

Engineering

OCR Level 3 Principal Learning in Engineering **F559**

Unit **F559**: Instrumentation and Control Engineering

Mark Scheme for June 2013

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

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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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1. Annotations in scoris

The following annotations are available:

✓ = correct response

✗ = incorrect response

ecf = error carried forward

bod = benefit of doubt

Yellow square to indicate work has been seen

Plus other items available on scoris toolbar

Highlighting is also available to highlight any particular points on the script.

- 10 Please send a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the RM Cambridge Assessment Support Portal.

Your report should contain notes on particular strength displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

Extra information provided June 2013

ADDITIONAL OBJECTS: You **must** annotate the additional objects for each script you mark. If no credit is to be awarded for the additional object, please use annotation as agreed at the SSU, likely to be 'seen' or the highlighting tool.

CROSSED OUT, RUBRIC ERROR (OPTIONAL QUESTIONS) AND MULTIPLE RESPONSES

Crossed-out Responses: Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions: Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses: When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate). *When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

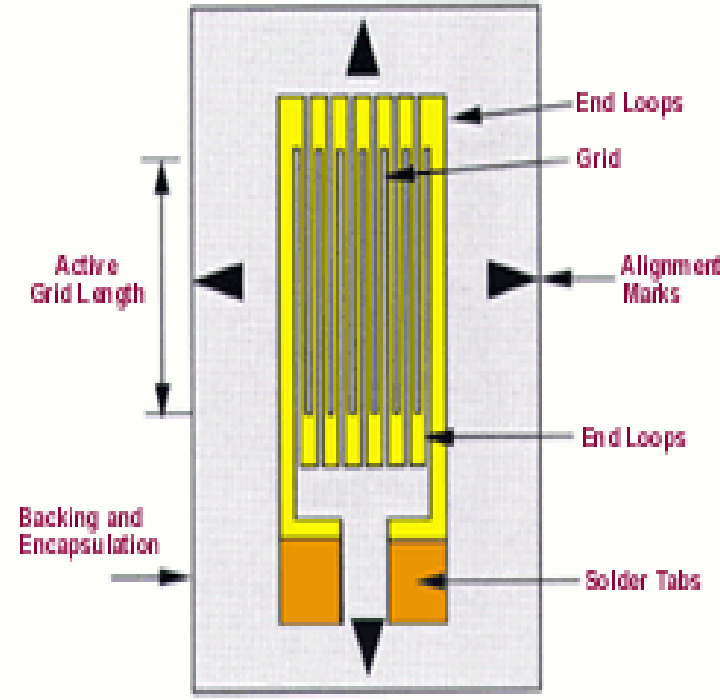
Contradictory Responses: When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

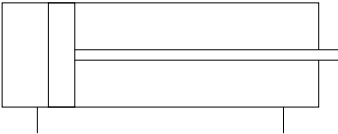
Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**): Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**): If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response): Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

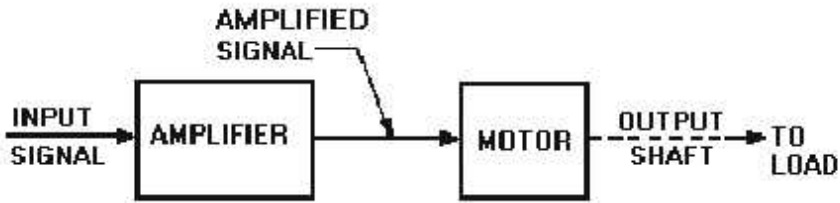
Section A

Question	Answer	Marks	Guidance
1	Potentiometer Thermistor Light dependent resistor Potential divider circuits Any type of switch	2	Award one mark for each correct input device.
2	A “closed loop system” has three blocks, input, control and output linked together with a built in checking system called feedback	1 1	Allow marks for understanding shown.
3		3	Diagram – award one mark for showing the grid and one mark for showing the end loops and solder tabs. Labels – award one mark for at least two labels.

