are omitted provided those shown are in a logical sequence. Correct answer only.
		(ii)	Stabilising circuit connected to DC output. 	1	Also accept block labelled **voltage regulator**
	(b)		• Maintains a constant voltage (or current) on the output • Regardless of changes in circuit load	1 1	Up to two marks for an explanation.
5	(a)	(i)	***A*** ***B*** ***Q*** 0 0 **0** 0 1 **1** 1 0 **1** 1 1 **0**	2	1 mark for 2/3 rows correct

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>(ii)</td><td>$A \oplus B$
or
$\overline{A}.B + A.\overline{B}$</td><td>1</td><td>One mark for either expression given.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td> 
</td><td>4</td><td>1 mark for NAND gate
1 mark for NOR gate
1 mark for correct connection of 2 gates
1 mark for correct labelling of A,B,C and Q</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>
<table>
<tr><th>A</th><th>B</th><th>C</th><th>A.B</th><th>$\overline{A.B}$*</th><th>Q</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
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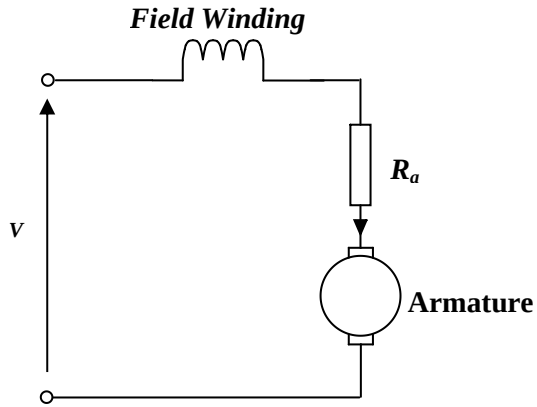
Code: A= 1 B =1 C= 0</td><td>4

1</td><td>For full marks all 8 possible combinations of ABC must be seen and all combinations bar 110 will return 0 for Q.
Award 1 mark for every 2 correct values of Q for non-repeated sequences of ABC in the truth table.
There should be no repeat combinations of ABC. If there are, and values of Q are contradictory or incorrect then do not credit. For repeated sequences where Q is correct only credit one line.

All digits must be correct.

*as per post-examination correction erratum.</td></tr>
</table>

Question			Answer	Marks	Guidance
6	(a)			4	1 mark each for correct symbols for armature, field winding, output voltage and armature resistance connected in series.
	(b)	(i)	• $V=I_aR_L$ • V=68 x 7 • V= 476 V	1 1	For applying knowledge from Unit 2 LO3 Unit **not** required for this mark.
		(ii)	• $V=E- I_aR_a$ • 476=E-(1.5x7) • E=486.5 V	1 1 1	For substitution For rearrangement- For applying knowledge from Unit 1 LO1 Allow ecf for 476 V from (i) Unit **not** required for this mark.
	(c)		• Advantage: Lower internal resistance. • Disadvantage: Requires additional voltage supply for field winding circuit.	1 1	

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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