

## **Principal Learning**

## **Engineering**

Unit **F559**: Instrumentation and Control Engineering

OCR Level 3 Principal Learning

## **Mark Scheme for June 2016**

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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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**Annotations in scoris**

The following annotations are available:

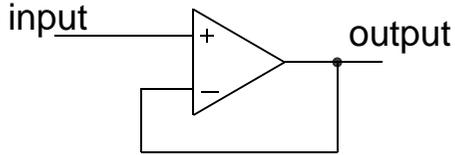
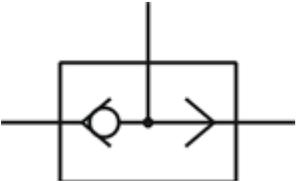
	correct response
	incorrect response
	error carried forward
	Benefit of doubt

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

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.

Question	Expected Answer	Mark	Rationale/Additional Guidance
A1	Closed loop systems will have feedback To reduce errors by automatically adjusting the systems input. To improve stability of an unstable system. To increase or reduce the systems sensitivity. To enhance robustness against external disturbances to the process. To produce a reliable, repeatable performance. Once started some systems do not require human intervention.	[2]	Award one mark for each correct characteristic.
A2	$G = V_{in}/V_{out}$ $= 100/10$ $= 10$	[1] [1]	Allow 10 V.
A3	<p style="text-align: center;">Digital signal</p>  <p style="text-align: center;">Analog signal</p> 	[1]  [1]	Accept any form of diagram that gives understanding.  Digital must be between logic 0 and logic1.

Question	Expected Answer	Mark	Rationale/Additional Guidance
A4	<div style="text-align: center;">  </div> <p>Buffer Amplifier</p>	<p>[1]</p> <p>[1]</p>	
A5	<p>A thermistor is a temperature sensing input device.</p> <p>When the temperature rises the resistance of the thermistor drops and vice versa.</p>	<p>[1]</p> <p>[1]</p>	
A6	<p>Flow control valve/throttle relief valve</p> <div style="text-align: center;">  </div> <p>Shuttle valve</p> <div style="text-align: center;">  </div>	<p>[1]</p> <p>[1]</p>	

Question		Expected Answer	Mark	Rationale/Additional Guidance
A7		Conductivity, capacitive, ultrasonic, radar, nucleonic, load cells, radiometric, microwave, hydrostatic and sonar e.g. pressure sensor/gauge, floating bob/ball cock, LDR or optical sensor.	[2]	Award one mark for each correct type of sensor. Award marks for named sensors.  Do not accept thermistor or strain gauge.
A8		Reliability - the probability that the system will <b>operate to an agreed level of performance</b> , for a specified period, subject to <b>specified environmental conditions</b> .	[1] [1]	
A9		Standard equipment for electronics troubleshooting and circuit design, a signal generator creates predictable <b>stable waveforms</b> over a range of frequencies to <b>mimic</b> the input signal of the device being tested.	[1] [1]	
A10		A multiplexer is used because it turns multiple signals into a single signal	[1] [1]	
		<b>Section A Total</b>	<b>[20]</b>	

SECTION B

Question			Expected Answer	Mark	Rationale/Additional Guidance
1	(a)	(i)	Closed Loop	[1]	
1	(a)	(ii)		[5]	Award one mark for each correct label.
1	(b)			[4]	Award one mark for at least two arrowheads. Award one mark for each correctly labelled block.
<b>Total</b>				<b>[10]</b>	

Question	Expected Answer	Mark	Rationale/Additional Guidance
2 (a)	<p>Open loop control – blocks are linked together end to end without a built in checking system.</p> <p><b>Examples</b></p> <p><b>Electric fire</b></p> <p><b>Light switch</b></p> <p>A <b>Closed-loop Control System</b>, also known as a <b>feedback control system</b> is a control system which uses the concept of an open loop system as its forward path but has one or more feedback loops.</p> <p>Examples            Positional control – pen plotter            Servo control – robotics            Temperature control - Industrial greenhouse</p> <p>If the feedback fraction is opposite in value or phase (“anti-phase”) to the input signal, then the feedback is said to be <b>Negative Feedback</b>.</p> <p>Examples            Central Heating system            Mercury thermostat            Centrifugal governor            Audio amplifier</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>	