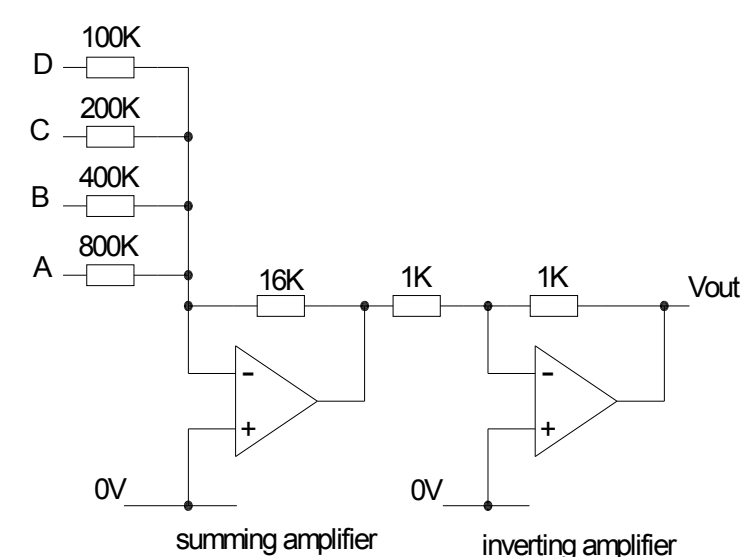
Question	Answer	Marks	Guidance
4	Bourdon tube Bellows gauge Diaphragm gauge Venturi Orifice plate	1	Accept other correct responses.
5	Overall gain $G = A/(1 + \beta A)$.	1	
6	Force = pressure x area = $400 \times 10^3 \times 0.005$ = 2000 N	1 2	Award one mark for the formula. Award one mark for the correct numerical value and one mark for the unit. Award three marks for correct answer with or without working.
7		2	Award one mark for a correct piston. Award one mark for the cylinder with two vents.
8	Traffic light control High speed counters Automatic machining stations Chemical batch production	2	Accept any two correct applications.

Question		Answer	Marks	Guidance
9		A software-defined system Not real instruments Computer generated to carry out the same functions as the real thing Software based on user requirements	2	Award one mark for each correct point made. Allow marks for understanding shown.
10		A control system is monitored to check that it: is doing what it is supposed to be doing operates effectively and efficiently does not lose time due to breakages	2	Award one mark for each correct point made. Allow marks for understanding shown.
Total			20	

Section B

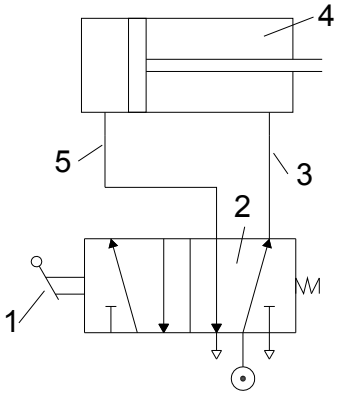
Question	Answer	Marks	Guidance
1 (a)	A block diagram shows the basic parts of a system and gives some detail about what each part has to do.	2	Allow marks for understanding shown.
(b)	 <p>MS Fig. 3</p>	2	<p>The block diagram shown is an example. Accept any correct block diagram that shows the basic elements of input, control and output.</p> <p>Award one mark for the blocks and one mark for the labels.</p>
(c) (i) (ii)	<p>A – Water level</p> <p>B – Water temperature</p>	1 1	Allow marks for understanding shown.
(c) (iii)	<p>A – This is a pressure sensor that keeps the control unit informed as to the pressure reached. The CU uses the information to decide when to close the water inlet valves.</p> <p>B – This is a temperature sensor which measures the water temperature and signals it to the CU. The CU compares it with the temperature needed. If the temperature is too low, the CU will switch on the heater. Once the correct temperature is reached the CU switches off.</p>	1 1 1 1	<p>Allow marks for understanding shown.</p> <p>Sensor A – Reward up to two marks for correct explanation</p> <p>Sensor B – reward up to two marks for a correct explanation</p>
	Total	10	

Question		Answer	Marks	Guidance
2	(a)	Negative feedback is when an output signal is fed back to the input and it opposes the input	1 1	Allow marks for understanding shown.
	(b)	Positional control Temperature control Servomechanism control	2	Accept any two correct responses. Accept other correct responses.
	(c)	Overall gain = $A/(1 + \beta A)$ = $20/(1 + [1/20] \times 20)$ = $20/2$ = 10	1 1	Award two marks for correct answer with or without working.
	(d)	Overall gain = $A/(1 + \beta A)$ $-20 = -40/(1 + 40\beta)$ $(1 + 40\beta) = -40/-20$ $(1 + 40\beta) = 2$ $40\beta = 2 - 1$ $40\beta = 1$ $\beta = 1/40$	1 1 1 1	Award four marks for correct answer with or without working.
Total			10	

Question		Answer	Marks	Guidance
4	(a)	An analogue signal is any continuous signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity	2	Allow 1 mark for graphical explanation.
	(b)	Compact Disc Players PC sound cards Digital speakers – USB speakers MP3 players	2	Accept any two correct applications. Accept other correct responses.
	(c)	<p>An example of a D/A converter is shown.</p> <p>Binary-Weighted DA converter.</p>  <p style="text-align: center;">summing amplifier inverting amplifier</p> <p>If a four-bit binary word is applied to the input resistors, the resistors produce binary currents ‘weighted’ according to the value of the word. In the weighted resistor ladder network, the resistance are inversely proportional to the numerical significance of the corresponding binary digit. So in this case we have 100K, 200K, 400K and 800K.</p>	2 4	<p>Allow marks for understanding shown. Accept alternative types of D/A converter.</p> <p>Award up to two marks for the diagram. and up to four marks for the description.</p> <p>Description must include reference to:</p> <ul style="list-style-type: none"> • Four-bit binary word A, B, C and D • Summing amplifier • Inverting amplifier • Analogue output <p>Award one mark for each correct point made.</p>

