Cambridge National

Systems Control in Engineering

R113/01: Electronic principles

Level 1/2 Cambridge National Certificate/Award

Mark Scheme for June 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.

Mark Scheme

Award full marks for a calculation when there is no working but the numerical answer is correct.

Annotations	Meaning
BP	Blank page
VG	Vague
	Tick
SEEN	Noted but no credit given
REP	Repeat
K	Knowledge
EG	Example/Reference
DEV	Development
	Cross
BOD	Benefit of doubt
	Unclear
L3	Level 3
L2	Level 2
L1	Level 1

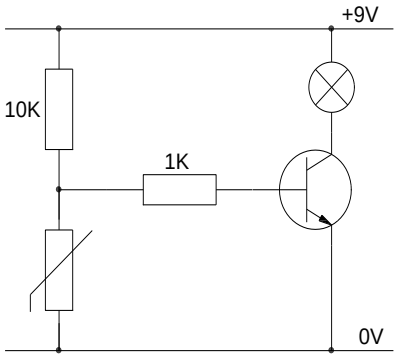
Mark Scheme

Award full marks for a calculation when there is no working but the numerical answer is correct.

Question			Answer	Mark	Guidance
1	(a)		230 V AC mains 12 V DC Battery Solar Panel	3	Award one mark for each correct response.
1	(b)		V = IR = (800/1000) x 15 = 12 V	3	Award one mark for V = IR Award one mark for (800/1000) x 15 Award one mark for 12.
1	(c)		P = VI = 6 x 4 = 24 W	2	Award one mark for P = VI or 6 x 4 Award one mark for 24.
1	(d)		W = PT = 50 x 2 x 60 = 6000 J	2	Award one mark for W = Pt or 50 x 2 x 60. Award one mark for 6000.
			Total	10	

Mark Scheme

Award full marks for a calculation when there is no working but the numerical answer is correct.

Question			Answer	Mark	Guidance
Question			**Answer**	**Mark**	**Guidance**
2	**(a)**	**(i)**		**2**	Award one mark for each correct component i.e. thermistor and signal lamp.
2	**(a)**	**(ii)**	With the thermistor when the temperature drops the resistance rises. (1) The thermistor and 10 K resistor act as a potential divider. (1) The thermistor resistance is higher than the 10 K resistance. (1) Current will flow into the base of the transistor, out of the emitter to the 0 V terminal. (1) The base current switches on the transistor and the signal lamp lights. (1)	**5**	Award one mark for each valid points up to a maximum of five. Award marks for a correct response that states ‘ temperature rises so resistance drops’ etc.
2	**(b)**		Applications: Used in: freezers and refrigerators washing machines	**3**	Award one mark each for three valid applications. Accept other correct responses..

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Question			Answer	Mark	Guidance
			electric cookers hair-driers microwave ovens food storage systems measuring the temperature of cooling water or oil in car monitoring the temperature of exhaust gasses controlling temperature inside a vehicle monitoring room temperature temperature stabilization of laser diodes and photoelements temperature compensation in copper coils temperature measurement and compensation in mobile phones		
			Total	**10**	

Mark Scheme

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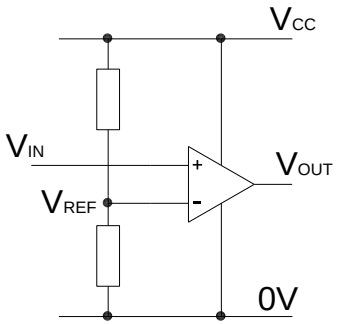
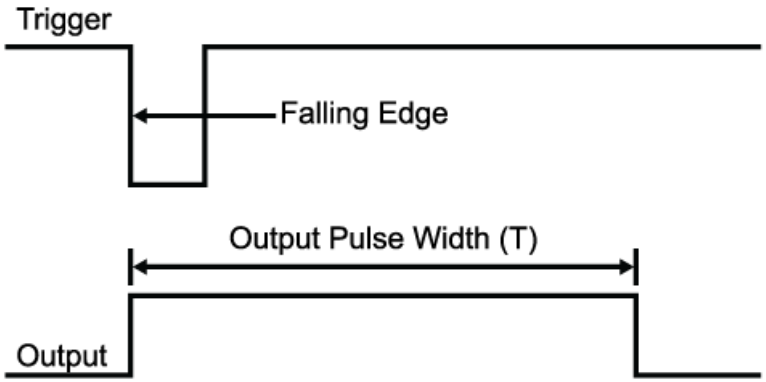
Question			Answer	Mark	Guidance
Question			**Answer**	**Mark**	**Guidance**
3	**(a)**		 The circuit amplifies the voltage difference between V_{IN} and V_{REF} and outputs the result at V_{OUT} (1) If V_{IN} is greater than V_{REF}, then voltage at V_{OUT} will rise to its positive saturation level; that is, to the voltage at the positive side. (1) If V_{IN} is lower than V_{REF}, then V_{OUT}, will fall to its negative saturation level, equal to the voltage at the negative side. (1)	**5**	Diagram: Award one mark for a correct potential divider and award one mark for a correct operational amplifier. Award one mark for each valid point up to a maximum of three.
3	**(b)**		A **monostable IC** is an electronic circuit that generates an output pulse. The trigger pulse is single short pulse starting high, going low and then returning to high. The single output pulse starts low, goes high for a period then returns to low.	**3**	Diagram: Award one mark for a correct potential divider and award one mark for a correct operational amplifier. Award one mark for each valid point up to a maximum of three.