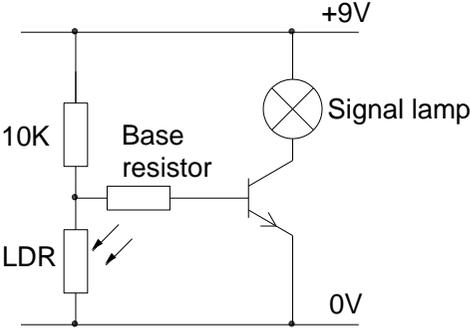
Question		Expected Answer	Mark	Rationale/Additional Guidance														
2	(b)	<p>Examples of input devices:</p> <table> <tr> <td>On/off switch</td> <td>Web Cam</td> </tr> <tr> <td>Keyboard</td> <td>Joy Stick</td> </tr> <tr> <td>Mouse</td> <td>Touch Screen</td> </tr> <tr> <td>Scanner</td> <td>Disk Drives</td> </tr> <tr> <td>Digital camera</td> <td>Track pad</td> </tr> <tr> <td>Joystick</td> <td>Voice</td> </tr> <tr> <td>Microphone</td> <td>Cloud</td> </tr> </table>	On/off switch	Web Cam	Keyboard	Joy Stick	Mouse	Touch Screen	Scanner	Disk Drives	Digital camera	Track pad	Joystick	Voice	Microphone	Cloud	[4]	<p>Award one mark for each correct input device.</p> <p>Accept any other correct responses.</p>
On/off switch	Web Cam																	
Keyboard	Joy Stick																	
Mouse	Touch Screen																	
Scanner	Disk Drives																	
Digital camera	Track pad																	
Joystick	Voice																	
Microphone	Cloud																	
		<b>Total</b>	<b>[10]</b>															

Question			Expected Answer	Mark	Rationale/Additional Guidance
3	(a)		1 Lever/foot lever	[1]	Accept
			2 Push/push button/press button	[1]	
			3 Standard or General	[1]	
3	(b)	(i)	5/2 directional control valve/5 port vave.	[1]	
3	(b)	(ii)	<p>Memory is a common basic function. It can keep a component at a certain state permanently until there is a change of signals.</p> <p>When control valve 1 is operated momentarily (that is, pressed for a short time), the output signal of the 5/2 directional control valve 3 will be set to ON.</p> <p>The signal will stay that way until control valve 2 is operated momentarily and generates another signal to replace it, causing it to stay permanently at OFF.</p>	[1] [1] [1] [1] [1]	
			<b>Total</b>	<b>[10]</b>	



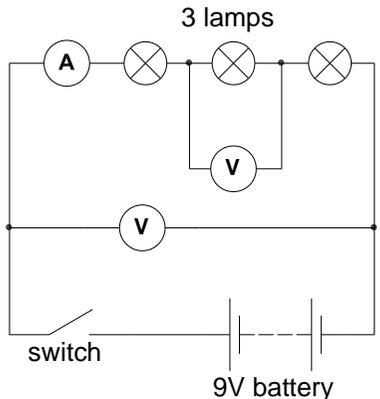
Question	Expected Answer	Mark	Rationale/Additional Guidance
5 (a)	<p>The orifice plate is the most common form of restriction that is used in flow measurement.</p> <p>An orifice plate is basically a thin metal plate with a hole bored in the centre.</p> <p>It has a tab on one side where the specification of the plate is stamped.</p> <p>The upstream side of the orifice plate usually has a sharp, edge.</p> <p>To measure the rate of flow by the differential pressure method, some form of restriction is placed in the pipeline to create a pressure drop. Since flow in the pipe must pass through a reduced area.</p> <p>The pressure before the restriction is higher than after or downstream.</p> <p>Such a reduction in pressure will cause an increase in the fluid velocity because the same amount of flow must take place before the restriction as after it.</p> <p>Velocity will vary directly with the flow and as the flow increases a greater pressure differential will occur across the restriction.</p> <p>So by measuring the differential pressure across a restriction, one can measure the rate of flow.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>	<p>Award up to six marks for valid points</p>