Question	Answer	Marks	Guidance
	<p>We have a reference voltage V_{ref} (not shown) and a summing amplifier that adds the current flowing in the resistive network to develop a signal that is proportional to the digital input.</p> <p>With the inverting amplifier the non-inverting input is connected to 0V. Both the input signal and the feedback signal are applied to the inverting terminal.</p> <p>The final process is for the inverting amplifier is to send out a continuous-time range of analogue signals.</p>		
	Total	10	

Question		Answer	Marks	Guidance
5	(a)	Electronics – An impulse or a fluctuating electrical quantity, such as voltage, current, or electric field strength, whose variations represent coded information	1 1	Allow marks for understanding shown.
	(b)	Input – small voltage or signal Output – larger voltage or signal	1 1	Accept 'amplified signal' for output
	(c)	Signal power may be reduced or lost The fields spread out around the wires Wires tend to act like an aerial Some of the power is radiated Resistance of the wire increases Signal becomes weaker and distorted Transfer is slow Reliability is reduced Signal replication is not precise	6	Allow marks for understanding shown. Award one mark for each correct point made up to a maximum of six marks.
		Total	10	

Question		Answer	Marks	Guidance
6	(a)	A pneumatic ram is a device that uses air to provide motion.	2	Allow marks for understanding shown. Award one mark for mentioning air and one mark for mentioning motion.
	(b)	Pneumatic actuator eg provides movement Ejecting components from a conveyor belt Date stamping on a package or carton Holding work in a vice Punching and pressing processes	2	Accept any two correct responses. Accept other correct responses.
	(c)	 <p>1. When the lever switch is not operated, the spring will restore the valve to its original position.</p> <p>2. From the position of the spring, one can deduce that the block is operating. The other block will not operate until the switch is pushed.</p> <p>3. Air pressure exists along this line because it is connected to the source of compressed air.</p> <p>4. As this cylinder cavity and piston rod are under the influence of pressure, the piston rod is in its restored position.</p> <p>5. The rear cylinder cavity and this line are connected to the exhaust, where air is released.</p>	2 1 1 1	Allow marks for understanding shown. Award one mark for a diagram and one mark for annotation. Up to four marks for the description. Description should include reference to any four numbers 1, 2, 3, 4 or 5 on the diagram.
Total			10	

Question		Answer	Marks	Guidance
7	(a)	At each stage of the operation the quality of the work is inspected. E.g. An arrangement of workers, machines, and equipment in which the product being assembled passes consecutively from operation to operation until completed.	1 1	Allow marks for understanding shown.
	(b)	Garage forecourt Domestic monitoring – security – baby monitor Hazardous process Power station – generation of electricity Air traffic control	2	Accept any two correct responses. Accept other correct responses.
	(c)	An embedded system is a <u>computer system</u> designed to perform one or a few dedicated functions often with <u>real-time computing</u> constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems are controlled by one or more main processing cores that are typically either <u>microcontrollers</u> or <u>digital signal processors</u> . The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processors. Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from <u>economies of scale</u> . Complexity varies from low, with a single <u>microcontroller</u> chip, to very high with multiple units, peripherals and networks mounted inside a large <u>chassis</u> or enclosure.	6	Allow marks for understanding shown. Description should include reference to: <ul style="list-style-type: none"> • embedded systems • dedicated functions • real time computing • function • purpose • reliability and performance. Award one mark for each correct point made up to a maximum of six marks.
Total			10	

Question		Answer	Marks	Guidance
8	(a)	<p>Circuit need not be physically built Simulation can be saved Less expensive – no need to purchase components Modifications are easier with a simulated circuit</p>	2	<p>Accept any two correct reasons. Accept other correct reasons.</p>
	(b)	<p>The CRO enables a variety of electrical signals to be observed and examined visually without connecting up a real circuit Tests can determine whether or not the circuit is fit for purpose Circuit can be modified and retested quicker than a real circuit Helps circuit designers test ideas before actually building real circuits, saving much time and money Relatively simple to use</p>	2	<p>Award one mark for each correct point made up to a maximum of two marks.</p>
	(c)	<p>Time Base There are two controls on the same spindle. One is calibrated in time/division and the other ranges from off to calibrate. Adjustment causes changes in the horizontal direction of the waveform. The time/division provides a selection of sweep rates e.g. 10ms/div i.e. allowing the horizontal scale to be changed.</p> <p>Frequency (X controls) The X gain allows the signal to be adjusted and expanded about the centre of the screen. The X shift control allows movement of the signal horizontally.</p> <p>Amplitude (Y controls) There are two controls on the same spindle. One is calibrated in V/div and can be adjusted to the appropriate value for the test being undertaken. The Y shift moves the signal up or down as the case may be.</p>	<p>1 1 1 1 1 1</p>	<p>Allow marks for understanding shown.</p>
Total			10	

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