Mark Scheme

Award full marks for a calculation when there is no working but the numerical answer is correct.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td> 
</td><td></td><td></td></tr>
<tr><td>3</td><td>(c)</td><td></td><td>
<table>
<tr><th>Input A</th><th>Input B</th><th>OR gate output</th><th>NOR gate output</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</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>1</td><td>0</td></tr>
</table>
</td><td>2</td><td>Award one mark for OR gate output column

Award one mark for NOR gate column</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>10</td><td></td></tr>
</table>

Mark Scheme

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Question			Answer	Mark	Guidance
Question			**Marks**	**Mark**	**Answer**
4	**(a)**		Logic probe Multimeter Power supply unit Signal generator	**4**	Award one mark for each correct response.
4	**(b)**		The correct sequence is 7, 3, **1**, 6, 2, 5 and 4	**6**	Award one mark for each correct response.
			Total	**10**	

Mark Scheme

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Question			Answer	Mark	Guidance
Question			**Guidance**	**Mark**	**Answer**
5	**(a)**	**(i)**	An RCD Safety Switch protects by constantly monitoring the current flowing in the Active and Neutral wires supplying equipment or circuits. (1) Under normal circumstances, the current flowing in the two wires is equal. An imbalance occurs if there is a fault. The RCD automatically cuts off the power before damage or injury can take place. (1) A leakage current can be detected in less than 20 ms. The RCD to earth will then disconnect the circuit from the supply to stop the flow of electric current through a person. (1)	**3**	
5	**(a)**	**(ii)**	By law, The 17th Edition of the IEE regulations states that circuits in domestic premises must be RCD-protected. (1) An RCD provides protection against an electric shock which could endanger life. (1) An RCD can provide some protection against electrical fires. (1) Overall the RCD is a safety device.	**3**	

Mark Scheme

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Question			Answer		Mark	Guidance
5	**(b)**		Smaller components can be used More components can be used on an equivalent area Initial costs are lower Fewer holes need to be drilled. Automated assembly is faster Small errors in component placement are corrected automatically Components can be placed on both sides of the circuit board. The mechanical performance under shake and vibration conditions is better Some SMT parts cost less than through hole parts.	**4**	Award one mark for each correct benefit up to a maximum of four.	
			Total	**10**		

Mark Scheme

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Question			Answer		Mark	Guidance
Question			**Guidance**	**Mark**	**Answer**	
6	**(a) ***		**Level 3 (5–6 marks)** • Detailed discussion showing a thorough understanding of the function and applications of a solenoid. • Information is presented clearly and accurately, with correct use of appropriate technical language and engineering terminology. • Accurate use of spelling, punctuation and grammar. **Level 2 (3–4 marks)** • Adequate discussion showing some understanding of the function and applications of a solenoid. • Information is presented clearly and with some accuracy. • Appropriate technical language and engineering terminology is used on some occasions. • Occasional errors in spelling, punctuation and grammar. **Level 1 (1–2 mark)** • Basic discussion showing limited understanding of the function and applications of a solenoid. • Information presented is basic and may be ambiguous or badly presented. • There will be little or no use of technical language and engineering terminology. • Errors of spelling, punctuation and grammar may be intrusive. **Level 0 (0 marks)**	**6**	Discussion points: **Function** • A **solenoid** is a coil of insulated wire wound on a rod-shaped form made of solid iron or solid steel • When electric current flows through that coil a magnetic field is generated and contacts are brought together to make an electrical connection • Contacts can be in different configurations, SPST, SPDT, DPDT etc. • The solenoid is sometimes called an electromagnet which allows it to control other systems • In the engineering industry, it is the term used to refer to solenoid valves. **Application** Solenoid valves are used • to actuate hydraulic or pneumatic valves • In devices that require locking, positioning, pinching, holding, rotating, diverting and valve operation • To control water pressure in sprinkler systems • To control air pressure in air conditioning systems • In agricultural irrigation equipment • In automatic locking mechanisms e.g. door locks for offices, hotels, and high security areas • In medical equipment e.g. a dialysis machine to control blood flow during dialysis • To deliver the correct dose of medicine / control the flow of medicine that goes into a person's blood stream. In cars a solenoid is used for:

Mark Scheme

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Question			Answer		Mark	Guidance
			• A response that is irrelevant and/or not worthy of a mark. • Annotate with 'Seen' at end of response.			• Interlocking in the gearbox drive selectors • Air conditioning controls • Entertainment release mechanisms • Security systems.
6	**(b)**		Light emitting diode (LED) LED 7 segment display Liquid crystal display module (LCD) Filament or signal lamp	**4**		Award one mark for each correct item up to a maximum of four marks.
			Total	**10**		

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