Question		Expected Answer	Mark	Rationale/Additional Guidance
	(b)	High differential pressure generated Exhaustive data available Low purchase price Low installation cost Easy replacement	[2]	Award one mark for each correct advantage.
	(c)	Venturi tube Rotameter Turbine meter	[2]	Award one mark for each correct response.  Accept any other correct response.
		<b>Total</b>	<b>[10]</b>	

Question		Expected Answer	Mark	Rationale/Additional Guidance
6	(a)	npn transistor	[1]	Accept bipolar transistor or specific part number
6	(b)		[3]	Award one mark for each correct symbol and position
6	(c)	<p>The LDR and the resistor act as a potential divider.</p> <p>During daylight the signal lamp will not light but as soon as it gets dark, the LDR resistance increases.</p> <p>Current to the base resistor increases.</p> <p>The base resistor will limit the current flow otherwise the transistor could be destroyed by overheating.</p> <p>This current flows into the base of the transistor forming the base emitter circuit.</p> <p>The base current switches on the transistor collector current which lights up the signal lamp.</p> <p>The 10K fixed resistor can be changed as required to alter the level of light required to turn on the signal lamp.</p>	[5]	<p>Award up to five marks for a description that includes reference to:</p> <ul style="list-style-type: none"> <li>• Potential divider</li> <li>• LDR</li> <li>• Base resistor</li> <li>• Transistor</li> <li>• Signal lamp.</li> </ul>

Question		Expected Answer	Mark	Rationale/Additional Guidance
6	(d)	Any form of lighting that depends on the LDR being activated by a level of darkness e.g. Street lamps.	[1]	Accept any other correct response.
<b>Total</b>			<b>[10]</b>	

Question		Expected Answer	Mark	Rationale/Additional Guidance
7	(a)	<p><b>Processor</b> : Processor (or CPU) is responsible for performing all the computer calculations and logical operations. Some processors called micro-processors have limited memory and few peripherals integrated on the same chip.</p> <p><b>Memory</b> : Memory is a device which can be used to store data or instructions in a system. An Embedded System can have on-chip fabricated inside the microprocessor, or off-chip memory or both.</p> <p><b>User Interface</b> : User Interface is a mechanism through which user can provide certain choices to the embedded system. These choices are used by the CPU to perform a given task in certain manner. A keypad is one of the most common user interfaces.</p> <p><b>Displays</b> : Displays are used to provide certain information to the user. Alpha numeric displays and LCD displays are widely used in embedded devices. These displays generally provide the 'User Menu' and 'System Status' to the User.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>	
7	(b)	<p>Cost size reliability development maintenance</p>	[2]	<p>Award one mark for each correct response.</p> <p>Accept any other correct response.</p>
		<b>Total</b>	<b>[10]</b>	

Question	Expected Answer	Mark	Rationale/Additional Guidance
8 (a)	Simulation can be saved Less expensive – no need to purchase components Modifications are easier with a simulated circuit. Probably safer when testing as compared to a real circuit. Circuit design can be converted for manufacture. Physically making the circuit requires equipment Circuits can be emailed to customer or manufacturer. Available to do anywhere.	[3]	Award one mark for each correct benefit up to a maximum of three marks.
8 (b)		[7]	Award one mark for each correct symbol and position for: (a) three lamps in series (b) cell (c) any type of correct switch.  Award one mark for: (a) an ammeter measuring total current (b) a voltmeter across a lamp. (c) a voltmeter measuring total potential difference.  Award one mark for correctly labelling the lamps, switch and the 9V battery.
	<b>Total</b>	<b>[10]</b>	

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